



Effect of Tai Chi, Hatha Yoga, and Meditation on HRV in Elderly Women

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Abstract

Background and Aims: The rapid aging of China's population has increased cardiovascular disease risk, making it the leading cause of death among the elderly. While tai chi, hatha yoga, and meditation are known to influence heart rate variability (HRV), research on their effects in China remains limited. This study aims to compare the impact of these practices on HRV in elderly women.

Methodology: From August to November 2024, 45 healthy women aged 60–65 years in Zhangjiakou, Hebei Province, were recruited and randomly assigned to three groups (n=15 each): Chen-style Tai Chi, Hatha Yoga, and Meditation. After 12 weeks of intervention, HRV improvements were assessed using time-domain and frequency-domain measures to determine the most effective training method.

Results: After 12 weeks, the Hatha Yoga group showed significantly greater improvements in SDNN and RMSSD compared to the Meditation group ($P<0.01$). The Tai Chi group also exhibited a significant increase in SDNN ($P<0.05$) compared to the Meditation group, while RMSSD in the Hatha Yoga group was significantly higher than in the Tai Chi group ($P<0.01$). In the frequency domain, HF, LF/HF, and TP significantly improved in both the Hatha Yoga and Tai Chi groups compared to the Meditation group ($P<0.01$). Additionally, LF values were significantly higher in the Hatha Yoga group than in the Meditation group ($P<0.05$).

Conclusion: Hatha Yoga, Tai Chi, and Meditation all enhance HRV in older women. However, Hatha Yoga led to the most pronounced improvements in vagal activity and autonomic regulation, followed by Tai Chi, which was more effective than Meditation in enhancing HRV.

Keywords: Tai Chi; Hatha Yoga; Meditation; Heart Rate Variability; Elderly Women

Introduction

In recent years, with the rapid economic development, the continuous improvement of living standards, and the constant change of lifestyles, people have taken health as the focus of their attention. The physical health status of the citizens has also become one of the conditions for measuring the comprehensive strength level of a country. At present, various sudden





cardiovascular and cerebrovascular diseases have become the main factors threatening human life in today's world, seriously endangering human life and health.

In China, due to the transformation of the social economy, the change of people's lifestyles, and the accelerated process of population aging, the risk factors for the onset of cardiovascular diseases have increased, and its mortality rate still ranks first among the total causes of death (Li & Qu, 2015). A large number of studies have shown and confirmed that the occurrence of many diseases is related to autonomic nerve activity, especially for the occurrence of certain cardiovascular diseases. The burden on patients with cardiovascular diseases is increasing day by day, which hinders the construction of a harmonious society. Cardiovascular diseases have become a major public health issue in our country. It is urgent to strengthen the prevention and treatment of cardiovascular diseases.

The development of the economy has brought convenience to people's movement, forming a lifestyle of "traveling by car" and "sitting still with little movement". The reduction in physical activity has led to the weakening of people's physical fitness and the gradual emergence of sub-health problems in the human body (Feng et al., 2016; Li, 2015). Exercise has become the key to changing one's health condition and can prevent the occurrence of various diseases. Research on the balance state of cardiovascular autonomic nerves has emerged in fields such as competitive sports, meditation, and fitness exercises, achieving certain results. However, research in China is still in its infancy (Wen et al, 2013).

The function of the cardiac autonomic nervous system can be evaluated using Heart Rate Variability (HRV) (Castaldo et al, 2015). HRV can reflect some pathological conditions of the body, such as congestive heart failure, diabetic neuropathy, and coronary heart disease (Tsuji et al, 1994). Middle-aged and elderly people are the main group affected by cardiovascular diseases. More and more communities are organizing mass sports activities, aiming to enhance the public's awareness of fitness, cultivate their interest in physical exercise, and promote the healthy development of middle-aged and elderly people in all aspects of society.

A large number of studies have shown (Annells et al., 2016; Golosheykin, 2005; Guo, 2015; Qu & Liu, 2009; Wu et al, 2009). Meditation training, Hatha Yoga, and Tai Chi can influence the activity of the autonomic nervous system, which can improve the health of the elderly, improve the cardiovascular function of the elderly, and achieve the prevention of chronic diseases. The purpose of this study is to explore the effects of Hatha yoga, Tai Chi, and meditation on heart rate variations in middle-aged and elderly women. This paper focuses on the study of the heart rate variability of elderly women. The starting point of this study is to compare and analyze the HRV parameters of elderly women under the influence of three different training methods combined with the physiological characteristics of elderly women, and to find out the training





items that have a greater impact on the heart rate variability of elderly women. To provide a theoretical basis for the prevention of heart rate variability and the selection of training programs for the elderly female population in the future.

Objectives

Through Hatha yoga, Tai Chi, and meditation, three different programs of intervention. According to the measurement results of the subjects, the change in HRV was analyzed. Compare the results of the three ways on the HRV of the subjects, and determine a more effective exercise method to improve HRV.

Literature Review

Heart rate variability (HRV) refers to the variability of continuous fluctuations between beat-to-beat RR intervals (instantaneous heart rate), which reflects the degree of sinus arrhythmia (Dreifus, 1993; Malliani et al.,1991). Mainly reflects the regulatory function of the autonomic nervous system on the heart. Under normal circumstances, the heart rate of healthy people will also fluctuate slightly. If the cardiac cycle remains constant or becomes smaller in different people, different genders, and different exercise situations, HRV will decrease, which is abnormal.

Tai Chi, as a relatively popular boxing technique in the treasure house of Chinese martial arts, has become an outstanding cultural heritage of the Chinese nation due to its characteristics of calming the mind and relaxing the body, combining hardness and softness, arc shaping, stable winding, coherent cooperation, and combination of movement and stillness. It requires the whole body to reach a state of relaxation from the inside to the outside, and only then can the body be controlled with consciousness, using intention rather than force, to complete "movement is like spinning threads, and steps are like cat walking", forming a penetration from internal movement to external movement in one go. Taijiquan has an impact on the heart rate, blood circulation, blood pressure, and physiological function of the human cardiovascular system, so that the improvement of the human cardiovascular system can be obvious (Wu, 2006).

Yoga is a philosophy that originated in ancient India. It is a movement that combines spirit and body. From the perspective of fitness, yoga is considered to be a kind of exercise, gymnastics, psychological adjustment, mental development, and other fitness methods. Qiu (2016) positioned yoga as a social sports project that integrates the four elements of posture, breathing, meditation, and prana-regulating, and aims to enhance physical fitness and promote the comprehensive and coordinated development of body and mind. The breathing of Hatha yoga is divided into two stages, pranayama and activity. In the pranayama stage, generally take chest breathing, and focus their consciousness on each breath, each breath to do deep inhalation and deep exhalation, as





far as possible to make their breathing slow, long, and smooth. So that the mind to get quiet, become peaceful. In the exercise phase, Hatha yoga will focus on chest breathing, complete breathing as a supplement, and combine breathing with asanas, and comply with the principles of yoga breathing and movement, namely, up and down breathing, and open and absorb breathing. In the exercise process, through the perfect coordination of breathing and exercise, adjust the breathing rhythm during the exercise, better improve the cardiorespiratory endurance.

Meditation can be defined as anything related to the training and conditioning of the body and mind. Meditation (Ren et al., 2010; Marlatt & Kristeller, 1999). It is a form of consciousness modification that enhances self-awareness and well-being by enabling people to achieve a deep state of calm, during which they may focus on and regulate their breathing, adopt certain physical postures to minimize external stimuli, and achieve a state of self-abandonment.

In the global aging pattern, 60-65 years old is generally adopted as the division of the elderly. For the elderly population, with the increase of age, the cardiovascular system is gradually degraded, the activity of myocardial energy synthetase is reduced, and lipofuscin is accumulated in the heart. The increase of myocardial parenchymal cell mortality leads to the acceleration of atrophy, which may cause cardiovascular and cerebrovascular diseases (Hou, 2015). At the same time, the strength and elasticity of the respiratory muscle gradually decrease, so that the alveolar ventilation volume also decreases, and the function of the respiratory system deteriorates (Ren et al, 2015).



Conceptual Framework

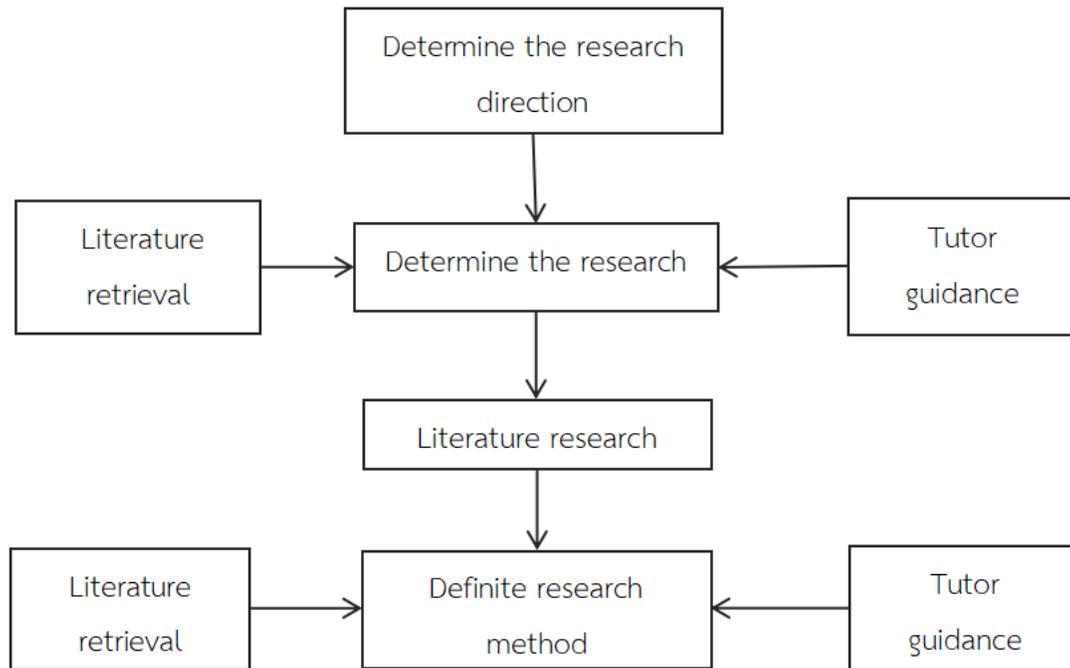


Figure 1 Conceptual Framework

Methodology

Data and methods

In this study, general elderly women aged 60-65 years old who have not done systematic exercise in the urban area of Zhangjiakou, Hebei Province, China, from August 2024 to November 2024 were selected. The basic physical conditions were first screened, and it was required that they were in good health and had no family genetic history. Finally, 45 elderly women were identified as the subjects of this experiment. All of them have participated in systematic physical fitness exercises and are practicing Tai Chi. For beginners of Hatha yoga and meditation, 45 elderly women were first given group training of Tai chi, hatha yoga and meditation for 2 weeks, and then randomly divided into three groups according to the statistical table method: tai chi group (15 people), Hatha yoga group (15 people) and meditation group (15 people). The selection criteria are as follows.

Inclusion criteria

1. The experimental subjects are women who have no experience in Tai Chi, yoga, or meditation and are aged between 60-65 years old;
2. Not engaging in regular exercise for a long time (duration of exercise ≥ 6 months; number of exercises per week ≥ 1 time; each exercise time ≥ 30 minutes);

3. No falls in the past year;
4. No damage to sensory organs, auditory organs, or nervous system in the past six months;
5. No injuries affecting limb connection in the past year (surgery or disease).
6. Voluntarily participate in the experiment and be able to complete learning and exercises independently. Your family members know and agree, and you can guarantee the exercise duration and complete the test.
7. The subject has no disease in any body system and has not been hospitalized due to major diseases in the past 2 years;

Shedding standards

1. Those who request to withdraw on their own initiative;
2. The absence from training lasts for one week and does not reach 30 hours;
3. Those who fail to meet the overall learning progress and those who fail to study according to the experimental requirements.

Termination criteria

1. Other symptoms occur during the experimental intervention and the intervention cannot be continued (such as joint pain, etc.);
2. Those who experience chest tightness, shortness of breath, and dizziness during the intervention period.

Screening of research objects

(1) Determination of sample size

To meet the experimental requirements and reduce the unnecessary experimental errors as much as possible, the Gpower3.1 sample is used to calculate the sample size required for software testing

(2) Sample screening

In this study, middle-aged and elderly women aged 60-65 years old in the urban area of Zhangjiakou, Hebei Province, China, were selected and recruited using publicity and poster posting in community activity centers. According to the principle of voluntary participation of the subjects, through the general data survey, AHA/ACSM health/physical fitness pre-exercise screening questionnaire, medical examination, and physical exercise survey, people who did not meet the requirements were selected and excluded.

Treatment methods

The experimental instrument was a Polar Team2 team heart rate kit produced in Finland. The instrument was used for a short-term test, recording the effective data of 5 minutes in the quiet state in the morning, and finally, the data was calculated and analyzed by the specific

software Kubios HRV. In the experiment, the ZT268 Bluetooth heart rate band was used to monitor the heart rate during exercise to control the exercise intensity.

Experimental arrangement

(1) Preparation before intervention:

Prepare short video training on knowledge related to the training program; 45 middle-aged women who had not systematically participated in physical fitness exercises and meditation practice were given a 2-week group training.

(2) Formal experiment:

This experiment was divided into 3 groups, namely the Hatha yoga group, the meditation group, and the Tai Chi group, according to the random number table method. Each group trained 90 minutes twice a week, respectively, for a total of 12 weeks, and the time was fixed at the same place, from 7:30-9:00 in the morning. Monday and Thursday are Tai Chi practice, Tuesday and Friday are yoga practice, Wednesday and Saturday are meditation practice, and Sunday is off.

A test was conducted before the exercise intervention and recorded as the HRV data before the experiment. Another test was conducted after 12 weeks of exercise and recorded as the HRV data after the experiment. Each time, the test time is strictly controlled, and the measurement time is 7:00-7:20 in the morning. After the subjects sit quietly for 10 minutes, the effective data is tested for 5 minutes. To monitor the intensity of exercise during exercise, subjects are asked to wear a Bluetooth heart rate band during exercise. Due to the limited experimental equipment, the measurement was carried out in the order of Tai chi group, yoga dance group, and meditation group for two days.

Since yoga, Tai Chi, and meditation are three different exercises and their contents are quite different, three teachers with a high professional degree and national Tai chi, yoga, and meditation instructor certification are selected for the selection of teachers. They do not know the specific grouping of all subjects. In this experiment, to ensure the minimum experimental error, all three teachers were given pre-job training by the requirements of the experiment.

The teaching progress and intensity were used to control the experimental load. The teaching environment of the three groups of experiments was the same, the teaching time was 12 weeks, and the same equipment was used for pre-test and post-test.

Test Indicators:

HRV test indicators: Time domain indexes include: SDNN, RMSSD; Frequency domain indicators are: HF, LF, LF/HF.

Statistical Method

SPSS 28.0 analysis software was used to analyze and process the collected data. A multifactor variance test was performed for HRV indexes of all subjects before and after the

experiment, and a paired sample t-test was performed before and after the experiment, respectively. The data were presented in the form of mean \pm standard deviation ($M \pm SD$), with $P < 0.05$ indicating a significant difference and $P < 0.01$ indicating a very significant difference.

Results

1. Basic information of the research object

Table 1 Basic information of the research object ($X \pm S$)

Group	N	age(ys)	Height(cm)
Meditation group	15	62.07 \pm 1.39	155.13 \pm 7.36
Taijiquan group	15	63.27 \pm 1.49	157.27 \pm 5.82
Hatha Yoga Group	15	62.67 \pm 1.23	159 \pm 5.17
F value		0.081	1.471
P value		0.922	0.241

Before the experiment, the basic information of the subjects in the meditation group, the Hatha yoga group, and the Tai chi group was tested and recorded. It can be observed from the records that the physical conditions of participants in each group are the same, with no significant difference ($P > 0.05$), which accords with the randomness of selection of experimental samples.

HRV test results and analysis in the quiet state after different training methods

2. RV time domain index changes before and after the experiment in a quiet state

Table 2 The changes of subjects' HRV time domain indicators before and after the experiment ($X \pm S$)

Test index		Meditation group (15)	Taijiquan group (15)	Hatha Yoga Group (15)
SDNN(ms)	Intervention for 0 weeks	58.07 \pm 14.62	58.96 \pm 16.69	62.13 \pm 21.06
	Intervention for 12 weeks	67.13 \pm 15.34 #	69.89 \pm 14.83 # Δ	75.41 \pm 17.70# &&
RMSSD(ms)	Intervention for 0 weeks	18.96 \pm 4.32	17.47 \pm 2.77	18.96 \pm 4.25
	Intervention for 12 weeks	19.23 \pm 3.47 #	18.67 \pm 3.91#	23.72 \pm 8.50# && @@

In the quiet state, after 12 weeks of intervention, in the Hatha yoga group Domain indexes SDNN and RMSSD were significantly different from those in the meditation group ($P < 0.01$), SDNN indexes in the Tai Chi group were significantly different from those in the meditation group ($P < 0.05$), and RMSSD indexes in the Hatha yoga group were significantly different from those in the Tai chi group ($P < 0.01$).

3. Comparison of frequency domain indexes before and after the experiment in a quiet state

Table 3 The changes of subjects' HRV frequency domain indicator before and after the experiment ($X \pm S$)

Test index		Meditation group (15)	Taijiquan group (15)	Hatha Yoga Group (15)
LF (ms ²)	Intervention for 0 weeks	222.52±15.40	223.17±13.82	221.96±13.08
	Intervention for 12 weeks	221.47±14.62#	219.00±17.31	212.65±11.88#&
HF (ms ²)	Intervention for 0 weeks	83.90±16.12	84.31±17.78	85.07±18.49
	Intervention for 12 weeks	100.08±13.16#	105.05±14.74 ##△△	115.49±33.09 ##&&
LF/HF (ms ²)	Intervention for 0 weeks	2.74±0.61	2.78±0.68	2.73±0.61
	Intervention for 12 weeks	2.26±0.57#	2.13±0.39 ##△△	1.98±0.52 ##&&

In the quiet state, after 12 weeks of intervention, the frequency domain indexes HF, LF/HF and TP of the Hatha yoga group and the Tai Chi group were significantly different from those of the meditation group ($P < 0.01$), and the frequency domain indexes LF after intervention were significantly different between the Hatha yoga group and the meditation group ($P < 0.05$).

Discussion

After 12 weeks of exercise intervention, HRV time-domain index test results between groups are shown in Table 2.2 for the Hatha yoga group. HRV time domain indexes SDNN and RMSSD were significantly higher than those of the meditation group and the Tai Chi group ($P < 0.01$). The index was significantly higher than that of the meditation group ($P < 0.05$), and the index RMSSD was lower than that of the meditation group, but there was no significant difference. The RMSSD index and SDNN index of the Hatha yoga group were significantly higher than those of the Tai Chi group ($P < 0.01$). But there is no significant difference.

The test results of HRV frequency domain indexes between groups are shown in Table 2.3. The frequency domain indexes of the Hatha yoga group and the Tai Chi group are shown. The frequency domain indexes of standard HF, LF/HF, and TP were significantly different from those of the meditation group ($P < 0.01$). The frequency domain index LF of the Tai Chi group was lower than that of the meditation group, but the difference was not significant, and the frequency domain index LF of the Hatha yoga group was significantly lower. There was no significant difference in the frequency domain between the meditation group, the Hatha yoga group, and the Tai Chi group ($P < 0.05$). Comprehensive specification. The Hatha yoga group, Tai Chi group, and meditation all improved heart rate variability in older women, but the effect of Hatha yoga was better than that of Tai chi, and Tai chi was better than meditation.

Hatha yoga, tai chi, and meditation training can cause heart rate variation in elderly women. Sexual indicators were improved, including autonomic nervous system regulatory function, vagus nerve activity, and sympathetic parasympathetic the balance of the classics. HRV index is affected by breathing pattern and body posture (Saboul et al, 2013). Comparatively speaking, the influence of the Hatha yoga group on heart rate variability is greater than that of the Tai Chi group, and the influence of the Tai Chi group on heart rate variability is greater than that of the meditation group. The improvement of the vagus nerve was mainly manifested. The main reason lies in the movement characteristics of Taijiquan, Taijiquan is a kind of boxing is a kind of martial arts. It is organically combined with Daoist guidance, breathing, and spitting, and forms a kind of boxing which is closely combined with consciousness, breathing, and movement, and unified inside and outside. Therefore, the movement form of Taijiquan highlights the characteristics of "wu", that is, "skills and techniques". In the practice of Taijiquan frame, it is required to take the waist as the



axis, the inner qi originates in the Dantian, and then through the coordination of consciousness, breathing, and movement, it is distributed throughout the body, to achieve the purpose of both physical and spiritual training, and then keep healthy and prolong life. For Tai Chi beginners, the most important and difficult part of the movement is the coordination of movement and breathing. The study of Sun (2000) on students shows that there is no significant difference in the size of LF /HF between the elderly who practice Tai Chi for a long time and the normal young people before and after practicing Tai Chi, that is to say, the elderly who practice Tai chi for a long time and the normal young people. People have the same autonomic nerve stability, and long-term practice of Taijiquan can slow down the decline of heart function in the elderly and keep the heart "age light".

The characteristic movement of yoga is that the practice process requires breath control and asana practice. The breathing and asanas of yoga are practiced separately. Breath control is the first stage. Ancient Indian yoga practitioners believe that people's emotions and conscious activities are related to the nervous system, through which the nervous system controls breathing, regulates people's emotions, and helps people concentrate. On the other hand, when we are focused, our breathing becomes slow and peaceful. The breathing control of yoga requires yoga practitioners to consciously slow down breathing, increase the depth of breathing, and enhance the rhythm of breathing. Yoga pranayama is divided into four stages: inhaling, exhaling, and holding breath. And natural breath regulation. Among them, inhaling, exhaling, and holding breath have certain standard requirements for the body, and they are also practiced for the three. It is considered that the reasonable time ratio of inhaling, holding, and exhaling is 1:4:2. Yoga considers chi as energy through Pranayama, which can spread it throughout the body, lead people to reality, and unite infinite spiritual and limited physical life.

Asana practice is the second stage of yoga practice, also known as "postures", which refers to the practice of maintaining a certain movement. Or pose for a certain time, and through some twisting, bending, and stretching postures and pauses between movements, and with breathing, to stretch the movement. There are many yoga poses, but there are only six basic positions: sitting, standing, kneeling, lying, prone, hands and feet, and handstand. The intensity of the exercise will change continuously for different asanas. Yang et al. (2024) found that the change of HRV in the quiet state was closely related to the training intensity during exercise.

Meditation practice manifests itself as concentration, meditation. Concentration refers to withdrawing one's attention from the complicated secular world and focusing on one's point, which is consistent with the Buddhist and Taoist ideas of inward concentration and elimination of distractions. Meditation refers to the continuous flow of awareness, this is because in the first practice of meditation, one's attention will continue to wander, and then I have to bring the



wandering consciousness back and forth, and so on, but when the focus becomes the stream of consciousness, I enter the state of meditation; Meditation practice strengthens the inner. Attention exerts an inhibitory effect on the sympathetic nerve. Kjaer et al. (2022) found that dopaminergic neuronal activity was enhanced during meditation. Mindfulness during meditation practice may be related to increased activity of dopaminergic neurons, and increased dopamine secretion inhibits sympathetic nerve activity in the body.

To sum up, Hatha yoga, tai chi, and meditation are three kinds of training that can improve elderly women to varying degrees. The group had heart rate variability, but the improvement was more pronounced with Hatha yoga. Hatha yoga can change significantly. Good vagus nerve activity, its autonomic nerve regulation ability improved and dominated. Tai Chi improved heart rate variability in elderly women better than meditation training.

Recommendation

1. Tai Chi, Hatha yoga, and meditation can all increase the level of heart rate variability, but tai chi exercise is difficult for beginners to achieve unity of movement and breathing, and meditation training requires a long time of practice to enter the state of focused meditation. The hatha yoga movement is simple and easy to learn, and the effect of hatha yoga on the autonomic nervous system is more obvious, so Hatha yoga is the first choice for elderly women.

2. As a non-invasive indicator, heart rate variability can accurately reflect the changes in autonomic nervous regulatory function, and it is suggested that it can be used to monitor the characteristics of center rate variability in different sports in people of different genders and different ages, to understand the degree of influence of different exercise modes on neuroregulatory function and the characteristics of heart rate variability in people of different ages.

3. As a professional master, due to the lack of theoretical basic knowledge and experimental skills, time constraint. Limited by conditions such as funds and other conditions, there may be many deficiencies in the experimental design, and the experimental design is put into practice. When the analysis and evaluation of physiological indicators are somewhat sketchy, it is necessary to base the experimental process on elderly women. Physiological and biochemical indicators are selected more comprehensively in the real situation, and then targeted evaluation is carried out.

The whole experiment design is more reasonable, and the experiment process is scientific, to solve the problem from a deeper level. The special features of Tai Chi and Hatha yoga, and meditation, and their impact on the body of elderly women provide a powerful theoretical basis



for guiding people to exercise better and for the further development of Tai chi, Hatha yoga, and meditation.

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