

# Effects of Various Exercises on the Microvascular Reactivity of the Skin of the Knee Joint in Middle-Aged and Elderly Women

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## Research Article

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## Abstract

The objective of this study was to investigate the effects of square dance and brisk walking with the same frequency on the microvascular reactivity of the knee joint of elderly and middle-aged women. For the first time in Enshi city, women aged 55 to 65 years old were selected for experimental subjects, which included 15 in square dance group, 15 in Taijiquan group, 15 in fast walking group and 15 in control group. The changes in the skin microvascular reactivity of the knee joint were studied. The effects of various exercise regimens on the knee joint were evaluated. The results after the experiment, compared with the pre-experiment group, the increase rate of MBP in Taiji group increased significantly, but there was no significant change in square dance group, brisk walk group and control group ( $P > 0.05$ ).

The MBP in control group decreased in different degrees but not significantly ( $P > 0.05$ ). The change in the AVBC rate in the Taijiquan group was significant, but not significantly so compared to the control group. The same results were obtained in the other groups. Hence, the increase rate of MBP in Taijiquan group was significantly higher than that in square dance group, fast walking group and control group, the increase rate of MBP in square dance group was significantly higher than that in control group, and the increase rate of AVBC in Taijiquan group was significantly higher than that in fast walking group and control group.

## Introduction:

As the only place of material and energy exchange, microcirculation is closely linked to human health. The change in microcirculation plays an important role in the occurrence and development of some diseases (such as diabetes, hypertension, coronary artery disease, osteoporosis, etc.) and is obviously abnormal in the early stages of the disease; At the same time, improving the functioning of microcirculation in the rehabilitation process of some diseases is also the key to promoting disease rehabilitation. With age, significant degenerative changes in body function occur, which lead to abnormal vasodilation and vascular reactivity of microvasculature, causing various diseases, so the detection and evaluation of microcirculatory function is of great importance to prevent the occurrence of diseases. (such as cardiovascular disease, diabetes, osteoporosis, etc.) Relevant studies by foreign scientists have shown that regular aerobic exercise can improve the responsiveness of human microvasculature and reduce the incidence of microvascular injury-related diseases [1–4]. Representative aerobic exercises in China, there are only a few studies on the connection between Taijiquan, brisk walking, square dance and microvascular reactivity. The knee joint is one of the most vulnerable parts of middle-aged and elderly women, and with age, the risk of knee joint disease also increases, so studying taijiquan, fast walking, square dancing, and microcirculation of the knee joint is of great importance.

This study suggests that given the same training cycle, frequency, and training time, different training modes have different effects on knee responsiveness in middle-aged and elderly women. Exercises that are widely accepted by the elderly are selected to study the effects of the same 16-week training cycle, frequency and time on the knee joint microcirculatory response in the elderly to enrich the workout and blood microcirculation of the middle aged and older old. and to provide a reference for improving the microcirculatory function of middle-aged and elderly people.

## Materials And Methods:

The experiment was performed in the Exercise Physiology Laboratory of Hubei Minzu University in Hubei Province, China, and approved by the President of Hubei Minzu University.

## Participants:

The subjects were all urban residents of Enshi City, Hubei Province, China, and the inclusion criteria were as follows: (1) 55 to 65 years of age, physical and mental health, diseases (medical history) that did not affect microvascular function, such as skin diseases, Varicose veins, diabetes, high blood pressure and no knee joint injuries, pain and no vasodilators taken within 6 months. (2) voluntarily joined and signed an agreement after understanding the process and purpose of this study. (3) No systematic sporting activity within six months, a healthy lifestyle, no long-term smoking and alcoholism, etc. After the recruitment, a total of 60 women finally met the recruitment criteria. They were divided into Taichi Group, Fast Walking Group, Square Dance Group, and No Movement Group, with 15 people in each group, the basic information about the subjects is shown in Table 1 below.

The test used the microcirculation test using the sixth generation laser Doppler blood flow (PF6000) manufactured by Parry Medical Company in Switzerland. The instrument's test indices include AVBC (mean blood cell velocity), CMBC (mobile blood cell concentration), and MBP (microcirculatory blood perfusion). The AVBC, CMBC and MBP test values include the base value and the local skin is heated to 44. Studies have shown that when the local muscle is heated to 44 ° C, the microvessels can reach a state of maximum relaxation and the blood flow in the microvessels reaches its peak [5]. In this study, the rate of increase = (post-heating value base value) / base value \* 100 was used to express the reactivity of the microvessels.

### INTERVENTION DESIGN:

The experimental group received a 24-hour intervention for brisk walking, square dancing, and simplified Taijiquan exercises for 16 weeks. The intensity of the exercise intervention of the experimental group was set for 16 weeks and the intensity of the exercise was approximately (220 years) \* (55% Mel 65%) After each exercise, the heart rate was measured via the radial artery. Due to the weather, the exercise period is from 6:30 a.m. to 8:00 a.m.

The specific ordinances are as follows in Table 2.

The control group maintained the original lifestyle, did not engage in systematic physical activity during the experiment, and did not take any drugs that affected vascular function.

## DATA ANALYSIS:

All data were statistically processed using the SPSS 26.0 statistical software package and Microsoft Excel 2019 software, and the results were expressed as the mean ± standard deviation. At the end of the experiment, the data of each group were analyzed by the paired-sample t test, and the data between the groups were analyzed by the independent-sample t test.

## Results:

After 16 weeks of training intervention, the changes in MBP, CMBC and AVBC in the four groups before and after the experiment are shown in Tables 3, 4 and 5.

1) Before the experiment, there were no significant differences in the initial data, reheating value, difference and rate of increase between the four groups.

2) After the experiment, the rate of increase in MBP in the Taiji group increased significantly compared to the pre-experiment group, but there were no significant changes in the square dance group, brisk walking group and group

control ( $P > 0.05$ ). The control group decreased to varying degrees, but not significantly ( $P > 0.05$ ). The rate of increase of AVBC in the Taijiquan group increased significantly, but there was no significant change in AVBC test scores in the square dance group, the fast walking group, and the control group ( $P > 0.05$ ).

3) Comparison between groups after the experiment: the rate of increase in MBP in the taijiquan group was significantly higher than that of the square dance group, the high-speed group and the control group, the rate of increase in the MBP in the square dance group was significantly higher than in the control group, and the rate of increase of AVBC in the Taijiquan group was significantly higher than that of the brisk walking group and the control group.

## Discussion:

Adequate aerobic exercise is viewed as an adjunct to the prevention and treatment of cardiovascular and cerebrovascular diseases, diabetes, and osteoporosis in the elderly [6], but there are no reports of the effects of various exercise regimens on blood microcirculation. The purpose of this study is to compare three types of aerobic exercise performed by older women: taijiquan, brisk walking and square dance, and to analyze the effects of the same training cycle (16 weeks), training frequency (5 times / week). and exercise time (90 minutes) in the microcirculation of the knee joint to provide a basis for research on improving the microcirculation of the elderly blood and preventing diabetes, hypertension, coronary artery disease and osteoporosis.

Because of the different frequency or time chosen during the 16-week training cycle, Taijiquan training has different effects on the blood microcirculation of the elderly. At present there are few studies of the effects of Taijiquan exercises on the microcirculation of human blood, and there are many cases. Zhang Yang (2017) selected 90 middle-aged and older women with a dominant right foot (30 in the Taijiquan group, 30 in the square dance group and 30 in the control group) for the exercise intervention [7]. Of the knee joint showed that both taijiquan and square dance could improve the static balance function of middle-aged and elderly women, and the effect of taijiquan was better than that of the square dance group, which also the results of this study (taijiquan group, taijiquan - Group, after heating, the difference and rate of increase reached significant levels in both MBP and AVBC), and taijiquan had an effect on the reactivity of the blood of the knee joint. Crocircularion: Many Taijiquan movements require the practitioner to assume a half-height position and constantly monitor the stability of their own equilibrium, which plays an exercise role in the muscle groups of the trunk, hip and knee joint [8]. Long-term exercise alters the changes in the stress levels of the muscle groups near the thigh and knee joints and then affects the microcirculation of the blood. WooJ et al. Taijiquan intervened in people aged 65 and 74 (90 men and 90 women) [9]. The results showed that taijiquan exercise three times a week (60 min) increased BMD and blood perfusion in older women, but not significantly, while there was almost no analysis that abnormal synthesis of NO and disruption of metabolic factors with age in vascular endothelial cells decrease the microvasodilation capacity, resulting in decreased microvascular reactivity and decreased bone mineralization. Density and calcium loss, while taiichi exercises can increase blood microcirculation, promote calcium supplementation, and reduce calcium loss [10].

Currently there is a positive attitude towards the effect of square dancing on blood microcirculation: a middle-aged woman and an older woman with an average age of 59.3 years received 3-month square dance exercise intervention and before and after the experiments Changes in cardiovascular function were analyzed [11]. The results showed that HR ( $P$  and  $<0.01$ ), SPTI ( $P$  and  $<0.01$ ), ED ( $P$  and  $<0.01$ ), PAS ( $P$  and  $<0.01$ ), PAD ( $P$  and  $<0.01$ ), PP ( $P$  and  $<0.01$ ) and CAP ( $P$  and  $<0.01$ ) decreased, DPTI ( $P$  and  $<0.01$ ) and SEVR ( $P$  and  $<0.01$ ) increased. The study showed that the difference between MBP and AVBC warming in middle-aged and older women changed significantly before and after

the experiment, and the reactivity of the blood microcirculation changed, but not significantly. This study considers that the reason for the differences between the results of previous studies and the results of previous studies is that the content, intensity and time of square dance exercises between different subjects are difficult to reconcile, so that their effects on the microcirculation of the blood are not the square dance selected in this study requires subjects to kick, heel, step and rotate, and other movements. However, when monitoring the heart rate, it was found that square dancing is a low level of physical activity, the effect of the intervention on the reaction of microcirculation in the blood is not significant, it can take a long time to accumulate more effective.

In this study, the brisk walking group received 16 weeks of intervention, although MBP blood perfusion volume and AVBC blood cell velocity improved, but not significantly. The difference in results may be related to the lack of additional muscle strength training or the advanced age of the selected subjects.

Lanting Sean M confirmed our analysis and believed that the effect of exercise on blood microcirculation decreased with age [12]. However, this study suggests that brisk walking has a positive impact on blood microcirculation in older women. analyzed serum calcium, phosphorus, and alkaline phosphatase levels in the elderly after 10 weeks of brisk walking intervention and found that alkaline phosphatase levels increased significantly, suggesting that brisk walking may promote the synthesis of human bone metabolism [13]. When analyzing the movement characteristics of fast walking, this study finds that the extension of the pedal and the swing of the lower extremities are greater in the elderly than with normal walking, resulting in a higher exercise load on the lower extremities. Long, brisk walking results in more stress changes in the lower extremities, which in turn affects the microcirculation of the blood. The reason it hasn't reached a significant level may be because middle-aged and older women walk every day, so the effect is less.

Currently, there are few reports of the effects of taijiquan, brisk walking, and square dancing on the blood microcirculation in middle-aged and elderly women. Lu Tao practiced taijiquan, walked, and danced for 48 weeks (6 times a week, 40 minutes each time). ) in 105 older women aged 55 to 65 years and tested all subjects after 16, 32 and 48 weeks for changes in blood velocity [14]. The results showed that taijiquan had the most obvious effect on improving blood speed. with increasing intervention time. In this study, the microcirculation of the knee joint blood was tested. After 16 weeks of training in the intervention group, the rate of increase in MBP in the Taijiquan group was significantly higher than that of the square dance group, brisk walking group, and control group, and the rate of increase in MBP in the square dance group was significantly higher than in the control group ( $P < 0.05$ ). The rate of increase of AVBC in the Taijiquan group was significantly higher than that of the brisk walking group and the control group. This indirectly confirms the point of view of Machado MV (Machado MV's) [15]. Based on the analysis of the circumstances, we believe that the subjects in the Taiji group also have a lot of walking (a lot of walking time) in their daily activities, and older women are not as good as Taijiquan. Supports the opinion of this study: Taiji and brisk walking in older women for 48 weeks (5 times a week) found that Taijiquan was better at improving blood microcirculation in older women than brisk walking while dancing in a square, which required a longer intervention time required to increase the microcirculation in the blood due to the decreased physical activity, so the effect of improving the MAP in the short term was not good [16].

This study asserts that brisk walking and square dancing have different effects on blood microcirculation because it is difficult to standardize exercise intensity, such as different heart rate controls, step or cadence, different square dance modes and Difficulty exercising. Taijiquan (simplification of 24 styles) has a fixed exercise rhythm (accompanied by musical instructions), which allows the intensity of the exercise to be easily quantified. Regular and prolonged Taijiquan exercises are believed to be a reliable method for improving blood microcirculation in older

women. It is worth noting that, although there were no significant changes in other indices of blood microcirculation in the Taiji group, the fast walking group, and the square group, there was no downward trend (compared to the control group). Age-related decrease in blood microcirculation. However, the study has limitations, such as the inability to compare the effects of the same training cycle, frequency, or time on outcomes, and the lack of comparisons of different age groups and genders, which will be the direction of follow-up research. .

## **Conclusion:**

Taichi, 5 times a week for 16 weeks, can significantly increase blood perfusion volume and the speed of blood cell function in middle-aged and elderly women; Fast walking and square dancing are effective in improving blood microcirculation, which is not as obvious as in the taijiquan group, but it can delay the decrease in blood microcirculation caused by aging.

## **Declarations:**

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### **DISCLOSURE STATEMENT:**

The authors did not report any potential conflicts of interest.

### **CONTRIBUTION OF AUTHORS:**

Yong Peng, Tambosky Anatoly Nikolaevich designed the study. Data collection and article writing were carried out by Fateh Zereg and Huan Zhu. Xiaoli Liu, Jiewen Xiao, Zhe Xiao worked on the methodology and analysis of the work. All authors have read and approved the final version of the manuscript.

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## Tables:

**Table 1 Basic information on the study objects**

Group	Persons (n)	Age / (y)	Height / (m)	Weight / (kg)	BMI	Systolic blood pressure (mmHg)	Diastolic pressure (mmHg)
Taijiquan group	15	60.4±6.0	1.66±0.06	63.7±7.2	23.1±3.3	122±8	79±7
Square Dance Group	15	59.1±5.5	1.65±0.07	65.1±5.9	24.0±4.1	120±7	80±6
Fast walking group	15	61.1±5.8	1.63±0.09	64.2±6.5	23.0±4.0	123±9	78±7
Control group	15	59.5±6.2	1.64±0.10	65.4±5.5	23.5±3.8	121±7	82±8

Values are presented as mean±standard deviation.

**Table 2 Exercise instructions for the test group**

Experimental group	Exercise intensity	Movement frequency	Exercise time	Activity arrangement
24-style simplified Taijiquan	220- Age* 55%-65%	5 times / week	Am 6:30-8:00	Warm up for 10 minutes before exercise, relax for 10 minutes after exercise, 5 minutes for each set of movements, rest for 1-2 minutes, and practice 10 sets each time
Square dance	220- Age* 55%-65%	5 times / week	Am 6:30-8:00	Warm up for 10 minutes before exercise, relax for 10 minutes after exercise, 10 minutes for each set of movements, rest for 2-4 minutes, and practice 5 times
Fast walking	220- Age* 55%-65%	5 times/ week	Am 6:30-8:00	Warm up for 10 minutes before the start of exercise, relax for 10 minutes after exercise, and the brisk walking frequency is controlled at 100-120 steps per minute

Values are presented as mean±standard deviation.

**Table 3 MBP changes in four groups of subjects before and after the experiment**

Experimental group	Before the experiment				After the experiment			
	Basic value	Heating value	Difference value	Increasing rate	Basic value	Heating value	Difference value	Increasing rate
24-style simplified Taijiquan	15±3	126±15	111±13	773±186	13±2	145±10	133±11	1085±280 <sup>*bcd</sup>
Square dance	16±4	130±13	114±12	761±156	14±2	141±7	127±6	907±133 <sup>ad</sup>
Fast walking	15±3	127±16	111±14	759±154	15±4	133±17	119±14	844±160 <sup>a</sup>
Control group	16±4	131±12	116±10	781±202	15±3	126±12	112±11	790±146 <sup>ab</sup>

Values are presented as mean±standard deviation.

\* Compared with the same group before the trial.

<sup>a</sup>Compared with the 24-style simplified Taijiquan group after the experiment, there was statistical significance.

<sup>b</sup> Compared with the 24-style simplified Taijiquan group after the experiment, there was statistical significance.

<sup>c</sup> Compared with the 24-style simplified Taijiquan group after the experiment, there was statistical significance.

<sup>d</sup> Compared with the 24-style simplified Taijiquan group after the experiment, there was statistical significance.

**Table 4 CMBC changes in four groups of subjects in different weeks**

Experimental group	Before the experiment				After the experiment			
	Basic value	Heating value	Difference value	Increasing rate	Basic value	Heating value	Difference value	Increasing rate
24-style simplified Taijiquan	127±27	311±35	184±34	144±55	126±24	313±35	187±26	154±37
Square dance	136±20	323±38	187±30	140±29	129±22	318±35	188±34	150±42
Fast walking	131±25	324±35	193±24	152±33	131±17	324±33	193±22	149±20
Control group	135±21	325±49	190±41	144±43	134±18	321±41	187±28	140±19

Values are presented as mean±standard deviation.

**Table 5 Changes in the AVBC in four groups of subjects in different weeks**

Experimental group	Before the experiment				After the experiment			
	Basic value	Heating value	Difference value	Increasing rate	Basic value	Heating value	Difference value	Increasing rate
24-style simplified Taijiquan	12±2	41±5	29±4	250±68	10±2	47±5	37±6	373±93 <sup>*cd</sup>
Square dance	12±4	41±7	29±5	265±80	11±2	45±6	34±6	318±91
Fast walking	12±3	39±5	27±4	245±66	11±4	42±7	30±5	284±85 <sup>a</sup>
Control group	12±3	41±8	30±7	269±107	11±2	40±5	29±4	273±67 <sup>a</sup>

Values are presented as mean±standard deviation.

\* Compared with the same group before the trial.

<sup>a</sup>Compared with the 24-style simplified Taijiquan group after the experiment, there was statistical significance.

<sup>b</sup> Compared with the 24-style simplified Taijiquan group after the experiment, there was statistical significance.

<sup>c</sup> Compared with the 24-style simplified Taijiquan group after the experiment, there was statistical significance.

<sup>d</sup> Compared with the 24-style simplified Taijiquan group after the experiment, there was statistical significance.