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*Original Article*

# Effects of regular physical exercise on quality of life improvement and laboratory parameters in cardiovascular patients

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**Abstract:** Objective: This study aimed to explore the effects of regular physical exercise on the quality of life (QOL) and laboratory parameters of cardiovascular patients. Methods: Diagnosed and treated in the Division of Sports Science of Wonkwang University in South Korea, 82 cardiovascular patients were enrolled as the research subjects, who were divided into the study and control groups (41 cases in each group) according to random number tables. Those in the control group only received conventional drug therapy and lifestyle interventions, while those in the study group received regular physical exercise in addition to treatment in the control group. The differences in terms of arterial blood pressure (ABP), cardiopulmonary function, laboratory parameters and QOL scores before and after intervention were compared. Results: Before intervention, there were no significant differences in the four aspects between the study and control groups ($P>0.05$). After intervention, patients in the study group had lower systolic blood pressure (SBP), diastolic blood pressure (DBP), resting heart rate (RHR), triglyceride (TG), total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) ($P<0.05$); but higher scores of somatic, mental and physiological functions in the 36-Item Short-Form Health Survey (SF-36) ($P<0.05$). Conclusion: Regular physical exercise is helpful to improve the ABP, cardiopulmonary function and laboratory parameters of cardiovascular patients, and is also conducive to preventing the occurrence of atherosclerosis and other adverse cardiac related events and to significantly improving QOL in the elderly.

**Keywords:** Regular physical exercise, cardiovascular patients, QOL, laboratory parameters, impact analysis

## Introduction

As the economy of China has developed rapidly in recent years, the lifestyle and dietary structure of Chinese people have changed significantly, and the prevalence rate of various cardiovascular diseases has also shown an annually increasing trend. Some investigations have pointed out that China is currently one of the countries with the heaviest cardiovascular disease burden in the world, with the incidences of atherosclerosis (AS), hemorrhagic stroke and ischemic heart disease clearly rising over the past few years, which has a great correlation with population aging and unhealthy living habits [1, 2]. According to survey data on the prevalence rate of AS, proportions of the death and the total number of deaths due to AS in China had increased from 40% and 11%, respectively, in 1990 to 61% and 25% in 2016; with the death toll during the same period increasing from 1 million/year to 2.4 million/year. This suggests that cardiovascular diseases have seriously affected the social progress and economic development of China [3, 4].

For all various therapeutic measures for cardiovascular diseases, such as regular medication, surgical operation and rehabilitation therapy, what medical workers emphasize most is proper exercise. Findings of many existing studies have also shown the excellent effects of regular physical exercise on improving the physical quality of individuals [5-7]. Known in exercise psychology, physical exercise helps to maintain the physical and mental health of individuals, being the most basic positive means to improve the health status and quality of life (QOL) in the elderly. Through proper physical exercise, the individuals' various system functions that

include immune system and cardiovascular system capabilities will be enhanced [8, 9]. In addition, this method is conducive to venting the individuals' negative emotions, to relieving and releasing their psychological pressure and tension that are caused by family, society and work, and to remarkably reducing the loneliness in the elderly. Meanwhile, the overall benefits gained by doing physical exercise contribute to promoting communication and cooperation with the individuals and improving their social support [10, 11]. The purpose of this study is to analyze the effects of regular physical exercise on the QOL improvement and laboratory parameters of cardiovascular patients through regular physical exercise interventions, so as to provide theoretical bases for improving the clinical symptoms and prognosis of the patients.

## Materials and methods

*General information*

Diagnosed and treated in the Division of Sports Science of Wonkwang University in South Korea from October 2019 to December 2019, 82 cardiovascular patients were enrolled as the research subjects, who were divided into the study and control groups (41 cases in each group) according to a random number table.

Inclusion criteria: (1) All enrolled patients were clinically diagnosed with coronary heart disease (CHD), arrhythmia or myocardial infarction. (2) Those who were conscious and able to cooperate in research. (3) Those who had complete patient data. (4) This study has been approved by the Ethics Committee of Wonkwang University. (5) The patients signed the informed consent form. (6) The patients had healthy limbs with normal functions.

Exclusion criteria: (1) Patients complicated with mental disorders. (2) Patients with congenital motor dysfunction (physical disabilities). (3) Patients with limb dysfunction caused by illness (such as stroke-induced hemiplegia). (4) Patients who were addicted to drugs or alcohol. (5) Patients complicated with malignant tumors. (6) Patients with expected survival time <6 months. (7) Patients who could not tolerate exercise interventions such as those with New York Heart Association (NYHA) class III-IV.

*Intervention methods*

Patients in the control group received regular medication and conventional lifestyle interventions, which included taking drugs on time, having a bland diet, having adequate rest, avoiding overwork, etc.

In addition to treatment given to the control group, patients in the study group received regular physical exercise. Specific measures were as follows: (1) Health assessment before intervention. Before physical exercise, the patients were first assessed for their health status including pathography, exercise tolerance tests, the collection of eating habits, and lifestyle analysis. Next, a health assessment report was formed for each subject in this group, designed to understand the basic situation of the subjects and to facilitate the selection of exercise measures and intensity that are suitable for most people. (2) Plan formulation for regular physical exercise. Fast walking and Wuqinxi exercise were finally determined as the exercise measures according to the preliminary assessment, both of which were implemented in a centralized way. Wuqinxi exercise, aerobic exercise with moderate-low intensity, was designed to be 60 min each time, consisting of 5-10 min limbering up, 40 min exercise and 10 min relaxation exercise. The exercise frequency was 5 times a week (Monday to Friday). It was appropriate to control the heart rate (HR) at approximately 95-100 beats/min during the exercise, which should be organized and guided by special coaches. Also conducted in a centralized way and organized and guided by special coaches, the fast walking training was performed every Saturday with the speed set at 6-7 km/h and the time set at 30 min. (3) Plan supervision and revision. Doctors should instruct the patients and their families to adhere to the intervention exercise as far as possible and do a good job of medical security during the intervention, besides understanding the opinions and suggestions of the subjects in real time and readjusting the frequency and intensity of physical exercise.

*Observational indicators and evaluation criteria*

*Comparison of SBP and DBP before intervention, at 1 month, 3 months and 6 months after intervention:* The patients' systolic blood pres-

sure (SBP) and diastolic blood pressure (DBP) were respectively detected before intervention, at 1 month, 3 months and 6 months after intervention, using a mercury sphygmomanometer manufactured by Jiangsu Yuyue Medical Equipment & Supply Co., Ltd. Before measurement, the mercury column was corrected. During measurement, the patients took a sitting position, had the blood pressure cuff on the right arm, and placed the stethoscope head at the radial artery for the measurement (unit: mmHg).

*Comparison of cardiopulmonary function before and after intervention:* The patients' cardiopulmonary function was tested before and at 6 months after intervention, respectively, with resting heart rate (RHR) and sit-to-stand test (STST) indices taken as the test indicators. The former indicator was tested by the Pm900 ECG monitor from Jiangsu Yuyue Medical Equipment & Supply Co., Ltd. Specific methods of the STST were as follows: sitting quietly for 5 min at first, the subjects then stood in front of the chair with a natural posture, with hands crossed on their shoulders and elbows close to their chest. After hearing the command, they sat and then stood continuously with a metronome, 20 times per minute. This continued for 3 min. After that, they sat on the chair with their HR measured by the medical personnel at 10 s, 2 min-2.5 min, 3 min-3.5 min and 4 min-4.5 min after the test. TST test indices = (sum of 180/4 HRs) × 100 [12].

*Comparison of TG, TC and LDL-C levels before and after intervention:* The patients' fasting venous blood was collected at 7:30-8:00 a.m. before and at 6 months after intervention. Their triglyceride (TG), total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels were detected by the Beckman Coulter AU5800 automatic biochemical analyzer. Each parameter was detected 3 times to take the average value as the final result, and then the three levels were compared between the two groups and between before and after intervention.

*Comparison of QOL scores before and after intervention:* The 36-Item Short-Form Health Survey (SF-36) was used to evaluate the patients' QOL before and at 6 months after intervention, consisting of somatic, mental and physiological functions. The higher the score of each dimension is, the better the QOL is. After evaluation, the QOL scores were compared between the two groups and between before and after intervention.

*Statistical methods*

The collected data were input into SPSS 20.0 for statistical analysis. Measurement data were expressed by ($\bar{x} \pm s$), and their differences between groups were compared by Student's t-test. Count data were expressed by [n (%)], and their differences between groups were compared by chi-square test, with the differences in continuous variables between groups before and after intervention compared by Student's t-test. When $P<0.05$, the difference was statistically significant [13].

## Results

*Comparison of general clinical indicators*

According to the evaluation, the differences between the study and control groups were not statistically significant in general clinical indicators such as gender, average age, types of diseases, body mass index (BMI) and educational background ($P>0.05$), indicating group comparability (**Table 1**).

*Comparison of SBP and DBP before intervention, at 1 month, 3 months and 6 months after intervention*

According to the evaluation, before intervention, the differences between the study and control groups were not statistically significant in SBP and DBP ($P>0.05$), while at 1 month, 3 months and 6 months after intervention, the indicators were significantly lower in the study group ($P<0.05$). In the study group, the indicators at 3 and 6 months after intervention were significantly lower than those before intervention ($P<0.05$) (**Table 2**; **Figure 1**).

*Comparison of cardiopulmonary function before and after intervention*

According to the detection, there were no statistically significant differences in RHR and STST indices between the study and control groups before intervention ($P>0.05$), while at 6 months after intervention, the RHR was significantly lower and the STST indices were significantly higher in the study group. The differenc-

**Table 1.** Comparison of general clinical indicators ($\bar{x} \pm s$)/[n/(%)]

| General clinical data | | Study group (n=41) | Control group (n=41) | $t/X^2$ | *P* |
|---|---|---|---|---|---|
| Gender | Male | 26 | 24 | 0.205 | 0.651 |
| | Female | 15 | 17 | | |
| Average age (Years) | | 66.19±4.11 | 63.87±6.51 | 1.651 | 0.104 |
| Average BMI (kg/m$^2$) | | 20.98±2.33 | 21.61±3.01 | 0.907 | 0.368 |
| Educational background | Illiteracy | 5 | 6 | 1.119 | 0.548 |
| | Primary school | 10 | 7 | | |
| | Junior high school | 16 | 15 | | |
| | Senior high school and above | 10 | 13 | | |
| Marital status | Married | 33 | 31 | 0.285 | 0.594 |
| | Unmarried | 8 | 10 | | |
| Types of diseases | Arrhythmia | 9 | 8 | 1.789 | 0.441 |
| | CHD | 21 | 19 | | |
| | Myocardial infarction | 11 | 14 | | |
| History of hypertension | Yes | 15 | 19 | 0.804 | 0.370 |
| | No | 26 | 22 | | |
| History of diabetes | Yes | 8 | 11 | 0.617 | 0.432 |
| | No | 33 | 30 | | |

**Table 2.** Comparison of SBP and DBP before intervention, at 1 month, 3 months and 6 months after intervention ($\bar{x} \pm s$)

| Observational indicators (mmHg) | Groups | Number of cases | Before intervention | Intervention for 1 month | Intervention for 3 months | Intervention for 6 months |
|---|---|---|---|---|---|---|
| SBP | Study group | 41 | 131.19±6.21 | 126.28±5.12 | 120.18±4.33 | 115.28±5.23 |
| | Control group | 41 | 130.89±6.65 | 129.19±5.71 | 126.29±4.55 | 118.29±5.41 |
| | t | - | 0.211 | 2.43 | 6.229 | 2.561 |
| | P | - | 0.833 | 0.017 | <0.001 | 0.012 |
| DBP | Study group | 41 | 83.98±4.11 | 79.28±3.22 | 73.89±3.98 | 72.19±3.43 |
| | Control group | 41 | 83.88±4.34 | 82.19±3.01 | 76.10±3.87 | 76.29±3.29 |
| | t | - | 0.107 | 4.227 | 2.549 | 5.524 |
| | P | - | 0.915 | <0.001 | 0.013 | <0.001 |

es in the two indicators were statistically significant between the two groups and between before and after intervention within the groups (P<0.05) (**Figure 2**).

*Comparison of TG, TC and LDL-C levels before and after intervention*

According to the laboratory tests, before intervention, TG, TC and LDL-C levels were not significantly different between the study and control groups (P>0.05), while at 6 months after intervention, the levels were significantly lower in the study group (P<0.05). In the study group, the levels after intervention were significantly lower than those before intervention (P<0.05) (**Table 3**; **Figure 3**).

*Comparison of QOL scores before and after intervention*

According to the evaluation, before intervention, the scores of somatic, mental and physiological functions were not significantly different between the study and control groups (P>0.05), while after intervention, the scores significantly increased in the two groups (P<0.05). After intervention, each score in the study group was higher than that in the control group at the same time point (P<0.05) (**Figure 4**).

## Discussion

With the rapid development of China's economy in recent years, Chinese people's living

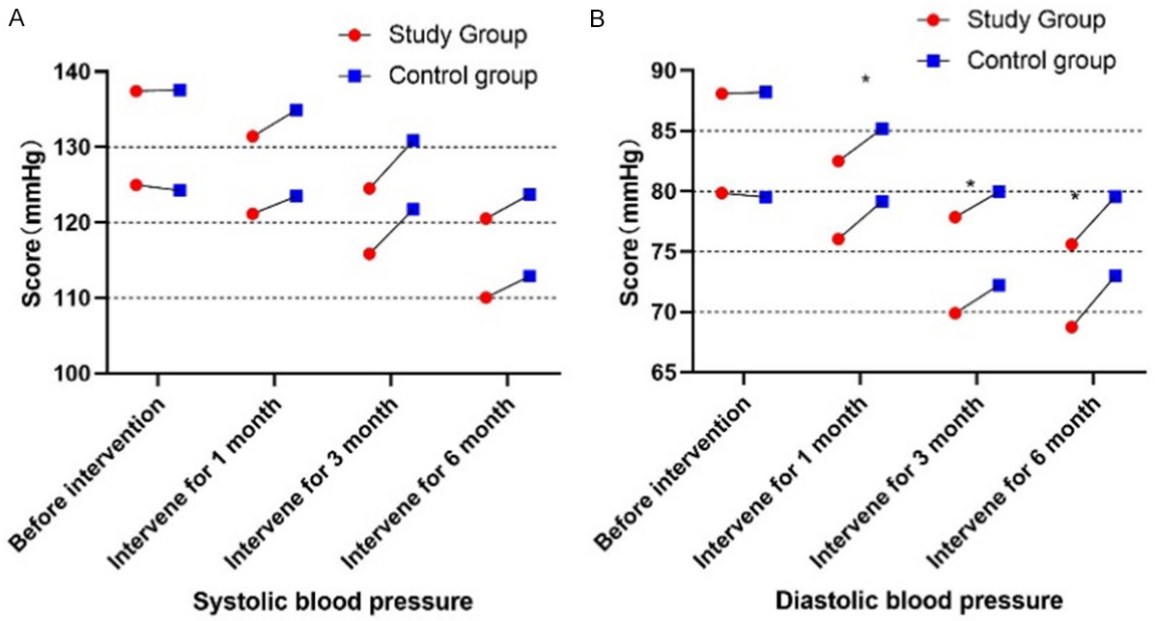


**Figure 1.** Comparison of SBP and DBP before intervention, at 1 month, 3 months and 6 months after intervention. Before intervention, the differences between the study and control groups were not significant in SBP and DBP, while at 1 month, 3 months and 6 months after intervention, SBP (A) and DBP (B) were significantly lower in the study group (P<0.05). * indicates a statistically significant difference in the same indicator between groups at the same time point.

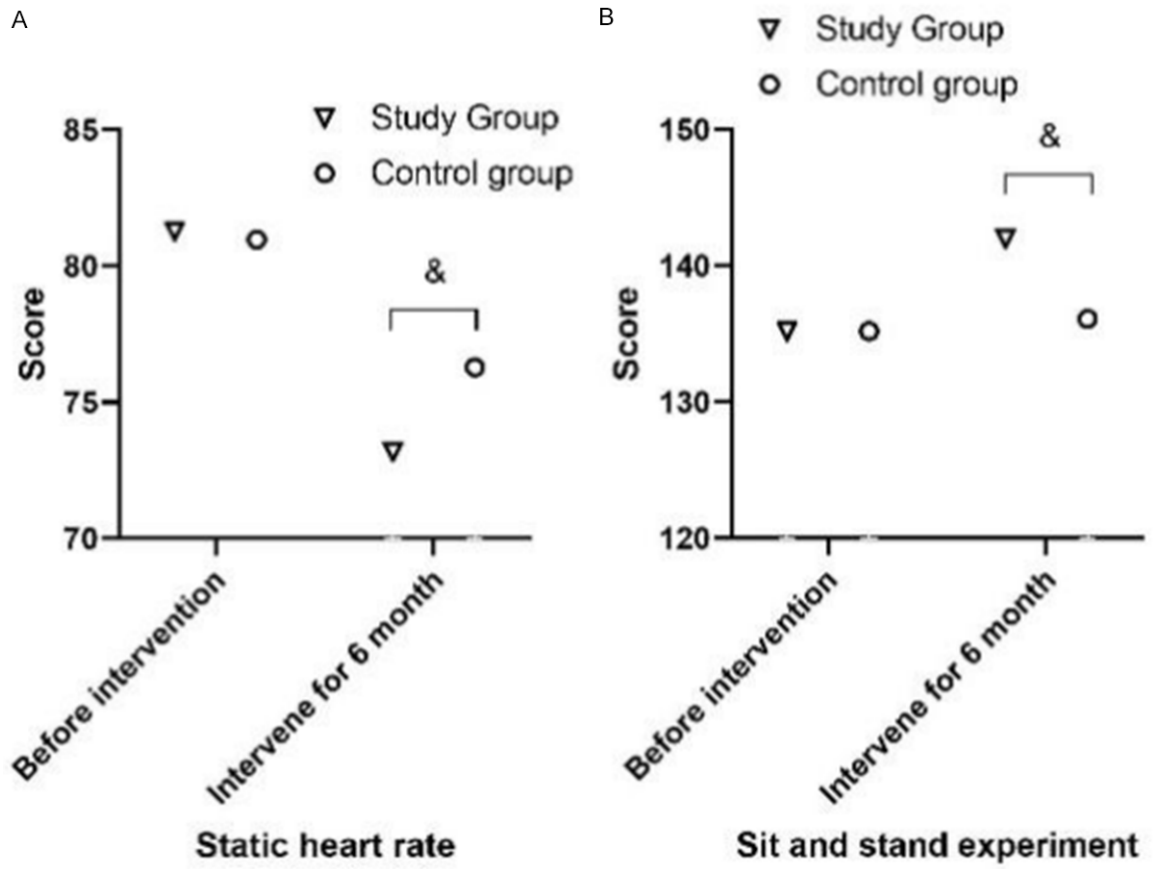

**Figure 2.** Comparison of cardiopulmonary function before and after intervention. Before intervention, there was no significant difference in RHR between the study and control groups (P>0.05), while at 6 months after intervention, the indicator was lower in the study group (P<0.05) (A). Before intervention, there were no significant differences in the STST indices between the study and control groups (P>0.05), while at 6 months after intervention, the indices were higher in the study group (P<0.05) (B). & indicates a statistically significant difference in the same indicator between groups at the same time point (P<0.05).

**Table 3.** Comparison of TG, TC and LDL-C levels before and after intervention ($\bar{x} \pm s$)

| Groups | Number of cases | TG (mmol/L) | | TC (mmol/L) | | LDL-C (mmol/L) | |
|---|---|---|---|---|---|---|---|
| | | Before intervention | Intervention for 6 months | Before intervention | Intervention for 6 months | Before intervention | Intervention for 6 months |
| Study group | 41 | 1.46±0.21 | 1.23±0.28* | 5.31±0.35 | 4.78±0.51* | 2.35±0.21 | 1.87±0.22* |
| Control group | 41 | 1.45±0.23 | 1.37±0.22* | 5.32±0.41 | 5.11±0.43* | 2.36±0.19 | 2.11±0.19* |
| t | - | 0.206 | 2.517 | 0.119 | 3.168 | 0.226 | 5.287 |
| P | - | 0.837 | 0.014 | 0.906 | 0.002 | 0.822 | <0.001 |

Note: compared with before intervention, *P<0.05.

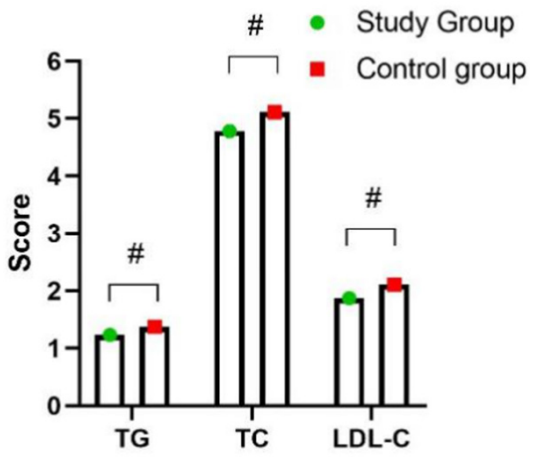


**Figure 3.** Comparison of TG, TC and LDL-C levels before and after intervention. At 6 months after intervention, TG, TC and LDL-C levels in the study group were significantly lower than those in the control group (P<0.05). # indicates a statistically significant difference in the same parameter between groups at the same time point.

standards have obviously improved, but the trend of social aging and the adjustment of life and diet structures have also led to significant changes in the prevalence rates of various diseases. Cardiovascular diseases, one of the most common diseases in China, have a prevalence rate as high as 80% in the middle-aged and the elderly. They account for 41% of the total causes of deaths and have a disability rate of 50%, both of which rank first in percentage. In China, 3.5 million people die from cardiovascular diseases every year, with the mortality ratio accounting for 42% of the total deaths of residents and far higher than that of other diseases [14]. Additionally, the long course of disease, difficult treatment, easy recurrence, and high fatality and disability rates are typical features of cardiovascular diseases, whose disease burdens account for approximately 70% of total disease burdens, which seriously affects the normal development of Chinese society and the improvement of Chinese people' living standards [15].

Physical exercise is a kind of physical activities in which individuals develop their bodies, enhance their health, regulate their spirits and enrich their lives according to their own needs through a variety of physical means and in combination with natural and health measures. In recent years, people's health awareness of health has deepened continuously. A number of studies have pointed out that appropriate physical exercise is helpful to improve the immune function of individuals and enhance the physique. According to existing research results, the cardiovascular system has obvious changes with age. Taking the heart as an example, myocardial cells will have obvious fibrosis, the muscle strength of ventricular muscle will be seriously reduced, and the celluar repair ability will weaken. Besides, the incidence of other events such as abnormal lipid metabolism and decrease in the elasticity of blood vessels will also increase. Nevertheless, appropriate physical exercise can effectively improve the above symptoms and delay myocardial

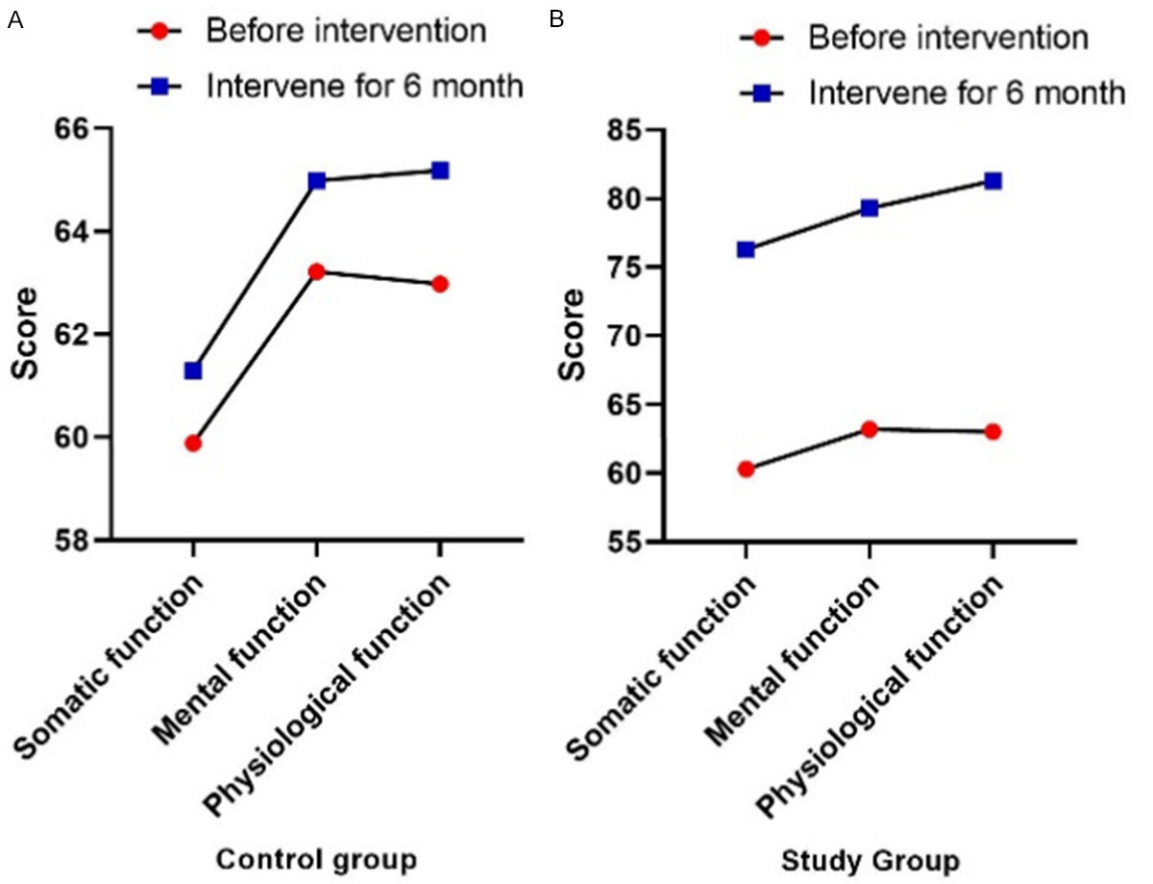


**Figure 4.** Comparison of QOL scores before and after intervention. The scores of somatic, mental and physiological functions in the control group did not significantly increase after intervention, with no significant differences between before and after intervention ($P>0.05$) (A). The scores in the study group significantly increased after intervention, with significant differences between before and after intervention ($P<0.05$) (B).

fibrosis, atrophy and denaturation [16]. In a survey of 94 middle-aged and older women who are aged 60-69 years old, through fast walking with a reasonable intensity for fitness, the cardiovascular and respiratory functions of the subjects have been obviously improved, their other zang-fu functions have been enhanced, even the anti-aging ability of the body has been developed, with remarkable effects [17]. Physical exercise, which is a relatively economic health behavior and the most basic positive and effective way to improve the health status and QOL of the elderly population, can promote individuals to be physically and mentally healthy. Moreover, the muscular and skeletal systems of the elderly will be strengthened and their disease resistance will be significantly enhanced via appropriate physical exercise [18].

In this study, the patients were grouped to analyze the influence of regular physical exercise on their QOL and laboratory parameters. The results showed that SBP and DBP in the study group (given combined regular physical exercise) showed more obvious improvement compared with those in the control group (given drug and conventional lifestyle interventions) after intervention. This suggests that physical exercise can significantly reduce individual blood pressure. The elasticity of blood vessels decreases with age, which is one of the physiological characteristics of blood pressure in the elderly, so the blood pressure increases by approximately 1.3 Kpa for every 10 years of age, and the increase elevates the incidence of AS [19]. The blood pressure in the study group showed more obvious improvement compared with that in the control group after intervention, possibly because the fast walking and Wuqinxi exercise used in the interventions belong to aerobic and metabolic exercise, which promotes the individuals to inhale ten times more oxygen under normal conditions. The increase

of oxygen content increases the hemoglobin of the body and speeds up the blood circulation, thus significantly changing SBP and DBP functions of blood vessels. At the same time, aerobic exercise also accelerates blood lipid metabolism, so that the thickness of the blood vessel wall is obviously reduced and the elasticity is increased, which thereby reduces blood flow resistance and obviously lowers SBP and DBP.

The results of this study also suggest that regular physical exercise can significantly reduce the subjects' RHR and improve their STST indices. As an important indicator reflecting the health status of individuals and a necessary indicator recommended by the World Health Organization for research on cardiovascular disease prevention, RHR not only reflects the individuals' cardiac reserve, but also predicts cardiovascular diseases to a certain extent [20]. We believe that due to the increase of peripheral vascular resistance, the elderly will have compensatory increase their HR to satisfy cardiac blood supply. Regular physical exercise can reduce the RHR, with two possible reasons as follows: (1) Aerobic exercise can improve the excitability of the cardiac vagus nerve and release acetylcholine from postganglionic fiber ending to reduce the HR. (2) Regular exercise can improve myocardial contractility, increase stroke volume and further reduce the HR [21]. The differences in the STST indices between the two groups may also be related to changes in cardiac function. The improvement of myocardial contractility makes individuals' HR changes more obvious in different stages of exercise. After exercise, the HR quickly recovers to RHR, which is reflected in the significantly higher indices in the study group.

The comparison of TG, TC and LDL-C levels between the two groups indicates that regular physical exercise can obviously reduce contents of the laboratory parameters in the individual's blood. The above parameters are commonly used cytokines for clinical hyperlipidemia evaluation, and their abnormal increase shows excessive blood lipid content in the blood, with hyperlipidemia considered as an independent risk factor for AS and an important index affecting the prognosis of cardiovascular patients. Accordingly, physical exercise can regulate the function of the autonomic nervous system of the body and reduce the excitability of the sympathetic nerve, positively significantly dilate motor muscle blood vessels, increase capillary density, and improve blood circulation and metabolism. Meanwhile, it accelerates the consumption of fat accumulated in the body, enhances lipase activity in individual muscles and adipose tissues, and then promotes the transfer of cholesterol and phospholipids to high-density lipoprotein. This process helps the liver to metabolize cholesterol accumulated on the blood vessel wall, further reducing the incidence of various cardiovascular events [22].

Finally, the comparison of QOL after intervention showed that the scores of somatic, mental and physiological functions in the study group were significantly higher than those in the control group. The authors of this paper believe that the evaluation of QOL should include not only the individuals' bodily function, but also the degree of their mental health [23]. In this study, the fast walking and Wuqinxi exercise were implemented in a centralized way, which provides the subjects with a communicative environment and reduces their time alone. The effects of proper social interaction on relieving individual anxiety and depression and improving their social support and self-cognition have been confirmed by many studies. The results in this study have further confirmed the positive significance of regular physical exercise in improving the QOL of cardiovascular patients.

In summary, regular physical exercise is helpful to improve the ABP, cardiopulmonary function and laboratory parameters of cardiovascular patients, and is also conducive to preventing the occurrence of atherosclerosis and other events and to significantly improving the QOL of the elderly, so it is worthy of clinical application. However, there are still deficiencies in this study: (1) The small sample size included leads to a certain one-sidedness in the research results. (2) The follow-up time for the investigated subjects was not long enough, so the long-term follow-up results are lacking. In view of the above deficiencies, surveys with a larger sample sizes and longer follow-up times are planned to be subsequently carried out, in order to provide more detailed theoretical bases for improving the QOL and bodily function of cardiovascular patients.

**Disclosure of conflict of interest**

None.

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