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Article

Effects of aerobic gymnastics exercise on humoral and cellular immunity response

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Abstract: To explore the effect of aerobic gymnastics on humoral immunity and cellular immune responses in college students. This article randomly selected 80 college students and divided them into an experimental group and a control group. The experimental group performed aerobic gymnastics training for three months, while the control group did not perform such exercises. By detecting immunoglobulin G (IgG), immunoglobulin M (IgM), immunoglobulin A (IgA), interleukin 2 (IL-2), interleukin 6 (IL-6) and white blood cell count (WBC) and other indicators to study changes in immune response. The results of the study showed that the humoral immunity and cellular immune response indicators of the students in the experimental group were improved, especially the white blood cell count and IL-2 levels were significantly improved. Aerobic exercise can increase the peripheral blood leukocyte levels of college students within the normal reference value range, enhance the body's non-specific immunity, and improve physical fitness.

Keywords: aerobic exercise; antioxidant; immune system; humoral immunity; cellular immunity

1. Introduction

Aerobic gymnastics exercise plays a very significant role in shaping the body, improving the body's aerobic metabolism, enhancing cardiopulmonary function, and promoting physical health. At present, aerobic gymnastics exercise is a popular sport in colleges and universities, and it tends to gradually become a new means of fitness and entertainment for college students. Aerobic gymnastics exercise for college students for a long time can enhance cardiopulmonary function, regulate nervous system, improve body shape and physical quality, and help college students to maintain a healthy body, healthy body shape and positive attitude. Physical activity has become more popular in recent years as a non-pharmacological means of inducing neuroprotection. For instance, numerous reports demonstrate improvements in the motor and non-motor symptoms of Parkinson's disease sufferers, the defense of dopaminergic neurons from toxicity, the prevention of toxic protein buildup in Alzheimer's disease, and other effects [1]. Ageing is intimately associated to the occurrence and development of a number of age-related diseases, such as cancer, type 2 diabetes mellitus, and cardiovascular and neurological diseases. Numerous theories have been put forth, even though the mechanics of ageing remain uncertain. Oxidative stress has been linked to both ageing and age-related disease, and it plays a role in the process of ageing [2]. Exercise is a well-known method for lowering Oxidative stress levels in older adults, but the connection between exercise and Oxidative stress depends on the type, level, and quantity of exercise. Aerobic gymnastics exercise also has a great significance to improve the immune function of the body. With the

improvement of modern living standards, people pay more and more attention to physical health. Appropriate aerobic exercise can help improve the structure and function of T cells, B cells, and macrophages. It significantly enhances the activity of certain receptors, making it easy to recognize the invasion of non-self-substances such as bacteria, viral proteins, cancer cells etc., so as to induce the body's cellular and humoral immune responses. Systematic aerobic exercise can improve the body's immune function and enhance physical fitness. Micronutrients maintain physical barriers (skin and mucosa), cellular immunity, and antibody synthesis, all of which are crucial to the body's natural defenses. It is vital to concentrate on the effect of aerobic exercise on the humoral immunity and cellular immunological response of college students in this study since the precise role of aerobic exercise in improving the immune function of the body is not sufficiently evident previously.

Aerobic gymnastics exercise is one of the favorite sports of the people, which can improve various functions of the body. There are also many college sports programs that offer aerobics-related classes. Abrantes [3] compared its effects on cardiorespiratory, hemodynamic, and perceptual variables using a reverse sequence of combined horizontal aerobic and resistance exercise during exercise and one hour after exercise. Yu [4] relied on artificial awareness for unique high-impact motion estimation in order to understand a preparation system that emphasizes aerobic, exercise-specific strength and quality in order to address the issue that traditional training system outcomes cannot be precisely evaluated, investigated, or dynamically examined. Wang [5] introduced the current situation of aerobics teaching and put forward the application of computer technology in aerobics teaching. Davenport [6] explored the effect of antenatal aerobic exercise on depression and anxiety during pregnancy and postpartum. In order to study how aerobic exercise can improve the quality of life, Wang [7] took patients with heart failure as experimental subjects and compared to study the path of aerobic gymnastics exercise to improve the physical function of patients. Many scholars have conducted comprehensive research on the impact of aerobics on physical health, but their research targets were different for different groups, and the duration of the research experiment was also different for different age. According to reports, aged persons have higher levels of Oxidative stress damage markers, which may be a result of aged mitochondria's increased generation of free radicals (also known as reactive oxygen species, or ROS) and diminished antioxidant defense [8]. Therefore, the conclusions drawn were not clear enough and there were even some completely opposite conclusions.

The study of the immune system has always been a hot topic in medical research. Jana [9] analyzed the effects of genetically modified foods on cellular immune responses. He focused on comparing IgE levels, proliferative activity of lymphocytes, phagocytic activity of granulocytes and monocytes, respiratory burst of phagocytes, phenotypic analysis of spleen, thymus and lymph node cells and cytokines produced by splenocytes in vitro. Almeida [10] investigated the efficacy of peptides as vaccines for the prevention of subcutaneous sporotrichosis. Fischer [11] found that a prime boost regimen using ChAdOx1-Lassa-GPC in guinea pigs significantly increased antigen-specific antibody titers and cleared live Lassa virus from tissues. Schmiedeke [12] investigated T cell subsets in the blood and lymphoid tissues of chickens from 1 to 21 days of age to comprehend their cellular composition and localization in order

to understand the development of immunity in chicks after hatching. To predict infection and comprehend the mechanism of viral infection between host cells, mathematical models and clinical research can be used. Fatini [13] used a viral infection model to describe the role of lytic and non-lytic immune responses. it has been observed that vitamin C consumption during a ten-week, five-day-per-week swimming exercise regimen in rats can reduce lipid peroxidation and raise levels of TAC, however it has no effect on enzyme and non-enzyme antioxidants or muscle injury [14]. Exercise and vitamin C have useful benefits on BP in persons with hypertension. Although there are many studies on cellular immunity and humoral immunity, there are not enough studies on the effects of aerobics on the immune response. The research is also not very in-depth.

The following are the novelties of this paper:

- This paper chose college students as the experiment's subjects based on the data that had been available. This not only resolved the issues of test sites and experimental data recording but also the issues of long-term studies and target tracking.
- In order to ensure the validity of the results, this article separately examined cellular immunity and humoral immunity in the immune system.

2. Aerobic gymnastics exercise and immune function

2.1. Immune system

The immune system is the protective system of the human body, which can capture and kill foreign antigens, remove senescent, dead and mutated cells, and maintain the stability of body functions as shown in **Figure 1**. Tumors develop as mutated cells escape the killing effects of the immune system. In addition to immune-related organs, immune cells and related molecules are also involved in the immune system. It can be classified into two categories based on the various modes of action: innate immunity, which can operate quickly, and adaptive immunity, such as an antigen-antibody interaction. There exist two categories of adaptive immunity: humoral immunity, in which B cell-secreted antibodies act as the primary force, and cellular immunity, in which T cells act as the primary source of cytotoxicity [15,16]. They both are essential components of the human immune response.

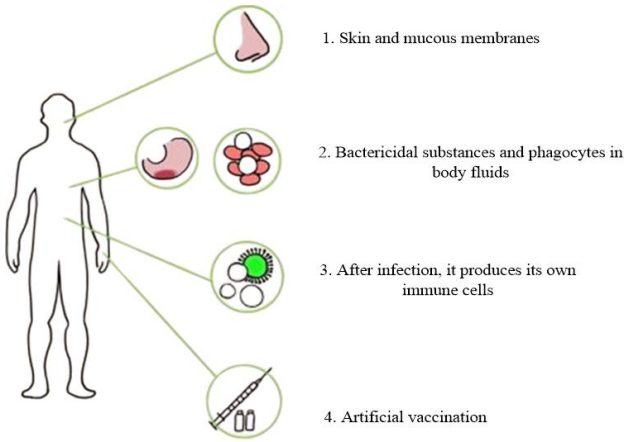

Figure 1. Human immune system.

Cellular immunity is a component of the human immune system and plays a major role in the adaptive immune response. The immune process is shown in **Figure 2**. The CD3+ molecule is expressed on the surface of all T cells, which is an important molecule that differentiates T cells from other immune-related cells. The CD4+/CD8+ ratios that are excessively high and inhibited NK cell function. Vitamin B12 supplementation reversed these effects, suggesting that it might function as a modulator of cellular immunity, particularly in respect to CD8+ and NK cells [17]. At the same time, according to the different antigens on the cell surface, T lymphocytes are divided into two categories: CD4+ and CD8+ T cells. CD4+ T cells can participate in immune responses by reacting with antigens and releasing corresponding cytokines. Cytotoxic T cells, on the other hand, play a cytotoxic function through the activation of cytokines and directly inactivate target cells. In addition to antigen presentation, B lymphocytes can also differentiate into memory B lymphocytes. When exposed to the same antigen again, it differentiates into plasma cells and secretes relevant antibodies to participate in the immune response. Natural killer cells are killer cells and do not require prior sensitization. They are directly activated after the interaction between activating and inhibitory signals in order to exert anti-tumor effect.

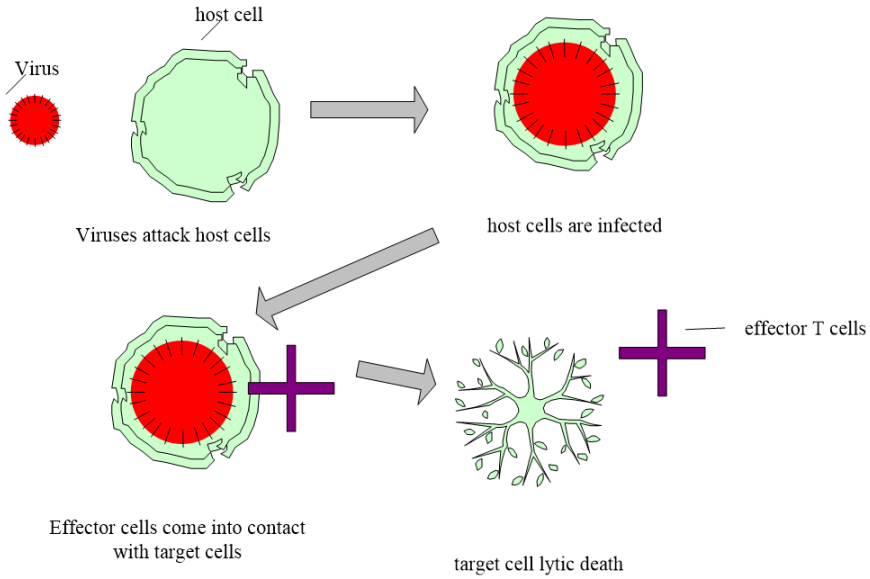

Figure 2. Cellular immune process.

Humoral immunity is a type of adaptive immunity. The complement system and plasma cells which are differentiated by B cells, create it to fulfill the objective of immunization. It is crucial for immunological stability, immune defense, and immune surveillance. **Figure 3** depicts its action procedure. Integral to innate immunity is complement, which cannot be disregarded. Innate and adaptive immunity can work together to successfully eradicate microbial infections and mutant cells from the body through the complement cascade. Blood contains the highest compliment, especially C3 and C4. In the cascade complement pathway, C3 is crucial. In a similar way, C4 promotes phagocytosis by encouraging the activity of macrophages and virus-neutralizing cells, both of which are important components of the complement system. Antibodies can neutralize and kill antigens in humoral immunity. It can bind to cell surface antigens and cooperate with T cells to kill infected and mutated cells. Most of

the diseases related to abnormal humoral immunity are currently related to IgA, IgG, and IgM [18,19]. Therefore, this paper mainly includes IgA, IgG, IgM and other related indicators for research.

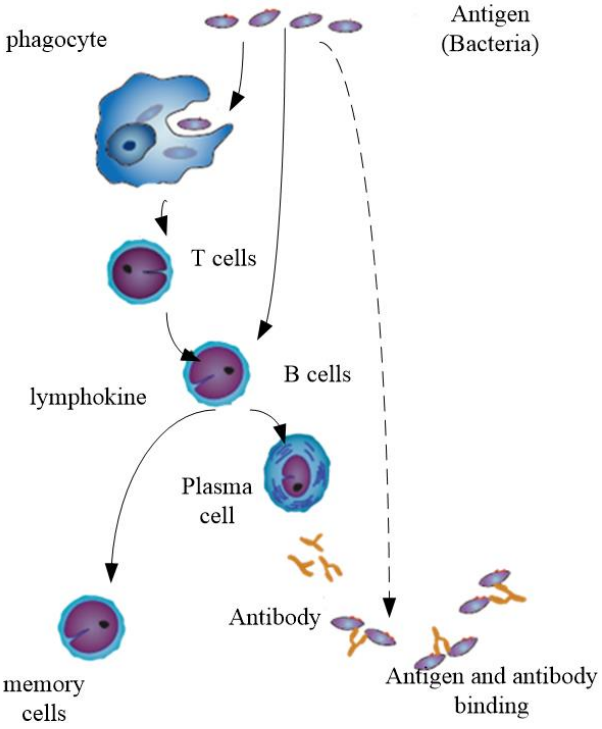

Figure 3. Humoral immunity.

IgM appears first in the body's immune response and is an important part of the primary immune response, while IgG is most abundant in the blood and is a key component of the secondary immune response. IgM can recognize tumor-modified cell surface antigens generated during tumorigenesis at an early stage. It has direct cytotoxic effect on tumor cells and can activate complement to kill mutant cells or induce apoptosis [20]. There are two main forms of IgA, namely secretory IgA (sIgA) and serum IgA. SIgA is mostly released by B cells in the lamina propria of a variety of epithelial cells such as breast epithelium, respiratory epithelium, digestive tract epithelium, etc. It has the functions of neutralizing antibodies, preventing pathogens from adhering to mucous membranes, and participating in local mucosal immune responses. It mainly plays a role in the mucosal area. The synthesis and secretion of IgA in serum is mainly affected by plasma cells in bone marrow, spleen and lymph nodes. The amount of IgA in serum is second only to IgG.

2.2. Aerobic exercises

The core of performing aerobics is "expressiveness and infection", and its main purpose is to enhance the atmosphere on the field and achieve resonance with the audience. Therefore, it has higher requirements on music, movements and formations, and pays attention to the performers' body language and expressions. A set of wonderful performance aerobics must achieve the perfect combination of music, movement, expressiveness and clothing. There are various forms of aerobics, as shown in **Figure 4**.

Figure 4. Various forms of aerobic exercises.

In this work, the aerobics exercise technique is used. Exercises that are aerobic can also be static. Yoga breathing can be beneficial for controlling the cerebral cortex, subcortical centre, and autonomic nervous system while stretching the limbs [21,22]. Many data have confirmed that the thymus, spleen, lymph nodes and other immune organs are all innervated by autonomic nerves. Immune cells have certain sensory functions and can sense allergens that cannot be sensed by the nervous system. Signals are transmitted to the brain and neuroendocrine system through immune neurotransmitters, so aerobic exercise can effectively improve the immune function of the body. Aerobic fitness operation is a rhythmic, uninterrupted aerobic exercise accompanied by music. The exercise intensity is controlled at about 60%. As a moderate-intensity exercise, the possible reason for the increase in leukocyte concentration is that exercise induces the innervation of the nervous system for regulatory factors such as catecholamines, cortisol, neuropeptides, and cytokines. In the process of exercise, the earliest and most obvious response is the increased secretion of catecholamines [11].

2.3. Performance equivalence

According to different product properties, there are two experimental schemes for performance equivalence comparison: (1) performance equivalence test for homogeneous samples and (2) performance equivalence test for non-homogeneous samples [23,24]. In this paper, the performance equivalence method is used to determine the index changes significantly before and after as the standard. It determines the effect of aerobics on the immune response indexes of college students.

(1) Comparison of Accuracy

The comparison of accuracy is actually the comparison of the mean of the new method and the original method. It mainly examines whether the absolute value $|\mu_D|$of the difference between the mean values of the two methods is less than a certain value d [25],

$$|\mu_D| = |\mu_N - \mu_O| < d \tag{1}$$

Among them, D and N are the representative symbols of different indicators. If the absolute value of the difference is less than d, it means that the two indicators are equivalent in accuracy. Its equivalence assumptions are as follows:

$$H_0: |\mu_N - \mu_O| \geq d \tag{2}$$

$$H_a: |\mu_N - \mu_O| < d \tag{3}$$

In fact, the alternative hypothesis H_a is two independent one-sided hypotheses is namely

$$H_{a1}: \mu_N - \mu_O < d \tag{4}$$

$$H_{a2}: \mu_N - \mu_O > -d \tag{5}$$

The graphical representation is shown in **Figure 5**:

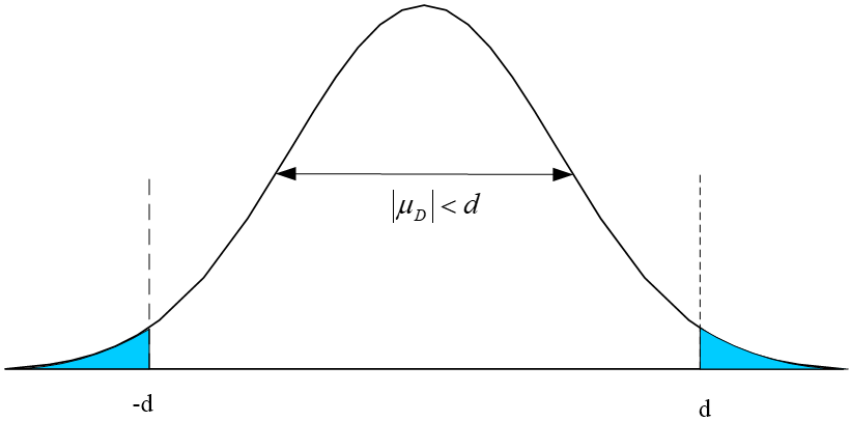

Figure 5. Schematic diagram of equivalence test.

When $|\mu_D| < d$, it means that the difference between the mean values is less than the fixed *d* value. At this time, H_0 can be rejected, and the new method is considered to be equivalent or better than the original method in terms of accuracy.

(2) Precision Comparison

The comparison of precision is actually the comparison of the standard deviation of the two methods. If the ratio of the standard deviations of the old and new methods is less than *k*, it means that the precision of the new method is not inferior to the precision of the original method [26]. Its non-inferiority assumptions are as follows:

$$H_0: \frac{\sigma_N}{\sigma_O} \geq k \tag{6}$$

$$H_a: \frac{\sigma_N}{\sigma_O} < k \tag{7}$$

The graphical representation is shown in **Figure 6**:

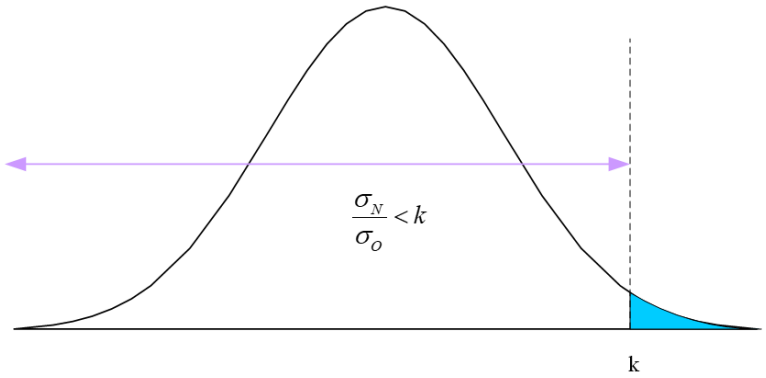

Figure 6. Schematic diagram of non-inferiority test.

When $\frac{\sigma_N}{\sigma_O} < k$, it means that the ratio of the mean to standard deviation is less than the fixed k value. At this time, H_0 can be rejected, and the new method is considered to be non-inferior to the original method in terms of precision.

(3) Determination of Sample Size and Power

In the performance comparison, according to the different experimental design schemes, the method of calculating the sample size is also different. Specifically, when the experimental scheme is a homogeneous and uniform sample, the calculation formulas of the sample size and efficiency are [27]:

$$n_N = n_O = 2\left[\frac{(z_{1-\alpha} + z_{1-\beta}) \times \sigma_0}{d - \mu_D}\right]^2 + 1 \tag{8}$$

$$1 - \beta = Pr\, F < \frac{\sigma_O^2 k^2}{\sigma_N^2} \times F_{\alpha:n_N-1,n_O-1} \tag{9}$$

Among them, $F_{\alpha:n_N-1,n_O-1}$ is the probability density function of the F distribution when the confidence level is α, the numerator degree of freedom is $n_N - 1$, and the denominator degree of freedom is $n_O - 1$.

When the experimental protocol uses a non-homogeneous uniform sample, the formulas for calculating the sample size and power are:

$$n = (1 + k^2)\left[\frac{(z_{1-\alpha} + z_{1-\beta}) \times \sigma_0}{d - \mu_D}\right]^2 + 1 \tag{10}$$

$$1 - \beta = Pr\, W < \frac{(k^2 + 1)\sigma_O^2 \times \chi^2_{\alpha:n-1}}{\sigma_O^2 + \sigma_N^2} \tag{11}$$

Among them, $\chi^2_{\alpha:n-1}$ is the chi-square probability density function when the confidence level is α and the degrees of freedom is $n-1$; W is a chi-square random variable when the degrees of freedom is $n-1$.

(4) Equivalence Test

When the experimental scheme used is a homogeneous sample, the calculation formula of the equivalence test is:

$$\bar{Y}_N - \bar{Y}_O \pm t_{1-\alpha:df}\sqrt{\frac{S_N^2}{n_N}+\frac{S_O^2}{n_O}} \tag{12}$$

The calculation formula of degrees of freedom *df* is:

$$df = \frac{\left(\frac{S_N^2}{n_N}+\frac{S_O^2}{n_O}\right)^2}{\frac{S_N^4}{n_N^2(n_N-1)}+\frac{S_O^4}{n_O^2(n_O-1)}} \tag{13}$$

When the experimental scheme used is heterogeneous samples, the equivalence test calculation formula is:

$$\bar{D} \pm t_{0.95:n-1}\sqrt{\frac{S_D^2}{n}} \tag{14}$$

If the equivalence interval calculated by the above two schemes is between the interval [−d, +d], it is very likely that the new method is equivalent in mean value compared with the original method [28].

(5) Non-inferiority Test

When the experimental scheme used is a homogeneous sample, the non-inferiority test calculation formula is:

$$U = \frac{S_N}{S_O}\sqrt{\frac{1}{F_{\alpha,n_N-1,n_O-1}}} \tag{15}$$

When the experimental protocol used is a heterogeneous sample, the non-inferiority test calculation formula is:

$$U = \sqrt{\frac{(n-1)S_D^2}{\sigma_O^2 \times \chi_{\alpha:n-1}^2}-1} \tag{16}$$

If the *U* value calculated by the above two schemes is less than the ratio *k* of the variances of the two methods, it is very likely that the new method is non-inferior to the old method in terms of standard deviation.

3. Experiment on the effect of aerobic exercise on the immunity of college students

3.1. Object of the experiment

When selecting experimental subjects, the researchers gave priority to college students as experimental samples, because college students usually have good physical fitness and regular work and rest, can better participate in the experimental process, and have a relatively concentrated age group, which helps to control age. and the impact of physical fitness on experimental results. In order to ensure the scientific nature of the experiment and the generalizability of the results, the proportion of male and female subjects in the experiment was balanced (20 boys and 20 girls), aiming to

reduce the possible interference caused by gender differences.

When selecting experimental subjects, the exercise group (Group A) selected students who voluntarily participated in aerobics exercise, and members of this group had no previous fixed high-intensity exercise habits to ensure that they received exercise intervention in the experiment. The control group (Group B) selected students who did not participate in moderate-intensity exercise such as yoga or aerobics to ensure that the activity level of the control group was significantly different from that of the experimental group. Members of each group were randomly selected from different departments to ensure the diversity and representativeness of the experimental samples, thus improving the reliability and external validity of the experimental results. The specific situation is shown in **Figure 7**.

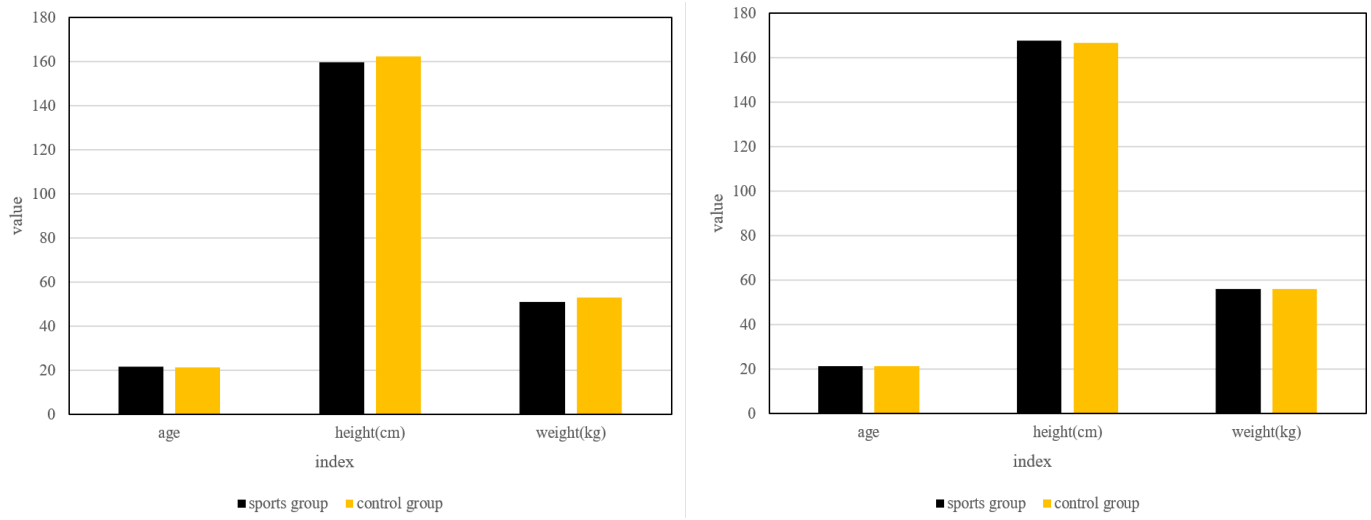

Figure 7. Basic information of students taking the test: **(a)** Male college student; **(b)** Female college students.

As shown in **Figure 7a,b**, the control group and the exercise group of male and female college students were comparable in age, height and weight and there was no difference in basic conditions.

3.2. Methods in the experiment

(1) Exercise Method

The heart rate was monitored by a qualified expert and professional using a heart rate monitor while the exercise was being conducted at a regulated intensity of roughly 60% of the maximum heart rate. Except for physical education, the pupils in the control group did not participate in any other amateur physical exercises. None of the individuals' daily routines, diets, or other factors changed.

(2) Collection of Samples

Before taking the test, all participants should be checked thoroughly to observe whether there are other diseases. Before performing aerobic exercise, professional medical staff collected blood samples from all subjects. Blood collection time is 7:00–7:30 in the morning. In a quiet fasting state, 5ml of blood was taken from the cubital vein under sterile conditions. After natural coagulation, the serum was centrifuged and frozen (−84 °C) for later use. The blood samples were divided into two groups: the

exercise group was the aerobic exercise group, and the control group was the group that did not participate in any physical exercise except physical education. After 120 days of systematic exercise, the same experimental operation as above was performed on all participants.

(3) Indicator Detection and Method

The testing indicators and testing instruments are shown in **Tables1** and **2**:

Table 1. Detection and instrumentation of cellular immune indicators.

Serial number	Monitoring indicators	Testing equipment
1	IL-2	T-Counter (State-run 262 Factory)
2	IL-6	T-Counter (State-run 262 Factory)
3	WBC	Three-part hematology analyzer

Table 2. Humoral immune index detection and instruments.

Serial number	Monitoring indicators	Testing equipment
1	IgG	T-Counter (State-run 262 Factory)
2	IgM	T-Counter (State-run 262 Factory)
3	IgA	T-Counter (State-run 262 Factory)

The IL-2 and IL-6 kits were purchased from the Institute of Radioimmunology of the Chinese People's Liberation Army (Beijing). The immunoglobulin G kit was purchased from Tianjin Jiuding Biotechnology Co., Ltd. The white blood cell kit was purchased from Jining Biotechnology. In order to reduce systematic errors, the detection of each index in this experiment was completed independently.

3.3. Results

(1) Changes of Cellular Immune Indexes before and after Students Exercise

The T test was used to statistically analyze the changes in students' indicators before and after exercise. It can be seen from the comparison between **Table 3** and **Figure 8** that there were no significant changes in the two immune indexes of IL-2 and IL-6 in the control group before and after the experiment. The students in the exercise group had considerable higher levels of IL-2 and IL-6 after three months of alternating aerobic exercise than they had before the trial. In comparison to prior exercise, the IL-2 index was considerably higher among them. After three months of exercise, the exercise group's levels of IL-2 and IL-6 and other immunological indices were considerably higher than those in the control group. When compared to the control group, the students in the exercise group's IL-2 index dramatically rose. This demonstrated that college students' immune systems may be strengthened by engaging in aerobic exercise, which raises levels of IL-2 and IL-6 in the body.

Table 3 shows that there is no significant change in the WBC level of the students in the control group, which is on the decline both before and after exercise. Following the aerobic exercise, the WBC of the students in the exercise group considerably increased ($p < 0.05$). After three months of exercise, the students in the exercise group had significantly higher levels of WBC in their immunological indices ($p < 0.05$) than the students in the control group. This demonstrated that college students' immune

systems might be strengthened by aerobic exercise by raising their WBC levels in peripheral blood, which are now within the normal reference value range.

Table 3. Cellular immune indicators before the experiment.

index	male		female	
	Exercise group	**Control group**	**Exercise group**	**Control group**
IL-2(ng/mL)	3.954 ± 1.3	3.963 ± 1.2	3.962 ± 1.2	3.932 ± 1.3
IL-6(pg/mL)	105.996 ± 16.5	105.986 ± 17.1	104.954 ± 17. 4	102.3 ± 15.2
WBC(×l0^9/mL)	5.63 ± 0.5	5.65 ± 0.3	5.42 ± 0.9	5.40 ± 0.7

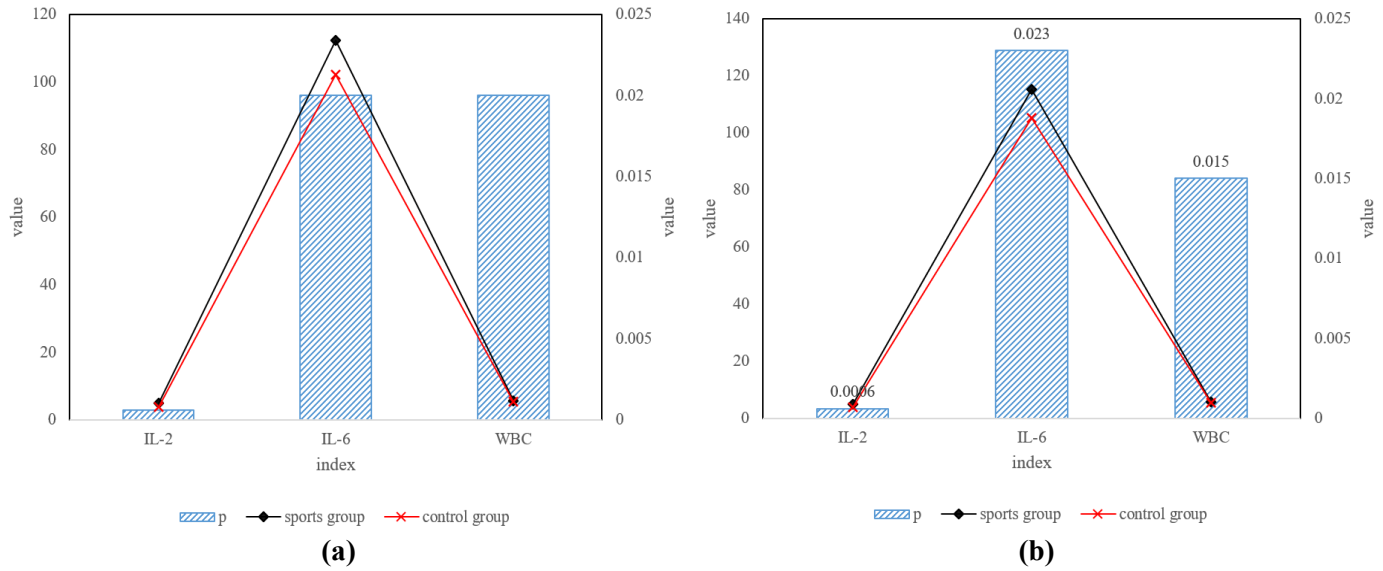

Figure 8. Changes of cellular immune indexes in the exercise group and the control group after the experiment: **(a)** Changes in girls after the experiment; **(b)** Changes in boys after the experiment.

Figure 8a showed the changes after the experiment for girls and **Figure 8b** showed the changes after the experiment for boys. Both boys and girls showed an upward trend in cellular immunity indicators.

(2) Changes of Humoral Immune Indexes before and after Students Exercise

As shown in **Table 4**, there was no significant difference in various humoral immune indexes between the exercise group and the control group before the experiment. The comparison between **Table 4** and **Figure 9** shows that the IgG of the female group (**Figure 9a**) increased by 2.17% ($p = 0.05$), with a significant difference. IgM was significantly increased ($P < 0.001$), and IgA was also significantly increased ($P < 0.01$). As shown in **Figure 9b**, after 3 months of exercise, the p-values of humoral immune indexes IgG, IgM, and IgA were 0.04 (< 0.05), 0.0008 (< 0.001), and 0.005 (< 0.01) respectively all of which were significantly increased. This showed that aerobic exercises can improve the body's IgG, IgM, IgA content, and enhance the body's immunity.

Table 4. Cellular immune indicators before the experiment.

index	male		female	
	Exercise group	**Control group**	**Exercise group**	**Control group**
IgG (mg/mL) 7–16	10.541 ± 1.5	10.654 ± 1.5	9.962 ± 1.2	9.932 ± 1.3
IgM (mg/mL) 0.7–2.3	1.57 ± 0.6	1.598 ± 0.5	1.495 ± 0.4	1.364 ± 0.5
IgA (mg/mL) 0.7–4	2.637 ± 0.9	2.65 ± 1.2	2.67 ± 1.3	2.66 ± 1.2

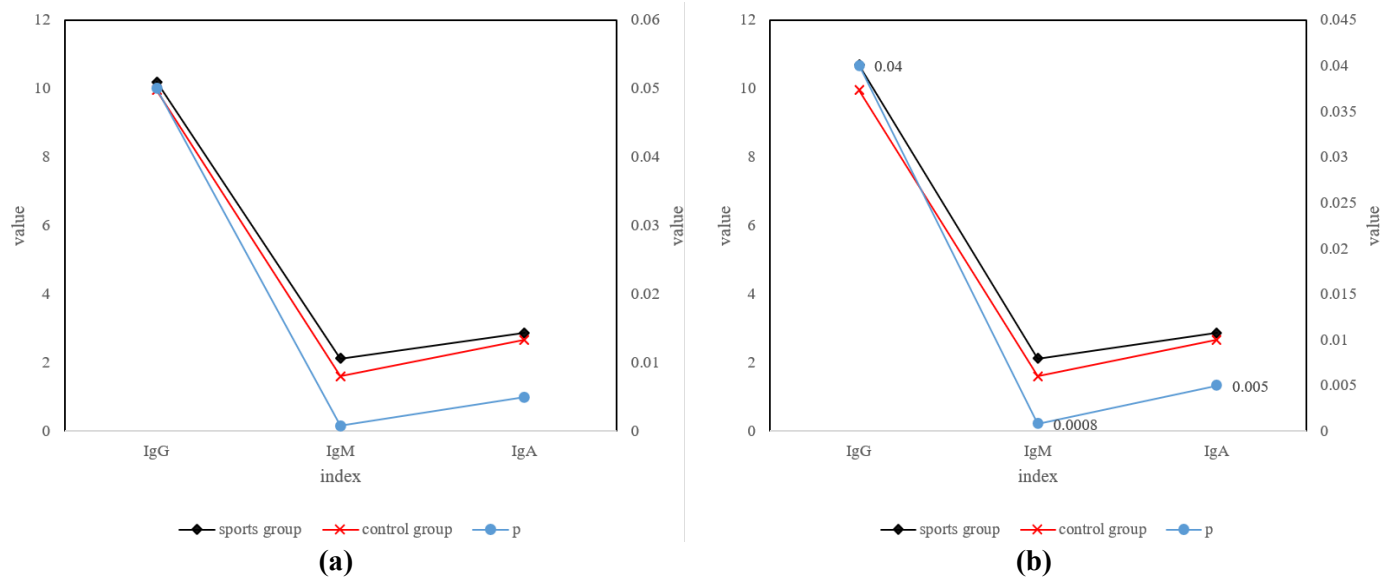

Figure 9. Changes of humoral immune indexes in the exercise group and the control group after the experiment. **(a)** Situation of the girls group; **(b)** situation of the boys group.

(3) Differences in Training Effects between Boys and Girls

The experiment in this paper is divided into boys and girls groups to compare that the boys and girls doing aerobic exercises can improve the immune system differently. The results are shown in **Figure 10**.

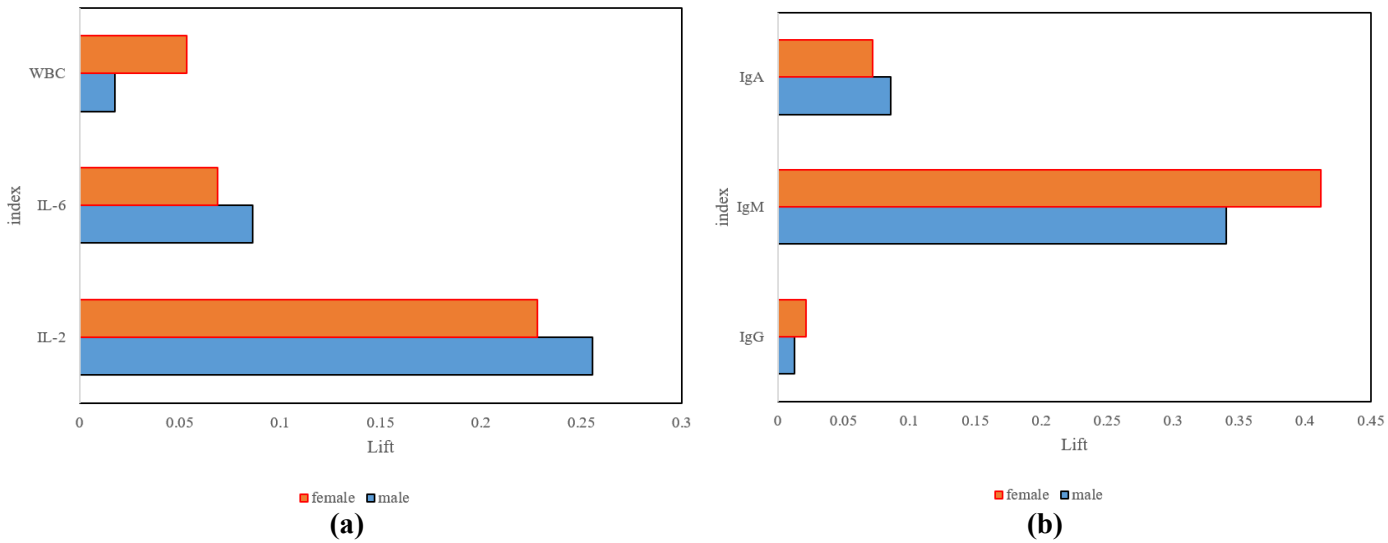

Figure 10. Comparison of training effects between boys and girls. **(a)** Cellular immune indicators; **(b)** humoral immune index.

As shown in **Figure 10a**, compared with girls, the increase of cellular immunity index was greater in boys who practiced aerobic exercises, but the increase in white blood cell count was smaller than that of girls. As evident from **Figure 10b**, compared with girls, boys who performed aerobic aerobics training had a smaller increase in IgA and IgM indexes of humoral immunity, but a larger increase in IgG index. In general, aerobic exercises for boys and girls can effectively improve their own cellular immunity and humoral immunity. The magnitude of the increase in the index is also related to gender but the effect is not large.

4. Discussion

The humoral immune response plays an important protective role during infection with many pathogens. In the process of chronic pathogen infection, a variety of cytokines can induce the activation of germinal centers and promote the differentiation of B cells into memory B cells. It has been suggested [5] that nutritional status plays a role in the deregulation of the immune response that comes with ageing. Vitamin E, a lipid-soluble antioxidant, is crucial for the immune system's healthy operation. The risk of consuming less vitamin E than is advised is higher in the elderly. When re-infected with the same pathogen, these memory B cells would rapidly differentiate into plasma cells to produce antibodies, so as to against pathogen infection [7]. NK cell activity was inhibited, and the CD4+/CD8+ ratio was abnormally high. These effects were reversed by vitamin B12 supplementation, suggesting that it may have a modulatory influence on cellular immunity, particularly in relation to CD8+ and NK cells [6]. Zinc supplementation boosts antibody responses, the amount of cytotoxic CD8+T cells, and cellular aspects of innate immunity (such as phagocytosis by neutrophils and macrophages, NK cell activity, production of oxidative burst, and DTH activity) (Th1 response). In the experimental part, the levels of IgG, IgM, IgA before and after exercise were analyzed. T cells play a central role in the protection of chronic infectious diseases such as malaria. Clinical interventions like drug therapy also focus on the treatment of various chronic infectious diseases by stimulating the body to generate a long-lasting T cell response. Persistent malaria infection can promote the differentiation and proliferation of central memory T cells (Tcm) and effector memory T cells (Tem). Low-level chronic plasmodium infection can directly promote Tem cell proliferation, or Tem expansion can be achieved by stimulating Tcm cells to produce Tem cells. Activated memory T cells can remain in lymphoid organs to assist in B cell-mediated immune processes, or they can migrate to sites of infection to directly participate in anti-infection processes.

Moderate exercise can increase the body's white blood cell count and enhance immune function. High-intensity exercise training can cause immune suppression, decrease white blood cell count, and decrease immune function. According to the study's findings, there was no discernible change between the students in the exercise group and the control group's peripheral blood WBC before exercise. The level of WBC in the peripheral blood of the students in the exercise group group was significantly higher than that in the control group after 3 months of alternating between yoga and aerobic exercises ($p < 0.05$); the level of WBC in the control group was significantly higher after 3 months of exercise ($p < 0.05$) than it had been before,

demonstrating that both aerobic exercises and yoga can raise WBC levels in the body's peripheral blood.

Aerobic exercises and yoga exercise alternately can be well integrated in terms of exercise intensity, exercise mode and exercise interest to improve the body's immune function. A study has pointed out that glutamine is an important energy-supplying substance for white blood cells. The impact of dietary glutamine on gene expressions linked to oxidative stress and tissue oxidative damage in diabetes. Most of the synthesis of glutamine in the body is done in the muscles. This substance is important for the synthesis of white blood cells. It appears that antioxidant supplements like vitamin C (ascorbic acid) are crucial for regulating blood pressure. Cells are protected by ascorbic acid against oxidative stress [29]. The intensity of aerobic exercise is moderate, but it would cause a certain degree of damage to the muscles and hinder the utilization of glutamine by white blood cells. However, if the two exercises are performed alternately, yoga can effectively alleviate the impact of aerobics on the muscles. Therefore, the alternate practice of aerobic aerobics and yoga can effectively improve the level of peripheral blood WBC. The students in the control group did not participate in physical exercise during the three-month period. Now the college students are under huge study pressure that leads to greater psychological pressure. This in turn inhibits the body's immune function resulting in a decrease of the number of white blood cells.

The findings of this study demonstrated that after three months of consistent exercise, the students in the exercise group had blood IL-2 levels that were considerably better than they had been before the experimental exercise. When compared to before the experimental activity, the students' blood IL-2 content in control group did not significantly alter. After the trial, the IL-2 content of the exercise group students was considerably greater than that of the control group students ($p < 0.001$), showing that aerobic exercise can raise college students' blood IL-2 levels.

IL-2 is closely related to natural killer cells. The proper increase of IL-2 secretion can improve the activity and functional network of natural killer cells. Natural killer cells are an important immune regulatory cell which plays a key role in the body's early immune defense against viral infections and the surveillance process of early non-specific killing of mutant tumor cells. Yoga practice can relieve students' depression and anxiety in study and life, weaken the activity of the sympathetic nervous system and the release of catecholamines, thereby improving the level of IL-2 in the body and enhancing the immune capacity of the body. Alternating practice of the two sports can significantly increase the level of serum IL-2 and enhance the immune function of the body.

Aerobic exercise enhances the function of the immune system through various mechanisms, mainly by increasing the activity and number of immune cells. Studies have shown that aerobic exercise can promote the increase in the number of natural killer cells (NK cells), T cells and B cells in peripheral blood, while enhancing their killing function and cytokine secretion capacity. Long-term aerobic exercise training can also improve the distribution of lymphocytes, enabling immune cells to more effectively identify and eliminate pathogenic microorganisms and tumor cells in the body. In addition, aerobic exercise also regulates the balance of the immune system by reducing chronic inflammatory responses, reduces excessive immune responses,

and prevents abnormal activation of the immune system and the occurrence of autoimmune diseases.

Aerobic exercise also further promotes the improvement of immune function by improving the physiological state of the body. During exercise, blood circulation is accelerated, and the oxygen and nutrient supply to tissues is improved, thereby enhancing the immune system's ability to fight infection. At the same time, aerobic exercise can regulate hormone levels, such as increasing the secretion of adrenaline and cortisol, which help regulate the intensity of immune responses and optimize the function of immune cells. By reducing the stress level in the body and improving mental health, aerobic exercise can also alleviate the negative impact of psychological stress on the immune system and enhance the body's immune defense capabilities. Therefore, aerobic exercise not only plays a role in improving the function of immune cells, but also comprehensively improves the efficiency of the immune system by improving overall physiological and mental health.

5. Conclusion

In current study the effects of aerobic exercise on the humoral and cellular immune responses are explored in young age people. Since there is growing evidence that regular exercise boosts cellular antioxidant defenses by activating NRF2 signalling, antioxidant defenses state may also change prior to a humoral immune response. In this regard an experimental study is conducted among 80 college students where test was done before and after exercise, this paper found that aerobic exercises can increase the level of WBC in the peripheral blood of college students within the normal reference value range. It can enhance the body's non-specific immunity, improve the physical quality and the ability to fight disease of college students. Aerobic exercises can increase the serum IgG, IgM and IgA content of college students which is much significant for enhancing humoral immunity. Aerobic exercises can improve the serum IL-2 and IL-6 levels of college students and enhance the immune function of the body. One could say that the outcomes of the research study were largely satisfactory. However, the article's sample set is restricted to students from a single school, and the sampling error is substantial. Consequently, the sample size would be increased in the subsequent study to reach more general results in future.

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