

New points of exercise therapy for hypertension

Jingjing Zheng¹, Yueying Liu², Xianglin Chi^{*1}

1. Postgraduate Training Base of Weihai Central Hospital, Jinzhou Medical University, No. 3 West of Mishan East Road, Wendeng District, Weihai 264400, China.

2. Weihai Central Hospital.

*Corresponding author: Professor Xianglin Chi; Telephone: 13563195807;

E-mail:chixl0631@163.com.

Received: May 15, 2022; Accepted: June 15, 2022

Abstract

Hypertension is a lifestyle-related systemic physical and mental disease with a complex pathogenesis. The blood pressure itself has the characteristics of complexity, non-linearity, and dynamics in the formation mechanism, which leads to more challenges in hypertension-related research, and there is still a long way to go for clinical prevention and control. For most hypertensive patients, stabilizing blood pressure from non-pharmacologic, pharmacologic to surgical treatment (e.g., some recalcitrant hypertension) requires a comprehensive, three-dimensional, and dynamic intervention that not only refers to evidence-based medical evidence, but also to individualized, unconsolidated, and uniform models of hypotension. Due to the individual differences in age, gender, body mass index, heredity, lifestyle, cultural

Correspondence author: Xianglin Chi, Doctor degree
Professional title: Associate chief physician
Research direction: Hypertension and related diseases
General Practice Department of Weihai Central Hospital
Affiliated to Weifang Medical College, China

background, economic role. Exercise therapy is not differences, psychological only an important non-demands, hypertension pharmacological treatment but classification, risk stratification, also a basic link of and so on, the pathways to hypertension prevention and maximize antihypertensive control. In the face of the benefits vary among serious situation of the hypertensive patients. For youthfulness of hypertension example, most patients with and the high incidence of pre-hypertension can achieve hypertension, strengthening the good results through non-national fitness exercise is the pharmacological treatments best choice. However, there is such as lifestyle improvement, no fixed method for rational exercise, psychological hypertension patients to counseling, and so on. For most exercise. We should not only hypertensive patients with consider the evidence from target organ damage, the above-evidence-based medicine, but mentioned non-pharmacological also vary depending on time treatment is also a basic and place to achieve the antihypertensive measure and greatest benefit//risk ratio. To an important guarantee for better guide the exercise antihypertensive drugs to play a treatment of hypertension, the

authors offer some new ideas and perspectives.

Keyword

hypertension; exercise therapy; aerobic exercise

1. The exercise method should be based on oxygen exercise and physical activity based on aerobic exercise should be advocated.

From a physiological point of view, there is a close interaction and fine coordination mechanism between the cardiovascular system and the respiratory system.

Dynamic cardiopulmonary coupling is essential not only to ensure effective blood oxygen supply, but also to ensure stable heart rate and blood pressure. High

cardiopulmonary adaptation coupling has been shown to prevent the progression of prehypertension to hypertension, as well as future deaths from coronary heart disease and all causes, even in people with hypertension or other cardiovascular risk factors [1-2]. The effect of different

respiratory patterns on blood pressure is based on cardiopulmonary interaction and fine regulation [3]. It can be said that any exercise is a combined cardiorespiratory exercise. Cardiopulmonary Exercise Test (CPET) can evaluate the upper limit of individual cardiopulmonary function and give individual exercise prescriptions

accordingly. The application of CPET in hypertension is helpful to the accurate formulation of individualized exercise rehabilitation prescription of moderate-intensity [4]. Exercise therapy advocating aerobic exercise has always been the basic principle, the so-called aerobic exercise, refers to the body in the oxygen supply when the aerobic metabolism-based exercise, generally prolonged (more than 30 minutes) exercise, moderate-intensity (40%~60%VO₂max), the main muscles of the body involved, the body through breathing oxygen intake and consumption of oxygen to achieve dynamic balance. At present, most studies [5-9] recommend low-and medium-intensity aerobic exercise, which can improve lung function and play an effective antihypertensive effect under the maximum safety factor. In particular, moderate-intensity aerobic exercise is superior to low-intensity and sustained high-intensity exercise in preventing and assisting in lowering blood pressure [5-9]. Of course, intensity classification is an artificially defined range but also has individual differences. At present, the commonly used moderate-intensity exercise is based on the heart rate. 60% to 70% of the maximum heart rate (220-age) is usually considered as high-intensity exercise [5-9].

Cardiorespiratory adaptations will further improve when exercise is sustained. Studies [10-11] showed that patients with good cardiorespiratory adaptations had fewer new episodes of hypertension than those with poor health status. Furthermore, in addition to the unconscious cardiopulmonary autonomic coupling, subjects can also adjust their breathing pattern consciously, such as deep breathing (also known as abdominal breathing), changing the respiratory frequency, and so on. The study [12] shows that respiratory training can restore the autonomic nervous regulation function, improve the dynamic balance of sympathetic/parasympathetic nerve, reduce heart rate and peripheral vascular resistance, and improve heart rate variability, thus lower blood pressure in hypertensive patients. Other studies [13-14] have shown that abdominal breathing can increase tidal volume through diaphragm movement. To stimulate pulmonary detrusor reflex, aortic arch, carotid sinus pressure receptor reflex, aortic body and carotid body chemoreceptor reflex, improve cardiovascular autonomic regulation and decrease heart rate and blood pressure. In addition, aerobic exercise based on cardiopulmonary dynamic coupling can activate

neuromuscular junction [15] and mitochondrial function [16], which may partly explain the improvement of functional autonomy.

2. The exercise therapy should be static.

Since it is exercise therapy and the combination of movement and stillness, it seems to be a logical paradox, but in fact it is not.. Because the stillness mentioned here is active stillness, it is a kind of "external stillness" and "internal movement", "mental calmness" and "pneumatic" movement, such as Taijiquan, relaxation training, meditation, Qigong, meditation, and so on. This is completely different from the passive sedentary

"stillness". Many studies [17-19] have confirmed that the above "quiet" exercises can reduce the excitability of the cerebral cortex, affect the neuroendocrine system, and then improve autonomic nervous regulation, reduce heart rate and blood pressure, and improve blood pressure variability. This type of exercise is much safer. The disadvantage is that it requires special guidance and training, and the cumulative effect of a certain period of time. In general, exercise therapy is an active and absolute mode of dynamic activity, such as running, swimming, mountain climbing, rope skipping, pedaling, and so on. This kind

of exercise has high exercise intensity and high oxygen consumption. Most of them have significant post-exercise hypotension [11, 20], which is mainly suitable for normal people, mild hypertension, young and middle-aged hypertensive patients, and hypertensive patients with mild target organ damage [21-22]. The disadvantage is that some elderly patients with hypertension, especially those with weakness, are often difficult to tolerate [9], and there will be a sharp increase in blood pressure during exercise, inducing and/or aggravating various complications of hypertension, and so on. Many studies have discussed the optimal training mode for this kind of sport (including intensity, frequency, time, type, combination form, etc.), which is mainly due to significant individual differences. This is also related to the significant differences in the subjects of the study, the difficulty of randomization, and other factors. According to Levine et al. [25], most exercises contain dynamic components and static components. Dynamic exercise components can promote the increase of blood flow, which mainly leads to left ventricular volume overload, while static exercise components lead to pressure overload. The primary risk factor for hypertension is age, and the prevalence rate of

hypertension increases with age. The results of the China Hypertension Survey (CHS) [26] showed that the prevalence rate of hypertension in Chinese adults aged 18 years was 23.2%; the Chinese Longitudinal Healthy Longevity Survey (CLHLS) [27] showed that the prevalence of hypertension in Chinese 80-year-olds was 56.5%. With the increase of age, the body weakens, the blood vessels gradually age, the arterial stiffness increases physiologically, and the blood pressure increases in varying degrees, so it can be said that hypertension is a kind of arterial degenerative disease. Exercise has a wide range of short-term and long-term effects, involving prevention of immunity, functional improvement, treatment and rehabilitation, anti-aging, etc. [28]; similarly, active "meditation" exercise also has these effects [17-19]. Therefore, exercise therapy should be a balanced combination of dynamic and static development.

3. The movement method, and body and body exercise therapy should move the body and body together.

In a fundamental sense, most diseases are physical and mental diseases, and mental health and physical health are one of two aspects that affect each other, and hypertension is just the same. Therefore, physical and mental co-

movement is also advocated for improving anxiety and diseases that are suitable for depression, while the exercise therapy. Competitive psychological stress caused by sports are generally more competitive sports may intense, athletes have greater counteract this benefit. mental stress, and the effects on Therefore, exercises hypertension and its prescription must pay attention complications may be two-way, to entertainment, from taking that is to say, strenuous exercise as a means of reducing exercise may lead to an increase blood pressure, and then in the risk of cardiovascular and forming a love of exercises, other events [29-30]. But the developing habits, and conclusions of related studies persevere. In China, some [25,31-32] are also traditional fitness sports, such as Wuqian Opera and Baduanjin, controversial as these studies have been re-concerned and have found that athletes may sought after in recent years, and have increased life expectancy. Some studies [24,33-34] some studies have found that advocate autonomous, they can reduce blood pressure recreational and purposeful [35]. In addition, square dance exercise as having a greater is very popular in China in neuroendocrine impact and recent years. It has even formed

a socio-cultural phenomenon, and some studies have found it to have a hypotensive effect [36]. These sports have obvious characteristics of the simultaneous movement of body and mind, of course, the way and intensity of exercise are different, and the influence on the mental state of athletes is also different. According to the study by Lind et al. [37], self-selective exercise intensity is helpful to establish a stable and positive emotional state, which can keep it close to but below the ventilation threshold, thus playing a more effective role in reducing blood pressure. Long-term exercise can promote the remodeling of the structure and function of all body systems, restore the dynamic balance of cardiovascular regulation, improve neuroendocrine regulation, enhance immunity, and improve the overall physical and mental health. With the development of society, increasing mental work, and the incidence of hypertension in cities is on the rise, which has exceeded that in rural areas in China, which seems to be related to the "heart and brain" moving and "body" sedentary [38]. In fact, it is not. The main reason may be that most mental workers are under mental stress load, often at the cost of non-benign work and rest, lack of exercise, and unreasonable diet, which leads to heart rate disorder, blood

pressure fluctuation and gradual increase. For most manual workers, who mainly work in a stressful, task-oriented, purposeless manner and lack emotion and recreation, and their physical exercise is either in an overload state or in a stereotyped mode. Not only does it fail to achieve effective exercise, but it also tends to cause chronic fatigue or chronic strain on the musculoskeletal system, which in turn leads to metabolic disorders and causes or aggravates hypertension.

4. Dynamic integration and department

The human body is not only a biomechanical system, but also a biochemical system, and the effect of exercise on the

body is also based on tissue structure mechanics and neuroendocrine. The human body is also a holographic fractal system with mainly open closed-loop control, which can reflect the whole, and the whole can also be shown as a local response. During exercise, fast and slow response information is transmitted through muscle, skeletal, fascia, neuroendocrine and other systems, and the effects of local exercise will cause systemic reactions through neurohumoral

mechanisms and vice versa. The prevalence of hypertension is proportional to age and is often associated with different degrees of cervical spondylosis, lumbar disc herniation, bone

and joint degenerative balance and improve inflammatory lesions, which neuroendocrine regulation, will limit the intensity, which is supported by most frequency, and mode of studies. Some studies [41] have exercise and increase the suggested that the probability of fall [39-40]. At antihypertensive effect of rapid the same time, most patients intermittent high-intensity with hypertension have whole-body exercise is more autonomic nervous regulation obvious than that of low-disorders such as high heart rate, intensity and medium-intensity decreased heart rate variability, whole-body exercise, but the and poor vascular reactivity. As population included in the study vascular disease progresses, this was limited to grade 1 will inevitably lead to 4 hypertension, and there was no impaired stress responses in long-term follow-up. After all, hypertensive patients. Therefore, blood pressure can often rise to whole-body exercise is suitable 2-3 times that of resting blood for almost all patients with pressure during exercise, and hypertension, especially "low to the increase may be more moderate intensity" whole-body pronounced in patients with endurance exercise, which can high blood pressure, especially regulate human mechanical in systemic high-intensity

endurance exercise and resistance exercise, such as running, swimming, and strength training. At this time, the risk of cardiovascular and cerebrovascular accidents is bound to increase [42].

Hypertension is a systemic disease, but local lesions can also induce or aggravate hypertension, such as arterial stenosis or occlusion of limbs or organs. In recent years, many studies [43-44] have also begun to pay attention to the combination of local exercise and systemic exercise, such as isometric resistance training, limb traction exercise, and general endurance exercise such as swimming and running, and found that a better

antihypertensive effect can be achieved.

5. The combination of active exercise and passive exercise should be considered in the exercise test and motion knot exercise therapy.

At present, most traditional training methods are active sports, such as running, swimming, playing football, and so on. In recent years, with the help of some tools, such as treadmills, power bicycles, robots, and other auxiliary sports have been accepted by some people. This exercise belongs to the combination of active and passive exercise, which mainly has three advantages: 1. It can be carried out at home and gym without

the influence of external rehabilitation techniques or environment such as rain and external counterpulsation snow, haze, crowding, etc.; 2. It therapy, which is not only can assist in exercise to avoid conducive to the improvement abrupt termination of exercise; of limb motor function, 3. It is suitable for some people prevention, and treatment of with limited activities, which complications but also are conducive to the smooth conducive to the stable control control of blood pressure. The of blood pressure [47]. In China, study [45-46] confirmed that some traditional Chinese this kind of exercise has the medicine techniques can be same antihypertensive effect as used in the treatment of active exercise, and has high hypertension, such as massage safety. There are also some combined with passive limb patients with hypertension who traction [48], including passive are mainly passive exercises, exercise, but its true such as some patients with limb effectiveness needs to be motor dysfunction caused by confirmed by large-scale stroke, bedridden patients clinical evidence-based caused by various reasons, and research. elderly weak people. They need

6. The quantification and quality of exercise therapy

to receive specific

should follow the evidence guide, and should be based on the real world.

Exercise therapy is not only a lifestyle intervention but also a natural therapy practice, which is different from drugs. Exercise therapy takes more time and requires a certain amount of perseverance, and lack of perseverance is often the main reason why most people are sedentary. Long-term and strenuous exercise not only needs the support of objective conditions but also needs higher subjective perseverance to endure fatigue and pain. Due to the pressure of survival, many people get up early and return late, or work three shifts, or the living

environment is limited, so they do not have sufficient conditions for exercise. On the other hand, many patients with hypertension have chronic fatigue or other complications of different degrees and/or levels (such as ischemic heart disease, degenerative inflammation of the bone and joint, etc.), which can't tolerate higher exercise intensity. It will lead to the prescription of exercise therapy can not being individualized and quantified. The physical exercise guidelines for patients with 2020ESC exercise Cardiology and Cardiovascular Disease [49] recommend that all healthy adults do at least 150min moderate-intensity aerobic

exercises every week, or pressure control, it is 75mm/-week high-intensity recommended to temporarily aerobic exercise; hypertensive restrict participation in patients should do at least competitive sports, except for 30min moderate-intensity skillful sports. For high-risk aerobic exercises (walking, groups, including target organ jogging, cycling or swimming) damage (such as left ventricular every day, 5~7d/ week; and 3d/ hypertrophy, diastolic week strength 5 exercise is also insufficiency, hypertensive recommended. If you need to retinopathy, ultrasound showing participate in high-intensity arterial wall thickening or exercise, you need to assess the atherosclerotic plaques), and cardiovascular condition to renal insufficiency, even if the determine whether there are blood pressure is well exercise-induced symptoms, controlled, discus/javelin, shot excessive blood pressure put and weightlifting are not response to exercise, and target recommended, and you can organ damage; if systolic blood participate in other competitive pressure is > 160mmHg, it sports. The author believes that should be postponed until the although the guide has put blood pressure is under control; forward some specific for people with poor blood suggestions on exercise

quantification, it is still insufficient in guiding real-world sports practice, especially for people with special sports hobbies, such as those who like Taijiquan, Baduanjin, yoga, and other forms of exercise. The curative effect of this form of exercise can't be evaluated only by time and the degree of fatigue, what is more, important is its exercise quality, which comes more from the subjective feeling and internal experience of the athlete, which varies greatly and has the certain fuzziness. It's hard to quantify objectively.

Conclusion

The current situation of hypertension is worrying, and the situation of prevention and

control is very serious. Lack of exercise is an important risk factor for hypertension. According to statistics, at present, residents in many places around the world have the characteristics and trend of lack of physical activity [50]. It is also estimated that by 2025, 30% of the world's adults will suffer from hypertension, and the likelihood of lack of exercise will increase in the future [51]. In particular, intractable hypertension, which accounts for about 10% of all hypertensive patients responds poorly to medications, and exercise therapy is effective [52]. It is noteworthy that there are still 20% to 25% of hypertension patients whose

blood pressure is not reduced as a result of acute or chronic exercise [53]. Some people even experience elevated blood pressure as a result of exercise training, although this is not common and not consistently reported. However, under the premise of optimizing the benefit/risk ratio, the higher the blood pressure, the more the benefits of exercise therapy, and the greater the decrease of blood pressure; while under the premise of ensuring aerobic exercise, the greater the exercise intensity, the greater the range of blood pressure reduction. In conclusion, encouraging the whole population to exercise and keep fit is an important measure to

reduce the incidence of hypertension and achieve the cardiovascular health for all.

references

- [1]Kodama S, Saito K, Tanaka S, et al.Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: a meta-analysis [J] .JAMA, 2009, 301(19):2024-2035.
- [2]Berry JD, Willis B, Gupta S, et al.Lifetime risks for cardiovascular disease mortality by cardiorespiratory fitness levels measured at ages 45, 55, and 65 years in men: the Cooper Center Longitudinal Study [J] . J Am Coll Cardiol, 2011, 57(15):1604–1610.
- [3]Zhang Z, Wang B, Wu H, et

- al.Effects of slow and regular breathing exercise on cardiopulmonary coupling and blood pressure [J] .Med Biol Eng Comput,2017,55(2):327-341.
- [4]Santoro C, Sorrentino R, Esposito R,_____et al. Cardiopulmonary exercise testing and echocardiographic exam: an useful interaction_[J].Cardiovasc Ultrasound. 2019,17(1):29.
- [5]Swift DL,_____Earnest CP, Katzmarzyk PT, et al.The Effect of Different Doses of Aerobic Exercise Training on Exercise Blood Pressure in Overweight and Obese Postmenopausal Women [J] .Menopause,_2012,_19(5): 503-509.
- [6]Wen H,_____Wang L.Reducing effect of aerobic exercise on blood pressure of essential hypertensive patients: A meta-analysis [J] .Medicine (Baltimore),_2017, 96(11):e6150.
- [7]Lopes S,_____Mesquita-Bastos J, Alves AJ,_____et al.Exercise as a tool for hypertension and resistant hypertension management: current insights [J] .Integr Blood Press Control,_2018,_11: 65-71.
- [8]Wiles JD,_____Taylor K,_____Coleman D, et al.The safety of isometric exercise: Rethinking the exercise prescription paradigm for those with stage 1 hypertension [J] .Medicine (Baltimore), 2018, 97(10): e0105.
- [9]Ghadieh AS,_____Saab B.Evidence for exercise training in the management of hypertension in adults. Can Fam Physician,_2015, 61(3):233-239.
- [10]Lee DC,_____Sui X,_____Church TS,_____et

- al.Changes in fitness and fatness on the development of cardiovascular disease risk factors hypertension, metabolic syndrome, and hypercholesterolemia [J] . Am Coll Cardiol, 2012, 59(7):665-672.
- [11]Alpsoy Ş.Exercise and Hypertension [J] .Adv Exp Med Biol,2020,1228:153-167.
- [12]Santoro C, Sorrentino R, Esposito R, et al.Cardiopulmonary exercise testing and echocardiographic exam: an useful interaction [J] .Cardiovasc Ultrasound, 2019 Dec 3; 17(1):29.
- [13]Ublosakka-Jones C, Tongdee P, Pachirat O, et al.Slow loaded breathing training improves blood pressure, lung capacity, and arm exercise endurance for older people with treated and stable isolated systolic hypertension.Exp Gerontol,2018,108:48-53.
- [14]Hamasaki H.Effects of Diaphragmatic Breathing on Health: A Narrative Review [J] Medicines (Basel). 2020,7(10):65.
- [15]Da Silva LA, Menguer L, Motta J, et al.Effect of aquatic exercise on mental health, functional autonomy, and oxidative dysfunction in hypertensive adults [J] .Clin Exp Hypertens, 2018, 40(6):547-553.
- [16]Konopka AR, Suer MK, Wolff CA, et al.Markers of human skeletal muscle mitochondrial biogenesis and quality control: effects of age and aerobic exercise training [J] .Gerontol A Biol Sci Med Sci, 2014, 69(4):371-378.
- [17]Gathright EC, Salmoirago-Blotcher E, DeCosta J, et al.The

- Impact of Transcendental Meditation on Depressive Symptoms and Blood Pressure in Adults with Cardiovascular Disease: A Systematic Review and Meta-Analysis [J] .Complement Ther Med, 2019, 46:172–179.
- [18]Schneider RH, Myers HF, Marwaha K, et al. Stress Reduction in the Prevention of Left Ventricular Hypertrophy: A Randomized Controlled Trial of Transcendental Meditation and Health Education in Hypertensive African Americans [J] .Ethn Dis, 2019, 29(4): 577–586.
- [19]Ponte Márquez PH, Feliu-Soler A, Solé-Villa MJ, et al. Benefits of mindfulness meditation in reducing blood pressure and stress in patients with arterial hypertension [J] .J Hum Hypertens. 2019 Mar;33(3):237-247.
- [20]Bocalini DS, Bergamin M, Evangelista AL, et al. Post-exercise hypotension and heart rate variability response after water and landergometry exercise in hypertensive patients [J] .PLoS One, 2017, 12(6): e0180216.
- [21]Lopes S, Mesquita-Bastos J, Alves AJ, et al. Exercise as a tool for hypertension and resistant hypertension management: current insights [J] .Integr Blood Press Control, 2018, 11: 65-71.
- [22]Saco-Ledo G, Valenzuela PL, Ruiz-Hurtado G, et al. Exercise Reduces Ambulatory Blood Pressure in Patients With Hypertension: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

- [J] . J Am Heart Assoc. American Heart Association and
2020,9(24): e018487. American College of Cardiology
- [23]Boutcher YN, Boutcher [J] . J Am Coll Cardiol, 2015,
SH.Exercise intensity and 66(21):2350-2355.
- hypertension: what's new?Journal [26]Wang Z, Chen Z, Zhang L, et
of human al.Status of Hypertension in China:
hypertension,2017,31(3):1-8. Results From the China
[24]Costa IBB, Schwade D, Hypertension Survey, 2012-
Macêdo GAD, et al.Acute 2015[J]. Circulation, 2018,
antihypertensive effect of self- 137(22):2344-2356.
- selected exercise intensity in older [27]Du J, Zhu G, Yue Y, et
women with hypertension: a al.Blood pressure and
crossover trial [J] .Clin Interv hypertension prevalence among
Aging, 2019, 14:1407-1418. oldest-old in China for 16 years:
[25]Levine BD, Baggish AL, based on CLHLS [J] . BMC
Kovacs RJ, et al.Eligibility and Geriatr. 2019,19(1):248.
- disqualification recommendations [28]Galloza J, Castillo B, Micheo
for competitive athletes with W.Benefits of Exercise in the
cardiovascular abnormalities: task Older Population [J] .Phys Med
force 1: classification of sports: Rehabil Clin N
dynamic, static, and impact: a Am,2017,28(4):659-669.
- scientific statement from the [29]Berge HM, Isern CB, Berge

- E. Blood pressure and hypertension in athletes: a systematic review [J] .Br J Sports Med, 2015, 49(11):716-723.
- [30] Börjesson M, Onerup A, Lundqvist S, et al. Physical activity and exercise lower blood pressure in individuals with hypertension: narrative review of 27 RCTs [J] .Br J Sports Med, 2016, 50(6):356-361.
- [31] Sarna S, Sahi T, Koskenvuo M, et al. Increased life expectancy of world class male athletes [J] . Med Sci Sports Exerc, 1993, 25:237-244.
- [32] Sharman JE, Gerche AL, Coombes JS. Exercise and cardiovascular risk in patients with hypertension [J] .Hypertens, 2015, 28(2):147-158.
- [33] Milanović Z, Pantelić S, Čović N, et al. Is Recreational Soccer Effective for Improving VO2max A Systematic Review and Meta-Analysis [J] .Sports Med, 2015, 45(9):1339-1353.
- [34] Krstrup P, Helge EW, Hansen PR, et al. Effects of recreational football on women's fitness and health: adaptations and mechanisms [J] .Eur J Appl Physiol, 2018, 118(1):11-32.
- [35] Song Y, et al. Front Cardiovasc Med. 2021.
- [36] Xie W, Chen WW, Zhang L. The effect of square dance on family cohesion and subjective well-being of middle-aged and empty-nest women in China. Health Care Women Int, 2021, 42(1):43-57.
- [37] Lind E, Joens-Matre RR, Ekkekakis P. What intensity of

- physical activity do previously sedentary middle-aged women select? Evidence of a coherent pattern from physiological, perceptual, and affective markers [J] . *Prev Med* (Baltim),2005,40(4):407-419.
- [38]Wang Zengwu, Hao Guang, Wang Xin, et al. Analysis on the status quo of overweight/obesity in middle-aged people and the aggregation of risk factors for cardiovascular disease in China[J].*Chinese Journal of Hypertension*,2014,35(10):1000.
- [39]Yu Yabin,Huang Jiaqiang,Xia Hong. Research progress on the correlation between metabolic syndrome and lumbar discherniation[J].*Chinese Journal of Physicians*,2018,20(2):315-318.
- [40]Angeli F, Trapasso M, Signorotti S, et al.Amlodipine and celecoxib for treatment of hypertension and osteoarthritis pain [J] . *Expert Rev Clin Pharmacol.* 2018,11(11):1073-1084.
- [41]Eicher JD, Maresh CM, Tsongalis GJ, et al.The additive blood pressure lowering effects of exercise intensity on post-exercise hypotension [J] . *Am Heart J*, 2010,160(3):513-520.
- [42]De Souza Nery S, Gomides RS, De Silva GV, et al. Intra-arterial blood pressure response in hypertensive subjects during low- and high-intensity resistance exercise [J] .*Clinics*,2010,65(3):271–277.
- [43]Cornelissen VA, Smart NA.Exercise training for blood pressure: a systematic review and

- meta-analysis [J] . Am Heart Assoc, 2013, 2(1):e004473.
- [44]Pescatello LP, MacDonald HV, Lamberti L, et al. Exercise for Hypertension: A Prescription Update Integrating Existing Recommendations with Emerging Research [J] . Curr Hypertens Rep, 2015, 17(11):87.
- [45]Dimeo F, Pagonas N, Seibert F, et al. Aerobic exercise reduces blood pressure in resistant hypertension [J] . Hypertension, 2012, 60(3):653-658.
- [46]Michishita R, Ohta M, Ikeda M, et al. Associations of the work duration, sleep duration and number of holidays with an exaggerated blood pressure response during an exercise stress test among workers [J] . Sangyo Eiseigaku Zasshi, 2016, 58(1):11-20.
- [47]Tao Yangyu, Xue Xinhong, Wang Xiaoguang, et al. The effect of new Bobathan technique in rehabilitation treatment in patients with stroke and hypertension [J]. Journal of Chronic Diseases, 2020, 21(10):1501-1503.
- [48]Deng Kelin, Lei Junxuan, Luo Yina, et al. Research overview of TCM tuina in the treatment of essential hypertension [J]. Journal of Guangzhou University of Chinese Medicine, 2021, 38(5):980-984.
- [49] Pelliccia A, Sharma S, Gati S, et al. 2020 ESC Guidelines on sports cardiology and exercise in patients with cardiovascular disease [J] . Eur Heart J, 2021, 42(1):17-96.
- [50] Ng SW, Popkin BM. Time use

- and physical activity: a shift away from movement across the globe [J] .Obes Rev,2012,13(8):659-680.
- [51]He L, Wei WR, Can Z.Effects of 12-week brisk walking training on exercise blood pressure in elderly patients with essential hypertension: a pilot study [J] .Clin Exp Hypertens, 2018, 40(7):673-679.
- [52]Nascimento LS, Santos AC, Lucena J, et al.Acute and chronic effects of aerobic exercise on blood pressure in resistant hypertension: study protocol for a randomized controlled trial [J] .Trials, 2017, 18(1):250.
- [53]Pescatello LS, Franklin BA, Fagard R, et al.American College of Sports Medicine position stand: exercise and hypertension [J] .Med Sci Sports Exerc, 2004, 36(3):533–553.
- [54]Leifer ES, Mikus CR, Karavirta L, et al.Adverse cardiovascular response to aerobic exercise training: is this a concern [J] . Med Sci Sports Exerc,2016,48(1):20–25.
- [55]Bouchard C, Blair SN, Church TS, et al.Adverse metabolic response to regular exercise: is it a rare or common occurrence [J] .PLoS One, 2012, 7(5):e37887.