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Article

Advanced resistance exercise combined with aerobic rehabilitation training on cardiopulmonary function

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Abstract: Chronic diseases are the number one killer in the world today, and the most common cause of chronic diseases is lack of exercise. Research on the application of artificial intelligence technology in the medical field can shorten the distance between clinical best practice and practical application, and promote the standardized management of clinicians according to specifications. In this paper, three different exercise methods, continuous aerobic, anaerobic, and control, were used to conduct a 12-week study. This paper discussed the effects of three different forms of exercise on the body shape, body composition, and metabolism of patients with chronic diseases, and discussed the intervention effects of the same exercise mode in different periods (0–6 weeks, 6–12 weeks), to provide a theoretical basis for more effective and targeted choice of exercise intervention programs. Through training load, training frequency, training sequence, training interval, and other factors, a training plan can be designed. To avoid mistakes, experts often try to do some items that are prone to mistakes, especially lung function measurement. The scores of self-care, extraction, standing, occupation/housework, social activities, and total scores were significantly lower than those before intervention ($P < 0.01$). Advanced resistance kinetic energy can significantly improve the exercise and cardiopulmonary function of patients with various types of chronic diseases. Advanced resistance kinetic energy can significantly promote the strength and explosive force of the shoulder, waist, and back muscles in chronic patients, and can significantly promote the muscle adaptability of the shoulder, waist, and back muscles in chronic patients.

Keywords: advanced resistance exercise; patients with chronic diseases; cardiopulmonary function; artistic intelligence

1. Introduction

Cardiovascular disease is a disease that endangers human health, and its mortality and disability rates are extremely high. Although the therapeutic effect of drugs on heart failure has been very good, the prognosis of patients is not very good. This is related to heart function, exercise endurance, anxiety, depression, and other factors. In recent years, with the gradual deepening of people's understanding of the progressive and multifactorial correlation of chronic diseases, secondary prevention for patients with chronic heart failure has also been gradually emphasized. Therefore, cardiac rehabilitation has become a new adjuvant drug therapy, and exercise rehabilitation is an important part of cardiac rehabilitation. Exercise therapy can delay the progress of the disease and reduce the incidence of malignant cardiovascular disease by preventing long-term bedridden complications, improving symptoms, and improving quality of life. Although many experts actively recommend exercise therapy, there are still doubts about its efficacy and safety in practical work. With the development of medical informatization, the application of medical health big data and artificial intelligence technology has been realized. Through a cardiopulmonary exercise experiment, the chronic cardiopulmonary function was comprehensively evaluated. According to the exercise function of the patient, the corresponding exercise program can be formulated, exercise training can be carried out, and the cardiopulmonary function, exercise endurance, and quality of life can be evaluated. Circulatory resistance training is mainly about diabetes, cardiocerebrovascular disease, obesity, and other middle-aged and elderly groups, but there is relatively little research on cardiopulmonary function. Shimomoto Yuta thought that the influence on cardiopulmonary exercise tests was still unclear. He obtained patient data, including patient characteristics, cardiac function, anesthesia data, and laboratory data, and believed that the cardiopulmonary function was the same as that before discharge [1]. Pugliese Nicola Riccardo believed that the cardiopulmonary exercise test is the gold standard for non-invasive estimation of peak oxygen consumption. To improve the analysis of the mechanism behind intolerance, he examined whether the measurement of exercise pressure echocardiography was related to the peak value of vanadium dioxide (VO2) directly measured during exercise in a large number of patients with heart failure spectrum [2]. Ibeneme believed that cardiopulmonary dysfunction was considered to be the main cause of death in patients with advanced Parkinson's disease. Aerobic exercise has been proven to improve the lung function of asthma patients and healthy people [3]. Lim Hee Sung aimed to explore the effect of improved Pilates exercise on the cardiopulmonary function of patients with chronic stroke. He believed that the 8-week improved Pilates exercise plan could have a positive impact on patients with chronic stroke by enhancing their cardiopulmonary function [4]. Jin Qi's immediate impact on cardiopulmonary function was rarely evaluated. He aimed to determine the safety and effectiveness of bisphenol A and its immediate and lasting effects on cardiopulmonary function in patients with chronic thromboembolic pulmonary hypertension [5]. The cardiopulmonary function test proposed by them is not very comprehensive. Advanced resistance exercise is introduced to optimize it. Advanced resistance exercise is widely used in clinical rehabilitation. Abu-Tair Tariq's study included 99 other healthy pectus excavatum patients. They received cardiopulmonary exercise tests and magnetic resonance imaging during inspiration and expiration to correlate cardiopulmonary function with the classification of chest malformations [6]. Chi Rui believed that many studies have explored the relationship between outdoor or indoor fine particulate matter (PM2.5) and health effects. He believed that exposure to indoor and outdoor PM2.5 has different health effects on the cardiopulmonary function of different populations [7]. Zens Tiffany J believed that the repair of pectus excavatum was beneficial to beauty, but the physiological effect was still controversial. The purpose of his research was to describe the relationship between the degree of pectus excavatum found in cardiac magnetic resonance imaging and cardiopulmonary exercise testing and cardiopulmonary dysfunction. His regression model evaluated the relationship between the pectoral muscle index and the clinical endpoint of cardiopulmonary function [8]. Shirai Hisaya believed that the correlation between preoperative cardiopulmonary function and myocytopenia in patients with hepatocellular carcinoma (HCC) undergoing hepatectomy was still unclear. He studied and investigated the effect of preoperative muscle loss on cardiopulmonary function in 402 patients indirectly undergoing the first hepatectomy for hepatocellular carcinoma from April 2005 to April 2015 [9]. Li believed that cardiopulmonary dysfunction caused by spinal cord injury seriously affects the rehabilitation and daily life of patients [10]. However, the advanced resistance motion proposed by them is not very effective.

In recent years, many foreign experts and scholars have attached importance to the recovery of lung function and have conducted a lot of research on it. At present, early intervention of most pulmonary diseases, especially for patients with chronic pulmonary diseases, can achieve good results by early lung rehabilitation treatment. However, before, during, and after rehabilitation, how to evaluate the effect of lung rehabilitation and whether to correct problems should be correctly evaluated. The focus of chronic diseases is limited to the lungs, and its main symptom is to limit the ventilation and diffusion functions, which leads to a decline in exercise tolerance, thus adversely affecting the quality of life. Therefore, most scholars believe that lung function, exercise endurance, and quality of life are comprehensive evaluations of the therapeutic effects of chronic diseases. Human vision can be regarded as a whole, which is composed of three functional axes: respiration, circulation, and metabolism. All organs and systems work together to realize the progress of oxygen, nutrients, and metabolism, provide power for the life activities of the body, and maintain the dynamic balance within the body. Based on the cardiopulmonary exercise experiment, this paper evaluates the comprehensive functions of the heart, lungs, metabolism, etc. of patients with chronic diseases, and determines their exercise frequency through continuous dynamic multi-function monitoring, to obtain a comprehensive and accurate individualized exercise prescription. The second is active exercise, followed by passive exercise, muscle resistance, and flexibility exercise. At the same time, people should pay attention to diet, work and rest, lifestyle, etc. There was no significant difference between the rehabilitation group and the control group ($P > 0.05$).

2. Methods for influencing factors of cardiopulmonary function of patients with chronic diseases under background of artificial intelligence

2.1. Cardiopulmonary function

The cardiopulmonary exercise experiment is the only test method that can objectively, quantitatively, and non-invasive evaluate the functional state of the human heart and lungs. It focuses on the coordination and ventilation of lung function of each sports center, and the coupling of external respiration and cell respiration to measure external respiration, to reflect the function of various tissues, organs, and systems of the body. Cardiopulmonary exercise has many clinical applications, mainly including differential diagnosis of unexplained dyspnea and decreased exercise tolerance; evaluation of the cardiac function of patients with heart disease, including the classification of heart disease, preoperative and postoperative monitoring, and prognosis prediction; prognosis evaluation, auxiliary diagnosis, and efficacy monitoring; evaluation of the effect of drugs, surgery, instruments, and interventional surgery; surgical risk assessment and postoperative patient management; loss of labor capacity; evaluation sports risk, formulate sports prescriptions, and evaluating the effect of sports rehabilitation, which could provide the basis for rehabilitation treatment. Cardiac rehabilitation centers and home cardiac rehabilitation therapy have similar effects on improving patients' cardiopulmonary function, psychology, and quality of life, with special attention paid to environmental problems related to cardiopulmonary function [11].

At present, the commonly used ECG, pulmonary function, and other function detection technologies mainly detect the cardiopulmonary function in the resting state, and the main organs of the human body usually have large functional reserves. In the process of exercise, to ensure the oxygen and energy required by muscles, the blood flow and gas exchange of the body would be accelerated, and all tissues and organs would be under pressure. Therefore, advanced resistance exercise combined with aerobic rehabilitation training is a kind of exercise load test. It can continuously and dynamically monitor the cause of exercise termination, morphological characteristics, circulation, respiration, metabolism, and other indicators during exercise, and sometimes pay attention to whether the repair of pectus excavatum is effective [12,13].

At present, the commonly used dynamometer for advanced resistance sports includes intermittent anaerobic power bicycles and treadmills. Among them, the treadmill has the disadvantages of high exercise intensity and imprecise quantification, while the upper body of the subjects is stable when using the intermittent anaerobic power bicycle, the exercise range is relatively small, and the interference to the measurement of ECG and blood pressure is small. At the same time, the exercise intensity is weak and the safety is stronger, which is suitable for healthy people and patients with limited functions of different disease degrees. Therefore, it is recommended to use intermittent anaerobic power bicycles for advanced resistance exercise of lower limbs. On the other hand, the intermittent anaerobic power bicycle has a high demand on the lower limb activities of the subjects, and it is difficult to successfully carry out advanced resistance exercise training for patients who are not good at pedaling or have lower limb movement disorders caused by various reasons. The upper arm strength meter is specially designed for patients with lower limb movement disorders. The lower body of the subject is fixed, and only bilateral arm shaking is required. The number of muscle groups mobilized is small, and the exercise load is low. It is widely used in sports teaching and research, lower limb disability training and testing, rehabilitation, and other fields. Cardiopulmonary exercise-related training is shown in **Figure 1**.

Chronic obstructive pulmonary disease (COPD) has a high incidence of concealment and missed diagnosis. The results of pulmonary function tests show that more than 60% of patients are diagnosed with COPD by pulmonary function tests. The combination of traditional therapy and rehabilitation therapy has a high effective rate of weight reduction. In terms of improving the exercise, heart, and lung functions of patients with chronic stable heart failure, the combination of traditional therapy G_i and cardiac rehabilitation therapy G_S is superior to traditional therapy alone.

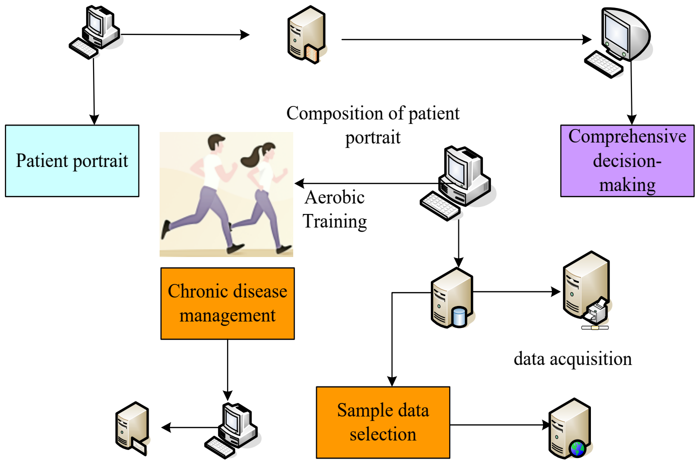


Figure 1. Cardiopulmonary exercise-related training.

$$G_i = -\frac{1}{\ln k}(\sum_{j=1}^{m} \frac{n_{ij}}{\sum_{j=1}^{k} n_{ij}}) \tag{1}$$

$$B_i = \frac{1 - H_i}{m - \sum_{j=1}^{m} H_i} \tag{2}$$

$$\mathrm{N} = \sum \mathrm{L_{ij}} \cdot Z_j \tag{3}$$

$$G_S = (Y_i - minS)/(maxK - minS) \tag{4}$$

Without timely diagnosis and standardized treatment, COPD patients would experience repeated acute exacerbations, accelerate lung function damage, seriously affect the quality of life H_i, increase the burden of disease Y, and increase the disability rate and mortality.

$$H_i = (maxK - x_i)/(maxK - minS) \tag{5}$$

$$\mathrm{Y} = \sum_{\mathrm{i}=1}^{\mathrm{m}} y_i a_i \tag{6}$$

The advanced resistance exercise program can improve cardiopulmonary function to a certain extent [14]. Health big data is a cross-technology based on artificial intelligence and medicine. At present, many diseases can be diagnosed by machine learning technology, and the diagnostic accuracy of some machine models is even higher than that of human experts. At present, the recognition of different CT images and ultrasonic images by machine learning is still based on image classification $\mathrm{y_k}$ and image segmentation.

$$\mathrm{y_k} = \mathrm{Max}\{\mathrm{U_{k-\sigma}}, \mathrm{U_{k-\sigma+1}}, \ldots, \mathrm{U_{k+\sigma}}\} \tag{7}$$

At present, there is a gap between risk assessment of chronic diseases, pulmonary function examination, process quality control, standardized management of patients with chronic diseases, establishment of good evidence-based medicine practice, and practical application. It is an urgent problem to be solved. With the development of medical information technology, massive medical health information has become a reality. Therefore, it is particularly important to explore a new mining technology for knowledge discovery. The application of artificial intelligence technology has provided new ideas for the current shortage and uneven distribution of medical resources in China. Carrying out chronic disease screening, management, grading diagnosis and treatment in China would help reduce the harm of chronic diseases to the health of Chinese residents. The artificial intelligence management of cardiopulmonary function is shown in **Figure 2**.

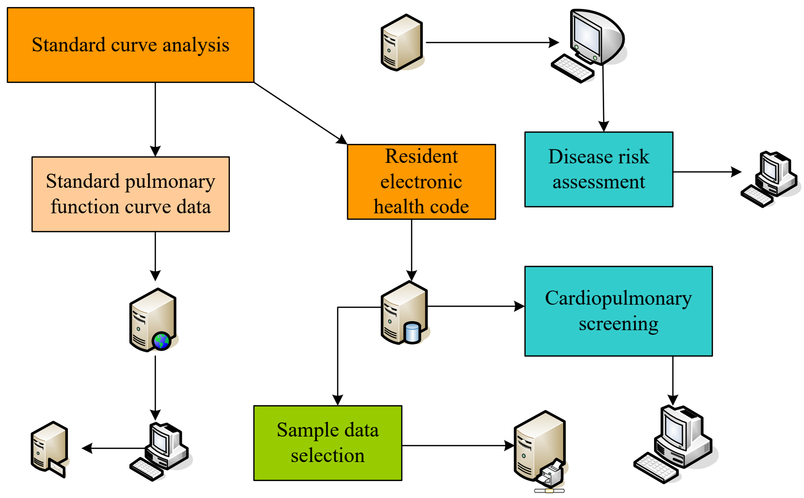


Figure 2. Artificial intelligence management of cardiopulmonary function.

2.2. Cardiopulmonary function of patients with chronic diseases

The main forms of rehabilitation training include walking on the treadmill, climbing steps, and pulling elastic bands. To increase the participation interest of patients with coronary heart disease, we supplemented them with Baduanjin, Taijiquan, and Wu qinxi. These exercises can allow patients to exercise their limbs in a balanced manner. Walking briskly requires the patient to raise their head lift their chest and swing their arms freely, which can increase the ventilation capacity of the lungs, which can improve the patient's vital capacity; During brisk walking, the contraction of abdominal muscles can massage the gastrointestinal tract, effectively promoting digestion and absorption of the gastrointestinal tract. In addition, vigorous walking can ensure the quality of sleep.

The subjects in each group were given exercise intervention 3 times a week for 45 minutes each time for a total of 12 weeks. Body shape, body composition, and metabolic indexes were measured before intervention, at the end of 6 weeks, and at the end of 12 weeks.

1) Body composition test

The IN BODY7.0 (model ef-265B, origin in China) body composition tester can be used to test body weight, body fat, muscle mass, BMI (Body Mass Index), body fat percentage, and waist-hip ratio.

2) Maximum oxygen uptake test and FATmax calculation

Cardioline CardioTread and Germany CORTEX cardiopulmonary function tester (Metalyzer II-R2) can be used to test the maximum oxygen uptake and FATmax. The experiment started the formal test after a warm-up run at a speed of 5 km/h at a gradient of 0% for 3 min, and the formal test used the Bruce program to exercise to exhaustion. Exhaustion criteria: The RPE (Rating of Perceived Exercise) of the subjects reached 19–20, and they could not continue to exercise after repeated encouragement. FATmax (maximum fat metabolism intensity) calculation: VO2 and VCO2 data in the last 30 of each level of exercise can be intercepted and substituted into the fat metabolism calculation formula proposed by Peronnet: 1.6946 × VO2 (L/min)–1.7012 × VCO2 (L/min) It calculates the amount of fat oxidation, and its maximum value is FATmax.

Observations:

(1) General data indicators include gender, age, height, weight, course of disease, cardiac function classification, basic diseases (such as stroke), etc. [15].

(2) Cardiopulmonary function observation indicators: PeakVO2 VO2@AT, PeakMets, VE/ VCO2@slope, running time and so on [16].

(3) TCM syndrome score: the main symptom of each syndrome type is mild, moderate, and severe, with 2, 4, and 6 points respectively, and the secondary symptoms are mild, moderate, and severe, with 1, 2, and 3 points respectively.

In this paper, the machine learning preliminary screening model based on actual data and professional accurate knowledge is used to establish a knowledge map based on intelligent aided decision-making. Among them, the data of medical records, physical examination, laboratory examination, image examination, and pulmonary function examination are real, and the quality control model of chronic disease machine learning and pulmonary function examination is established. Through expert guides, typical cases, and other professional precise knowledge, it has established a model based on preliminary screening. By using the methods of interactive retrieval and knowledge atlas, an intelligent grading model of chronic diseases can be established, and personalized and optimal treatment plans can be formulated according to the characteristics of different patients. This paper aims to develop and apply this model to enable it to have intelligent application scenarios such as risk assessment, disease diagnosis, and decision support, and preliminarily verify and optimize each model to explore the application of AI big [17–19] data technology in the field of chronic diseases. This paper aims to support new ideas, new technical means, and tools (such as rehabilitation archives) for the standardized management of chronic diseases by establishing digital case data based on multidimensional structure [20].

3) Mathematical statistics

SPSS25.0 software was used for data processing and analysis. The two-factor repeated measurement method was used for the analysis of variance to determine the impact of different intervention methods on various indicators over time. Shapiro Wilk test can be used according to studentized residuals. All data are by normal distribution ($P > 0.05$), and no abnormality is found. The influence of interaction item (group, time) was tested by Mauchly's spherical hypothesis. Under the condition of interaction, the experiment tested the effect of internal factors (group, time) of two participants respectively.

Scientific and reasonable physical exercise can effectively improve heart and lung function and reduce body fat content. Grassroots medical institutions are the most extensive group, "healthy gatekeepers", and the main battlefield for early detection and diagnosis of diseases. The key to improving the ability of early diagnosis and early treatment of chronic diseases is to carry out effective case finding at the grass-roots level, timely and effectively identify high-risk groups of chronic diseases, and make a preliminary diagnosis of their pulmonary function. The increase of maximum power is the maximum value $f(a, b, j)$ of the patient's exercise load, which indirectly reflects the tolerance of the pulmonary function of the exercise center to the atmospheric environment [21].

$$\Delta I_k(m, n) = I_k(m, n) - I_{k-1}(m, n) \tag{8}$$

$$f(a, b, j) = \frac{1}{j\sqrt{2\pi}} e^{-\frac{(x-f)^2}{2j}} \tag{9}$$

Advanced resistance exercise can not only enhance the strength of the body but also enhance cardiovascular function and muscle endurance. In recent years, a large number of studies have been carried out on middle-aged and elderly people such as diabetes, cardiovascular and cerebrovascular diseases, obesity, etc., while relatively few studies have been conducted on the cardiopulmonary function of young healthy people [22]. Therefore, this paper discusses the cardiopulmonary function $P(X_i)$, muscle adaptability $L(Y_i, \varepsilon_i)$, and constitution composition of patients with four weeks of advanced resistance exercise.

$$P(X_i) = \sum_{L=1}^{P} \alpha(Y, L) \tag{10}$$

$$L(Y_i, \varepsilon_i) = |Y_i - \varepsilon_i| \tag{11}$$

Different exercise styles have different effects on the heart and lungs. Advanced resistance exercise training M is mainly strength training, but it does not improve the cardiopulmonary function significantly, which is related to the short intervention cycle S_G. At present, both the epidemiological investigation project of COPD and the discovery of COPD are collected and recorded manually, with heavy workload and high cost, which is not suitable for basic level medical personnel with heavy daily work to carry out daily prevention and treatment of COPD.

$$M = \frac{1}{N} \sum (T_1, T_2, \ldots, T_n) \tag{12}$$

$$S_G = \sum_{i,j=1}^{N} H(U_i + U_j) \tag{13}$$

The changes in metabolic indexes and ventilation indexes such as heart rate, blood pressure, electrocardiogram, oxygen uptake, and CO2 exhaust volume were observed to evaluate the patient's circulatory function and respiratory function $F(T)$. Exercise cardiopulmonary function is a comprehensive cardiopulmonary function test, which can comprehensively evaluate the exercise, heart, and lung functions of the subjects. Its basic principle is to measure the cell's respiration condition and time by detecting the respiration in vitro, to reflect the maximum aerobic metabolism and mental reserve of the body.

$$F(T) = \int_{-\infty}^{+\infty} f(T) E^t dT \tag{14}$$

The cardiopulmonary exercise measuring instrument can be used to measure the exercise heart rate, blood pressure, electrocardiogram, and respiratory index, to judge the exercise metabolism that the patient's heart and lung functions can withstand, and to formulate an appropriate exercise recovery plan accordingly. When the oxygen concentration is lower than the oxygen consumption, the reduction rate of muscle oxygen increases rapidly until the lowest. This is because of insufficient oxygen.

Therefore, aerobic training of cardiopulmonary function is required to prevent scoliosis and improve the oxygen supply capacity such as blood output and vital capacity [23]. In addition, the screening of the COPD questionnaire requires high investigation ability $\mathrm{H_{ij}[n]}$ and skill $\mathrm{K_{ij}[n]}$ of investigators, which cannot meet the needs of a large-scale COPD risk questionnaire. Developing an efficient and accurate screening method for high-risk groups of COPD is very important for improving the work efficiency and effect of clinical front-line medical staff.

$$\mathrm{H_{ij}[n] = H_{ij}[N + M]e^{-\alpha} + N} \tag{15}$$

$$\mathrm{K_{ij}[n] = K_{ij}[N + O]e^{-\alpha L} + B_L[N + G]} \tag{16}$$

$$V^{N+1} = F(X, Y^C) \tag{17}$$

In this paper, two groups of conventional therapy and traditional therapy for chronic stable heart failure were used to carry out cardiac rehabilitation therapy, and the effect was evaluated by exercise cardiopulmonary function test to evaluate the effect of X_N on chronic stable heart failure.

$$N^N = \mathrm{C + H} \tag{18}$$

$$X_N = M^{-2}(K_F)(\varphi + Y + X) \tag{19}$$

$$\mathrm{H} = \sum_{\mathrm{i=0}}^{\mathrm{N}} G_i \tag{20}$$

3. Results of cardiopulmonary function test

After the intervention, NT proBNP was significantly different from the control group ($P < 0.05$). In the control group, the NT proBNP level did not change significantly before and after treatment ($P > 0.05$). After intervention, the content of NT proBNP in the rehabilitation treatment group was significantly lower than that before treatment ($P < 0.05$). The NT proBNP comparison is shown in **Figure 3**.

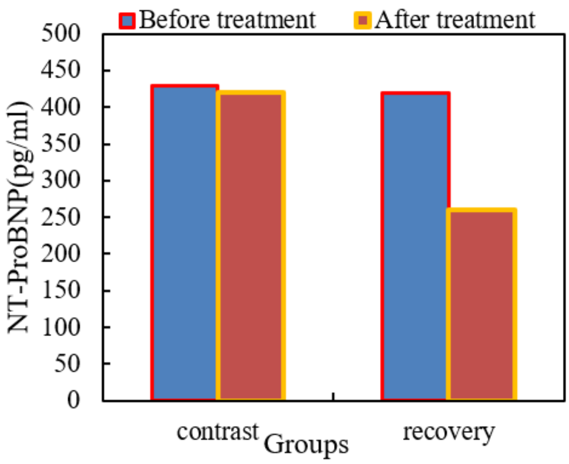


Figure 3. NT proBNP comparison.

There were 8 persons in the single training group, combined training group, and control group respectively. The weight is below 60 kg. The course of the disease was less than 9 months. The single training group has half men and half women, and the joint training group has three men and five women. The general conditions of the subjects before intervention are shown in **Table 1**.

Table 1. General information of subjects before intervention.

	Single training group (n = 8)	Joint training team (n = 8)	Control group (n = 8)	*P* value
Male/Female	4/4	3/5	2/6	0.595*
Age	25.14 ± 1.35	23.83 ± 2.48	30.33 ± 7.61	0.056#
Height (m)	1.67 ± 0.85	1.65 ± 0.51	1.67 ± 0.13	0.933#
Weight (kg)	58.00 ± 10.07	54.5 ± 6.19	59.17 ± 8.79	0.656#
BMI (kg/m^2)	20.70 ± 1.98	19.95 ± 1.69	21.11 ± 1.17	0.493#
The course of disease (month)	7.86 ± 2.33	7.83 ± 3.71	8.83 ± 3.76	0.882#

Note: BMI stands for body mass index; * stands for chi-square test; and # stands for *t*-test.

At present, the application of artificial intelligence technology to the standardized management of COPD is still in the process of exploration. This article introduces the establishment of personal basic information, cardiovascular and cerebrovascular diseases, diabetes, and other chronic diseases of electronic prescription information. Although there is information on risk factors such as COPD, it is not included in the national basic public health service plan, so there is no standardized management of COPD at the grass-roots level, nor is there any filing for COPD patients.

By jogging 2 km every two days and practicing Baduanjin once a day for 1 month, the training effect and intensity were monitored by monitoring the heart rate of the subjects, and timely adjustment was made. To ensure the accuracy of the experiment, the subjects were supervised to ensure that each subject could complete the training in time. Finally, for the subjects' muscle soreness or physical discomfort after training, rehabilitation massage therapy was performed by professional massage therapists.

The intra-group comparison among the three groups is shown in **Table 2**. Intra-group comparison: The sitting score of the single group was significantly lower than that before the intervention ($p < 0.05$), and the scores of self-care ability, extraction, standing, occupation/housework, social activities, and total scores were significantly lower than that before the intervention ($p < 0.01$). The occupational/housework scores of the combined group were significantly lower than those before the intervention ($p < 0.05$), and the scores in pain degree, self-care ability, extraction, sitting, standing, social activities, and total scores were significantly lower than those before the intervention ($p < 0.01$).

Table 2. Intra-group comparison among three groups.

	Before the intervention			After the intervention		
	a	b	c	a	b	c
The degree of pain	3.00 ± 1.15	3.50 ± 0.84	3.33 ± 0.52	2.14 ± 1.07	1.50 ± 0.55**	2.83 ± 0.75
Ability to care for	1.71 ± 0.95	2.33 ± 0.82	2.50 ± 0.55	1.00 ± 0.82**	0.67 ± 0.52**	1.83 ± 0.41
Extract	2.71 ± 0.95	2.33 ± 0.52	1.83 ± 1.17	1.57 ± 0.79**	1.00 ± 0.89**	1.67 ± 0.82
Walking	0.00 ± 0.00	0.00 ± 0.00	0.33 ± 0.82	0.00 ± 0.00	0.00 ± 0.00	0.50 ± 1.22
Sit	2.29 ± 1.38	3.00 ± 1.10	3.17 ± 0.75	1.43 ± 0.79*	1.17 ± 0.75**	2.50 ± 0.84
Standing	3.00 ± 0.82	2.33 ± 0.52	2.83 ± 0.75	1.86 ± 0.38**	0.83 ± 0.41**	2.50 ± 0.84

Table 2. (*Continued*).

	Before the intervention			**After the intervention**		
	a	**b**	**c**	**a**	**b**	**c**
Sleep	1.14 ± 0.90	0.67 ± 0.52	1.50 ± 0.55	0.71 ± 0.49	0.17 ± 0.41	1.67 ± 1.21
Occupation/Housework	2.00 ± 1.15	2.33 ± 0.82	2.83 ± 0.75	1.29 ± 0.95**	1.00 ± 0.89*	3.00 ± 0.63
Social activities	1.71 ± 1.11	2.17 ± 0.75	2.00 ± 0.89	0.57 ± 0.98**	0.50 ± 0.84**	2.33 ± 1.63
Travel	0.57 ± 0.53	0.83 ± 0.41	0.67 ± 0.52	0.57 ± 0.53	0.33 ± 0.52	1.00 ± 0.00
Total score	0.36 ± 0.12	0.39 ± 0.09	0.43 ± 0.09	0.22 ± 0.06**	0.14 ± 0.06**	0.40 ± 0.06

Note: a represents single training group; b represents joint training group; c represents control group; * represents significant difference before and after intervention in the group; ** represents very significant difference before and after intervention in the group.

Biomechanics is a discipline that studies the mechanical properties of organic bones, muscles, joints, and other biological tissues. In advanced resistance exercise combined with aerobic rehabilitation training for sports injuries, understanding the principles of biomechanics is crucial for correctly performing sports skills, including the effects of force, mass, acceleration, and angular momentum on core muscle strength and physical fitness. It has important guiding significance for improving sports technology level. Improving physical fitness and core muscle strength is an important part of sports rehabilitation training. By analyzing athlete sports techniques and biomechanical indicators, risk factors for sports injuries can be identified, thereby reducing the probability of injury occurrence.

To better understand the mechanism of combining advanced resistance exercise with aerobic rehabilitation training, this article analyzes the mechanical state of core muscle strength of sample objects in different groups through biomechanical parameters. Based on this, unknown variables such as displacement, stress, and strain of muscle tissue in different states are tested and compared.

Firstly, a reasonable mesh generation is performed on the sampled target entity model, using hexahedral mesh generation technology. The mesh elements are defined by nodes, each node has 3 rotational degrees of freedom and has translational degrees of freedom in the *x*, *y*, and *z* directions.

During the experiment, the static equilibrium equation is used to determine the displacement and stress of the sample object under various experimental states. Assuming that the sample object undergoes deformation due to external forces, but still maintains its mechanical equilibrium. At any point $P(x, y, z)$, take the hexahedral differential body $dxdydz$, whose six faces are distributed with normal stress σ perpendicular to the surface and shear stress τ in the section. The differential body is subjected to zero force in three directions, and the static equilibrium equation can be obtained as follows:

$$\begin{cases} \frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} + F_x = 0 \\ \frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \sigma_y}{\partial y} + \frac{\partial \tau_{zy}}{\partial z} + F_y = 0 \\ \frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial \sigma_x}{\partial z} + F_z = 0 \end{cases} \tag{21}$$

The static equilibrium equation represents the relationship between the internal stress component of a deformed object and the external force, where F_x, Fy, F_z are the components of the internal volume force in the $x, y, and\ z$ directions.

Under the same loading and constraint conditions, observe the stress and displacement changes of core muscle groups in different groups of samples under different movements or loads, and evaluate them.

The test results of the main indicators of each group before intervention are shown in **Table 3**. Core muscle strength test: the value of lateral bending (left) in the single training group was 115.76 ± 30.19, 102.65 ± 14 in the combined training group, and 107.1 ± 20.09 in the control group.

Table 3. Test results of main indicators of each group before intervention.

	Index	**Single training group (n = 8)**	**Joint training team (n = 8)**	**Control group (n = 8)**	***P* value**
Evaluation of pain and lumbar function	VAS	4.14 ± 1.77	5.17 ± 0.98	4.83 ± 0.75	0.363
	ODI (0–100)	15.32 ± 10.81	15.38 ± 4.23	16.28 ± 3.39	0.978
Core muscle strength	Anteflexion	134.09 ± 48.87	130.70 ± 24.02	168.80 ± 62.00	0.328
	Dorsal extension	118.23 ± 38.84	139.63 ± 31.08	126.52 ± 29.72	0.534
	Lateral flexion (left)	115.76 ± 30.19	102.65 ± 14	107.1 ± 20.09	0.587
	Lateral flexion (right)	118.17 ± 32.47	120.07 ± 11.92	126.83 ± 24.83	0.816
	Rotate (left)	91.47 ± 41.34	93.75 ± 27.47	123.48 ± 38.71	0.248
	Rotate (right)	93.37 ± 40.23	96.68 ± 11.04	111.1 ± 15.05	0.485
Core fitness (s)	Static endurance of abdominal muscles	34.86 ± 17.44	33.17 ± 10.07	37.67 ± 14.10	0.549
	Dorsal muscle static endurance	58.14 ± 20.21	61.33 ± 8.45	71.33 ± 23.28	0.479
	Dynamic endurance of abdominal muscles	16.43 ± 18.93	12.17 ± 10.53	8.50 ± 16.05	0.670
	Dorsal Dynamic Endurance	12.71 ± 8.81	16.5 ± 12.55	15.83 ± 4.07	0.610

Note: The *t*-test is used for mathematical statistics of various indicators.

The ultrasonic test results of the intervened rectus abdominis muscle are shown in **Table 4**. The *P* value of cross-sectional area and thickness is below 0.3.

Table 4. Results of ultrasonic testing of rectus abdominis muscle before intervention.

Muscle name	**Index name**		**Single training group (n = 8)**	**Joint training team (n = 8)**	**Control group (n = 8)**	***P* value**
Rectus abdominis	Thickness	Left	1.21 ± 0.28	0.98 ± 0.14	1.19 ± 0.24	0.159
		Right	1.26 ± 0.28	1 ± 0.16	1.21 ± 0.25	0.184
	Cross-sectional area	Left	7.44 ± 2.64	5.48 ± 1	6.21 ± 2.05	0.202
		Right	7.26 ± 2.32	5.28 ± 1.08	6.37 ± 1.95	0.250
	Blood resistance index	Left	1.08 ± 0.53	0.93 ± 0.3	1.08 ± 0.53	0.236
		Right	1.45 ± 0.67	0.95 ± 0.26	1.34 ± 0.5	0.798

Visual analog scale (VAS) and low back pain score are shown in **Figure 4a**. The Oswestry Disability Index is shown in **Figure 4b**. In the visual simulation scoring method, there was an upward trend in group C after intervention and a downward trend in other groups.

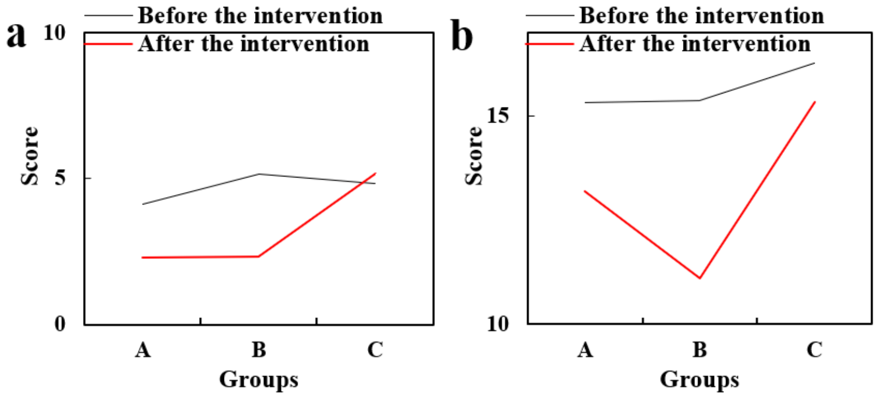


Figure 4. Visual simulation score and low back pain ODI score. (**a**) Visual simulation scoring method; (**b**) Low back pain ODI scoring standard.

The ultrasonic testing results of the back muscles and bones showed that the thickness of the painful side and the cross-sectional area of the painless side of the gluteus maximus in the single group were significantly increased compared with those before the intervention ($p < 0.05$). In the combined group, the thickness and cross-sectional area of the painful side of the erector spinal muscle and multifidus muscle were significantly increased compared with those before intervention ($p < 0.05$). In the combined group, the cross-sectional areas of the painful side and the painless side of the gluteus maximus were significantly increased compared with those before intervention ($p < 0.05$). Comparison between groups: the effect of a single group and a combined group on increasing the thickness of the side with vertical spinal myalgia was better than that of the control group ($p < 0.05$). The comparison of thickness and cross-sectional area is shown in **Table 5**.

Table 5. Comparison of thickness and cross-sectional area.

		Thickness						**Cross-sectional area**					
		Painful side			**Painless side**			**Painful side**			**Painless side**		
		Before intervention	**After intervention**	***T*-test**	**Before intervention**	**After intervention**	***T*-test**	**Before intervention**	**After intervention**	***T*-test**	**Before intervention**	**After intervention**	***T*-test**
1	A	2.22 ± 0.43	2.28 ± 0.47C	*P* = 0.77 *t* = –0.30	2.44 ± 0.41	2.59 ± 0.27	*P* = 0.57 *t* = –0.63	5.81 ± 1.13	6.45 ± 2.48	*P* = 0.49 *t* = –0.72	7.15 ± 1.62	7.21 ± 4.07	*P* = 0.97 *t* = –0.04
	B	1.95 ± 0.19	2.52 ± 0.27C	*P* = 0.00 *t* = –4.36	2.52 ± 0.34	2.31 ± 0.28	*P* = 0.03 *t* = 3.70	4.9 ± 0.91	7.3 ± 1.49	*P* = 0.01 *t* = –3.66	6.11 ± 1.79	6.85 ± 1.75	*P* = 0.09 *t* = –2.52
	C	1.94 ± 0.23	1.9 ± 0.26AB	*P* = 0.58 *t* = –0.59	2.4 ± 0.23	2.52 ± 0.16	*P* = 0.11 *t* = –2.30	6.07 ± 3.1	5.87 ± 3.03	*P* = 0.14 *t* = 1.69	8.4 ± 4.03	8.25 ± 4.2	*P* = 0.56 *t* = 0.64
	F value	*P* = 0.11 *f* = 2.39	*P* = 0.01 *f* = 6.23		*P* = 0.88 *f* = 0.13	*P* = 0.29 *f* = 1.41		*P* = 0.45 *f* = 0.84	*P* = 0.51 *f* = 0.69		*P* = 0.49 *f* = 0.77	*P* = 0.83 *f* = 0.19	
2	A	0.57 ± 0.1	0.66 ± 0.22B	*P* = 0.32 *t* = –1.07	0.67 ± 0.13	1.09 ± 0.57	*P* = 0.19 *t* = –1.70	0.99 ± 0.24	1.32 ± 0.53B	*P* = 0.10 *t* = –1.92	1.45 ± 0.43	1.36 ± 0.45	*P* = 0.62 *t* = 0.55
	B	0.5 ± 0.04	0.9 ± 0.25AC	*P* = 0.00 *t* = –5.63	0.64 ± 0.08	1.46 ± 0.03C	*P* = 0.06 *t* = –11.0	1.07 ± 0.43	2.49 ± 1.02AC	*P* = 0.01 *t* = –3.79	1.25 ± 0.53	2.73 ± 1.74	*P* = 0.07 *t* = –2.24
	C	0.52 ± 0.16	0.49 ± 0.1B	*P* = 0.41 *t* = –0.90	0.73 ± 0.23	0.59 ± 0.24B	*P* = 0.13 *t* = 1.79	1.05 ± 0.65	0.77 ± 0.27B	*P* = 0.12 *t* = 1.77	1.59 ± 1.00	1.29 ± 0.70	*P* = 0.17 *t* = 1.82
	F value	*P* = 0.37 *f* = 1.03	*P* = 0.00 *f* = 7.66		*P* = 0.77 *f* = 0.27	*P* = 0.04 *f* = 4.86		*P* = 0.94 *f*= 0.06	*P* = 0.00 *f* = 13.01		*P* = 0.71 *f* = 0.36	*P* = 0.16 *f* = 2.18	
3	A	1.63 ± 0.66	2.82 ± 0.49C	*P* = 0.01 *t* = –3.79	1.65 ± 0.41	2.18 ± 0.33	*P* = 0.14 *t* = –1.82	23.33 ± 3.38	26.21 ± 2.35C	*P* = 0.00 *t* = –6.15	19.09 ± 2.49	25.2 ± 2.54C	*P* = 0.00 *t* = –5.94
	B	1.98 ± 0.56	2.32 ± 0.43C	*P* = 0.06 *t* = –2.36	2.11 ± 0.66	2.26 ± 0.55	*P* = 0.23 *t* = –1.43	22.45 ± 3.11	26.13 ± 3.58C	*P* = 0.00 *t* = –7.78	18.62 ± 1.7	26.12 ± 2.34C	*P* = 0.01 *t* = –5.86
	C	1.45 ± 0.66	1.63 ± 0.87AB	*P* = 0.18 *t* = –1.53	1.74 ± 0.81	1.82 ± 0.54	*P* = 0.71 *t* = –0.29	22.08 ± 2.38	22.51 ± 3.68AB	*P* = 0.71 *t* = –0.39	18.9 ± 1.71	19.32 ± 1.71AB	*P* = 0.27 *t* = –1.34
	F value	*P* = 0.29 *f* = 1.30	*P* = 0.00 *f* = 7.42		*P* = 0.51 *f* = 0.71	*P* = 0.36 *f* = 1.13		*P* = 0.71 *f* = 0.35	*P* = 0.05 *f* = 3.22		*P* = 0.94 *f* = 0.06	*P* = 0.00 *f* = 10.79	

Note: 1 is a dorsal muscle; 2 is a multifidus muscle; and 3 is a gluteus maximus muscle.

The core muscle fitness test is shown in **Figure 5** (abdominal static muscle endurance is shown in **Figure 5a**, and back static muscle endurance is shown in **Figure 5b**). The mean value of static muscular endurance of the back is greater than that of the abdomen.

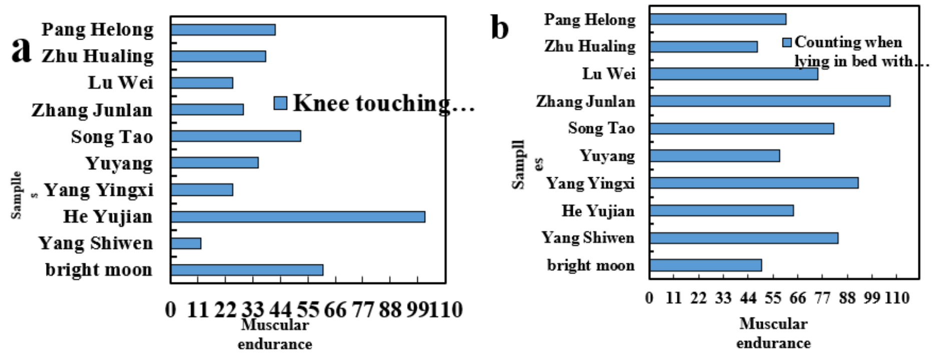
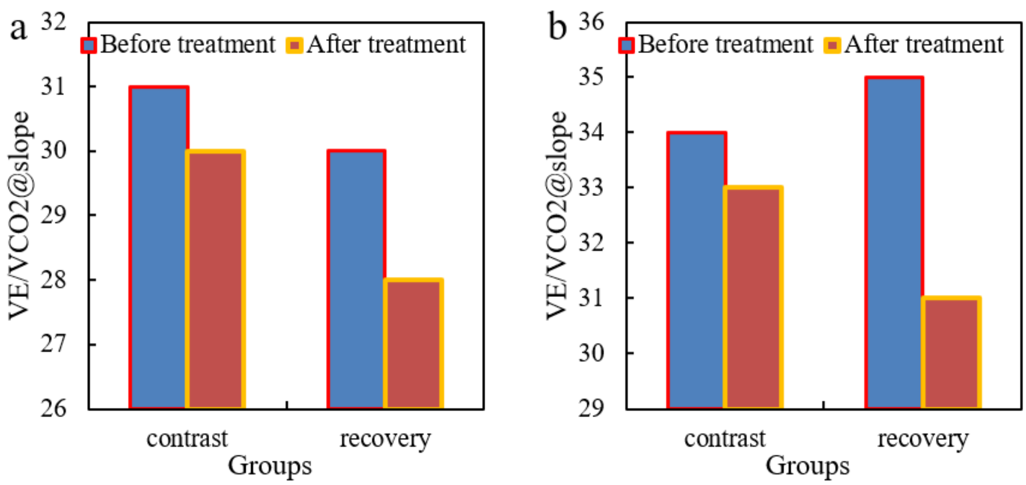


Figure 5. Core fitness test. (**a**) Abdominal static muscle endurance; (**b**) Back static muscle endurance.

After 8 weeks of treatment, VE/VCO2@slope in the rehabilitation group and the control group was lower than that in the control group ($P < 0.05$). VE/VCO2@slope of the rehabilitation group and control group of each symptom type is shown in **Figure 6** (Qi and Yin deficiency and blood stasis syndrome are shown in **Figure 6a**). The syndrome of yang qi deficiency and blood stasis is shown in **Figure 6b**.



(**a**) Qi yin deficiency and blood stasis syndrome. (**b**) Yang deficiency and blood stasis syndrome.

Figure 6. VE in rehabilitation group and control group/ VCO2@slope.

After 8 weeks of treatment, the rehabilitation group was better than the control group ($P < 0.05$). The comparison of TCM symptom scores between the rehabilitation group and the control group and aerobic training is shown in **Figure 7** (Aerobic training is shown in **Figure 7A**, the comparison of TCM symptom scores between the rehabilitation group and the control group is shown in **Figure 7B**).

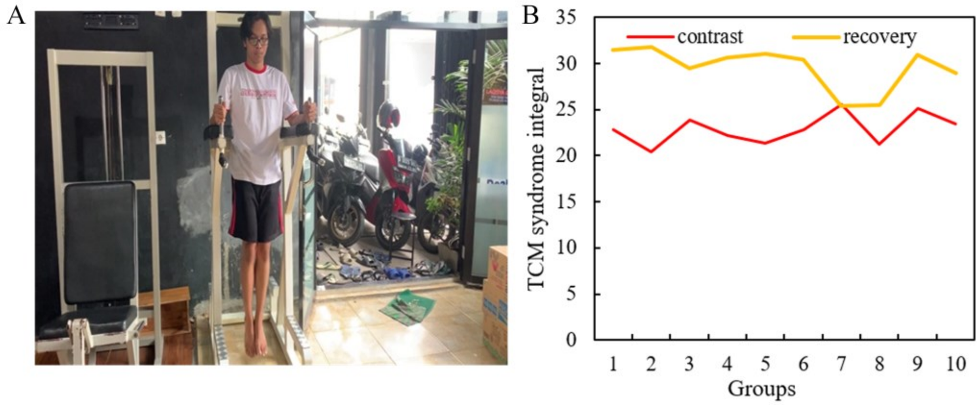


Figure 7. Comparison of TCM symptoms between the rehabilitation group and the control group and aerobic training [24].

Compared with the rehabilitation treatment group, the 6 MWD value of the control group had no significant change before and after the intervention ($P > 0.05$). However, after intervention, 6 MWD in the rehabilitation treatment group was significantly higher than that before intervention ($P < 0.05$). The comparison between advanced impedance exercise and 6MWD before and after intervention is shown in **Figure 8** (The comparison between advanced impedance exercise is shown in **Figure 8A**, 6MWD before and after intervention is shown in **Figure 8B**).

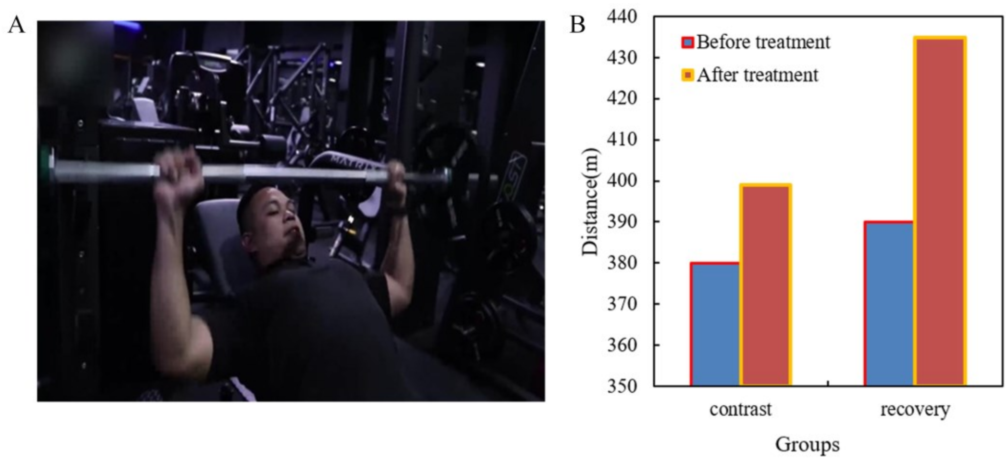


Figure 8. The comparison between advanced impedance exercise and 6MWD before and after intervention [24].

The analysis and evaluation of the treatment cost of chronic diseases is the key. In recent years, the absolute number of major chronic diseases and the Chinese population published by Chinese scholars in academic journals of other countries in China has shown a steady growth trend. However, the research on the treatment and diagnosis, epidemic investigation, and risk factors of the disease is increasing. In the fields of health economics, rehabilitation measures, etiology, and treatment costs, there is still a lack of relevant literature. At present, researches on overtreatment of chronic diseases focus on qualitative issues such as the current situation, causes, and hazards of the disease. Empirical studies have been conducted on the treatment costs of chronic diseases, and a comprehensive analysis has been conducted on them. Few epidemiological studies can measure the impact of disease development and intervention on costs, health outcomes, and quality of life. Literature research shows that patients often overestimate the expected return and underestimate the risk assessment and lack of awareness when quantifying the expected damage or benefit during treatment. Due to the lack of basic health care knowledge, patients would turn to the hospital instead of necessary additional physical examination or drug treatment. At the same time, the patient would feel that the more medicine the doctor gives, the more satisfied the patient would be with the medical service, thus forcing the doctor to make negative changes to the patient's needs. Excessive medical treatment has become the focus of the current society, but also the focus of many contradictions.

4. Conclusions

Before exercise therapy, it is necessary to evaluate the patient's exercise ability. The cardiopulmonary function evaluation based on the holistic theory is a method that can objectively and quantitatively evaluate the functional status of multiple systems of cardiopulmonary metabolism so far and has certain significance in disease prevention, diagnosis, treatment, prognosis, etc. The application of artificial intelligence technology in the prevention and treatment of chronic diseases provides a new way to further strengthen the standardized management of chronic diseases at the grass-roots level. At present, it is widely recognized that chronic diseases have a high predictive effect on cardiovascular diseases and related mortality. At the peak of exercise, comprehensive indicators such as oxygen uptake, oxygen pulse, load power, cardiac output, oxygen uptake, and ventilation efficiency index comprehensively reflected the cardiopulmonary function of the subjects. The peak oxygen uptake and peak oxygen pulse reflect the coupling and matching of respiration, circulation, and muscle metabolism, while the peak oxygen uptake represents the aerobic metabolic limit of large muscle groups and reflects the aerobic metabolic capacity of the body. Through the research experiment, it is found that aerobic exercise has a good effect on the cardiopulmonary rehabilitation training of the vast majority of people and has a very excellent development prospect in the future research field. For patients with chronic diseases, aerobic exercise intervention can not only improve the exercise endurance and quality of life of patients, but also help patients recover, and there is a lot of room for development in the future. However, for patients with severe cardiopulmonary damage and mobility difficulties, aerobic exercise not only cannot effectively alleviate the condition but also may cause secondary damage.

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