

# A preliminary study of the effects of medical exercise *Wuqinxi* on indicators of skin temperature, muscle coordination, and physical quality

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## Abstract

**Background:** *Wuqinxi* is a traditional medicinal exercise that is widely practiced in China now. Because of its obvious medical rehabilitation, *Wuqinxi* has been used in the physical education for more than 1.2 million people in at least 24 Chinese Medicine university campuses in China for many years. This investigation aimed to evaluate whether *Wuqinxi* has the positive effect on physical improvements for female college students.

**Methods:** Infrared scanners were used for real-time monitoring of body calorie dynamics; the electromyography (EMG) was used to detect the iEMG on biceps, brachioradialis, quadriceps, and gastrocnemius; beside, the physical health elements, heart rate and cardiopulmonary function were also taken within the scope of our investigation and records.

**Results:** *Wuqinxi* exercise can improve the body function through making the abdominal muscles, back muscles and limbs strength exercise more effectively; *Wuqinxi* exercise had also made the athletes better control their muscles to have a good way to contraction and keeping balance; Moreover, the performances of speed of 800 m run, setting flexion, set-ups and grip strength had a comprehensive promotion for each of the participants including long-time practitioners and short-term practitioners.

**Conclusions:** Therefore, the new gymnastics derived from ancient Chinese *Wuqinxi* exercise can improve the physical health of female college students so that it can be used as part of the development of higher education's health quality in the future.

**Abbreviations:** EMG = electromyography, iEMG = imaging electromyography.

**Keywords:** EMG, female college students, fitness, physical exercise, student's sports

## 1. Introduction

In China, sport fitness activities are promoted and developed by the *General Administration of Sports of China* (the Chinese Sports Ministry) by using one after another promotion of

projects since 1950s.<sup>[1]</sup> In general, Chinese sport practice includes modern gymnastics and traditional sports.<sup>[2]</sup> Among them, traditional sports have a broad public foundation and strict inheritances of the traditional cultural.<sup>[3]</sup> Nowadays, the internationalization of the traditional sports Tai-Chi or Kung-Fu has affected generations of the world.<sup>[4]</sup> Furthermore, the nearly 50 years of practice of Chinese traditional sports revealed that the standardized traditional sports have important significance in athletic competition,<sup>[5]</sup> sports fitness,<sup>[6]</sup> unity culture, and higher physical education.<sup>[7]</sup> Similar to Tai-Chi, there are at least 4 forms of Chinese traditional movements had been promoted for health care, and *Wuqinxi* is the one of the longest spread and the largest number of practitioners in the mainland of China.

*Wuqinxi*,<sup>[8]</sup> also called gymnastics of 5 animals in foreign countries, is a traditional form of exercise comes from the ancient *Daoyin* (a breathing method for health preserving, Fig. 1) and choreographed by Huatuo in Han dynasty (about 200 AD), as a kind of medical sport, it has been used to prevent disease, cure diseases and health care for a long time. It is very different from other forms of Chinese martial arts sports such as Tai-Chi, Wing-Chun, and so on, that *Wuqinxi* is usually targeted to the special parts of the human body and practicing for body functional fitness, including facial muscles, eyes, teeth, fontanel, spine, shoulder, cervical vertebra, etc. Besides, *Wuqinxi* is the only one form of exercise practiced to develop a good facial expression. So, the special medical treatment is its advantages and characteristics. Therefore, sports medicine research of *Wuqinxi* was carried out

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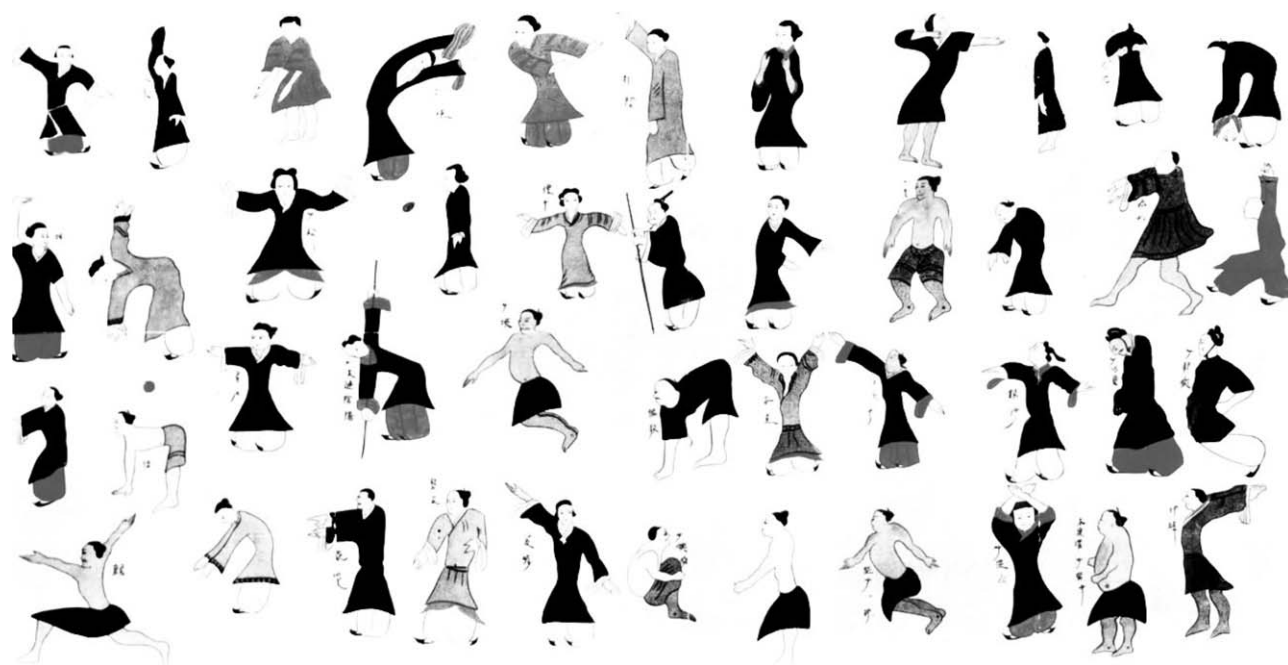
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**Figure 1.** Posturography of Daoyin unearthed in 3rd Han tomb of Mawangdui in Changsha, Hunan. (To explain the origin and basic forms of the movement of *Wuqinxi*).

in various physical education colleges and Chinese medicine colleges, and a large number of sports medical data shown that practicing *Wuqinxi* can improve key indicators of blood system, and enhance human immunity, regulate the nervous system.<sup>[9]</sup> In recent years, further professional and systematic studies of practicing *Wuqinxi* in at least 10 universities of Traditional Chinese Medicine have indicated that *Wuqinxi* can significantly improve the physical quality of college students.

The lack of activity for sports exercise is a common problem for women, and in the college physical education class, female college students are usually not active in their individual exercise time, and often manifested with habitually reducing the number of activities or the quality of action. Because the college physical education teaching is not accustomed to separate male and female, so the behavior of female college students usually affect the initiative of the male college students, and directly lead to the decline of teaching quality of college physical education. In this environment, a meta-analysis of college students' physical activity behaviors indicated that higher physical education specialists face the great challenge of encouraging college students to participate in physical education on a daily basis to accrue health benefits.<sup>[10]</sup>

In order to improve the participation of female college students in physical exercise, and develop a kind of physical education program with strong interesting and medical characteristics, we started the *Wuqinxi* teaching in 2006 in Anhui University of Traditional Chinese Medicine. So far, accumulated more than 70 students who received more than 3 years of long-term exercise, and the number of students receiving short-term exercise (>3 weeks) is more than 1000 female students. We focus on the participation of female college students in physical exercise, dynamic changes of the indicators about the health, and also their self-confidence and employment outcome after their graduation. Now we are pleased to report these results as follows.

## 2. Methods

### 2.1. Subjects

Since September 2006, all female students of the first year in college were encouraged to voluntarily participate in *Wuqinxi* practice that was held and trained by the sports department in the Anhui University of Traditional Chinese Medicine. As of July 2016, more than 1000 female students participated in this study through more than 3 weeks of physical exercise with *Wuqinxi* practice, and their average age was  $18.3 \pm 3.46$  years old, the average height was  $162.77 \pm 3.48$  mm, and the body weight was  $53 \pm 5.21$  kg; besides, in recent 10 years, a total of 70 people were finally selected to develop professional *Wuqinxi* practice with an exercise intensity of at least 5 hours per week. Simultaneously, we also set-up 2 groups of controls whose basic character of above 3 quality traits was appeared to be a normal distribution, respectively. The first group of 20 female college students does not like to participate in exercise, or just take a walk as a means of their main exercise; the second group of 20 female college students was selected from different sports teams including aerobics, taekwondo, basketball, football and other teams. All studies here do not involve volunteers' privacy, so there is no necessary for ethical review, and all participants are blinded in this study.

### 2.2. Exercises design

There are many forms of *Wuqinxi* exercise inherited and developed in different regions of China mainland from generation to generation, and in recent years, the competition activities popularized by the State General Administration of sport have gradually been widely accepted and recognized by the public, especially the young people studied at college. In this research, professional *Wuqinxi* practice activities are the optimized movements' composition (Action video data are kept at the

sports department of Anhui University of traditional Chinese Medicine).

### 2.3. Dynamic recording of skin temperature by infrared thermography system

FLIR-ONE iOS 2 infrared thermography system imaging system was used with iPhone 5S to record the surface skin temperature of practitioners in real time. Numerical temperature observation before exercise and after exercise were recorded as  $B_n$  and  $A_n$ , respectively. The relative temperature ( $R_n = A_n - B_n$ ) of the following 5 body regions including the head, spine, upper abdomen, lower abdomen, and knees are used as the indicators of observation objects for the health function analysis.

### 2.4. EMG analysis

The electromyography (RM6240B/C Physiological Recorder made in Chengdu, China) was used to detect the electromyogramme on the deltoids, brachioradialis, quadriceps, and gastrocnemius at 3 representative action nodes of the imitation of 3 animals such as the deer, bear and crane. In this part, digital camera (Canon DS126371, made in Japan) and disposable surface electrodes were also used for data collection.

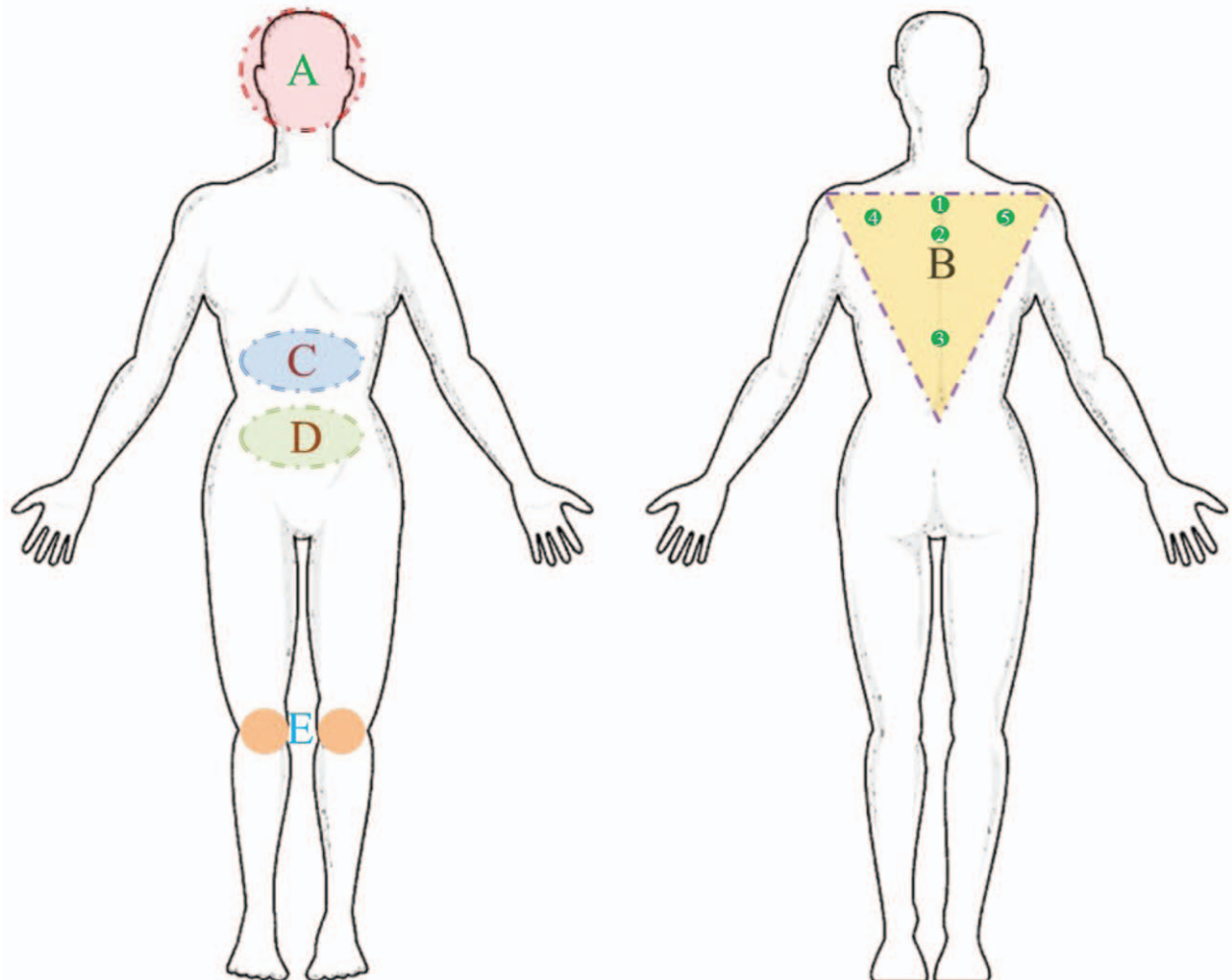
### 2.5. Analysis of physical quality indexes

Exercise watch (SUUNTO\_t6c) was used to record and track the data of heart rate of movement; cardiopulmonary function was recorded by the Spirometer made by PMD Healthcare USA; Inbody 2.0 was used to compare the improving of the physical quality indexes, such as body weight, waist circumference, BMI ( $\text{kg}/\text{m}^2$ ), thickness of abdominal skinfold, body fat rate, grip strength, back force, sit and reach and so on.

## 3. Results

### 3.1. Effects of Wuqinxi exercise on the skin surface temperature

In general, an appropriate amount of aerobic fitness can reduce the healthy skin surface temperature. Effective research showed that falling in skin temperature during initial exercise was not due to the increased evaporative cooling, but to vasoconstriction,<sup>[11,12,13]</sup> and also is not related to the thermal factors.<sup>[14]</sup> Dynamic imaging of the surface temperature of the human body is susceptible to environmental disturbances. So, in this sturdy, 14 athletes completed their practices of *Wuqinxi* action in a 20°C constant temperature environment with 70% constant humidity.<sup>[11]</sup> As shown in Figure 2, 5 body areas (A–E) were selected and



**Figure 2.** The selected body areas (A–E) which have been observed by infrared thermography system for collecting the temperature changing information.

**Table 1****skin temperature changing of 5 body areas in the practice process of *Wuqinxi* (N=5).**

Area	Tiger imitation, °C	Deer imitation, °C	Bear imitation, °C	Ape imitation, °C	Bird imitation, °C
A	-3.54±0.26**	2.98±0.13	3.62±0.13	3.12±0.29**	2.40±0.43**
B	-3.88±0.49**	3.94±0.40	4.48±0.18*	4.22±0.36	3.82±0.52**
C	-2.12±0.08	3.30±0.23	3.56±0.11	3.78±0.30	3.92±0.24
D	-2.06±0.11	3.14±0.26	3.64±0.17	4.36±0.11	3.46±0.17*
E	-0.86±0.05	1.50±0.18	2.34±0.11	1.36±0.21**	0.82±0.19**

T-test: \* $P < .01$ ; \*\* $P < .001$ .

observed by infrared thermography system to collect the temperature changing information. In fact, different skin temperature distribution was presented in each selected body areas. Especially as the B area, it covers the almost entire spine and back muscle group, so the temperature changing throughout this area is not uniform. Therefore, we comprehensively evaluated the temperature changing of each region through observation of several points with a stable temperature changing, just like the points 1 to 5 in Figure 2. According to these operations, we analyzed the temperature changing of the mentioned 5 body areas.

As shown in Table 1, this results have showed the changing and distribution information on the skin temperature. Taking the normal skin surface temperature as a control, we observed a conventional characteristic on starting to exercise that skin temperature began to fall immediately in the beginning of 10 minutes of *Wuqinxi* exercise called the imitation of the tiger, and especially manifested on the head (A) and the back muscles (B); after 15 minutes of the exercise, the practitioners started to practice the deer imitation, the infrared image suggested that a rapid warming phenomenon on whole body within 60sec, and the most significant warming is over the back area, but except the spine in the center; after 20 minutes of the exercise, practitioners began to sweat visibly, a further falling in skin temperature over the head and knees trunk indicated that evaporation removed the accumulated heat on vascular-intensive areas, but except the active muscle areas; at the end of the exercise, practitioners are adjusting the breath and body balance with the bird imitation of *Wuqinxi* as shown in Figure 3, then the skin temperature of the whole body was falling down significantly, however the surface temperature of upper abdomen (C) was still warming and keeping warm. It is noteworthy that the temperature of the abdomen (C and D) has been maintained above the average level. According to the characteristics of *Wuqinxi* exercise, we believed that the records of the surface temperature showed that *Wuqinxi* exercise can improve the body function through making the abdominal muscles, back muscles and limbs strength exercise effectively. Furthermore, internal organs, especially gastrointestinal can get sufficient massage and conditioning from the process of *Wuqinxi* exercise which plays an important role in improving immunity, relieving dysmenorrhea and regulating endocrine system in female college students. However, there is few sport research of *Wuqinxi* to support more advantages of *Wuqinxi* exercise, especially in physical quality. So, next, we investigated the effects of long-term exercise and short-term exercise of *Wuqinxi* on muscle function and physical quality.

### 3.2. EMG analysis in promoting muscle balance

Electromyograph (EMG) is a regular method to detect the muscle function through recording the electrical activity of muscle at rest

or contraction. Previous studies have shown that EMG has important application value in the following areas, analysis of characteristics of the kicking movement; correlation and optimization of the exercise movements with a physiologic interpretation. In recent years, surface electromyograph (sEMG),<sup>[14–16]</sup> as a noninvasive way for motions recording, not only can dynamic display and record the muscle activity patterns, but also can be used as an indicator collection to compare the different athlete individuals or movement patterns by monitoring the muscle surface electric current. The latest research shows that advanced data analysis and visualization methodologies have played an important role in making surface electromyography both a valuable test methodology of partial muscles, and image EMG (iEMG) technology is based on using the crosstalk between a sufficiently large number of surface electromyographic electrodes to achieve the overall status of the partial muscle.<sup>[17]</sup> Considering the convenience and the operability of data collection and the representation of test results, in this investigation, we selectively detected the special position of 4 muscles on arms and legs, including the deltoids, brachioradialis, quadriceps and gastrocnemius, to compare and evaluate the limb strength, muscle coordination and the muscle status during their practice of *Wuqinxi* exercise for female college students of professional and nonprofessional. From 2010 to 2016, there are 30 professional *Wuqinxi* practice athletes (Marked with ‘P’ in Table 2) and 30 nonprofessional *Wuqinxi* practicing athletes participated in our experiments, and nonprofessional athletes selection principle is that the proportion of the number of the part of other-sport athletes and the other part with almost no exercise practice is 1:1, in other words, there are 15 other-sport athletes (Marked with ‘O’ in Table 2) and 15 students with almost no exercise practice (Marked with ‘N’ in Table 2). All actions of interest and observations and the related results have been shown in Table 2. The 3 groups of actions we selected were bear sway, deer stretch and the crane stand which are the imitations of animal movements and have been called in traditional *Wuqinxi* exercise for 2000 of years.

As shown in Table 2, the results showed that there are significant differences almost in all the observed indicators between the professional athletes and the nonprofessional athletes when the bear sway, deer stretch or crane stand was been performed. Deltoids and quadriceps were the main observation objects for muscle activity monitoring on arms and legs of the individuals. The performances of the bear sway and deer stretch indicated that the duration of the activity was significantly prolonged and uniformed in the group of professional athletes; and this also directly affects the performance of the interval time that leads to a shorter interval in the professional group’s actions and strengthens the actions more coherence. In contrast, the performances of the quadriceps showed the duration of the activity was significantly shortened in the

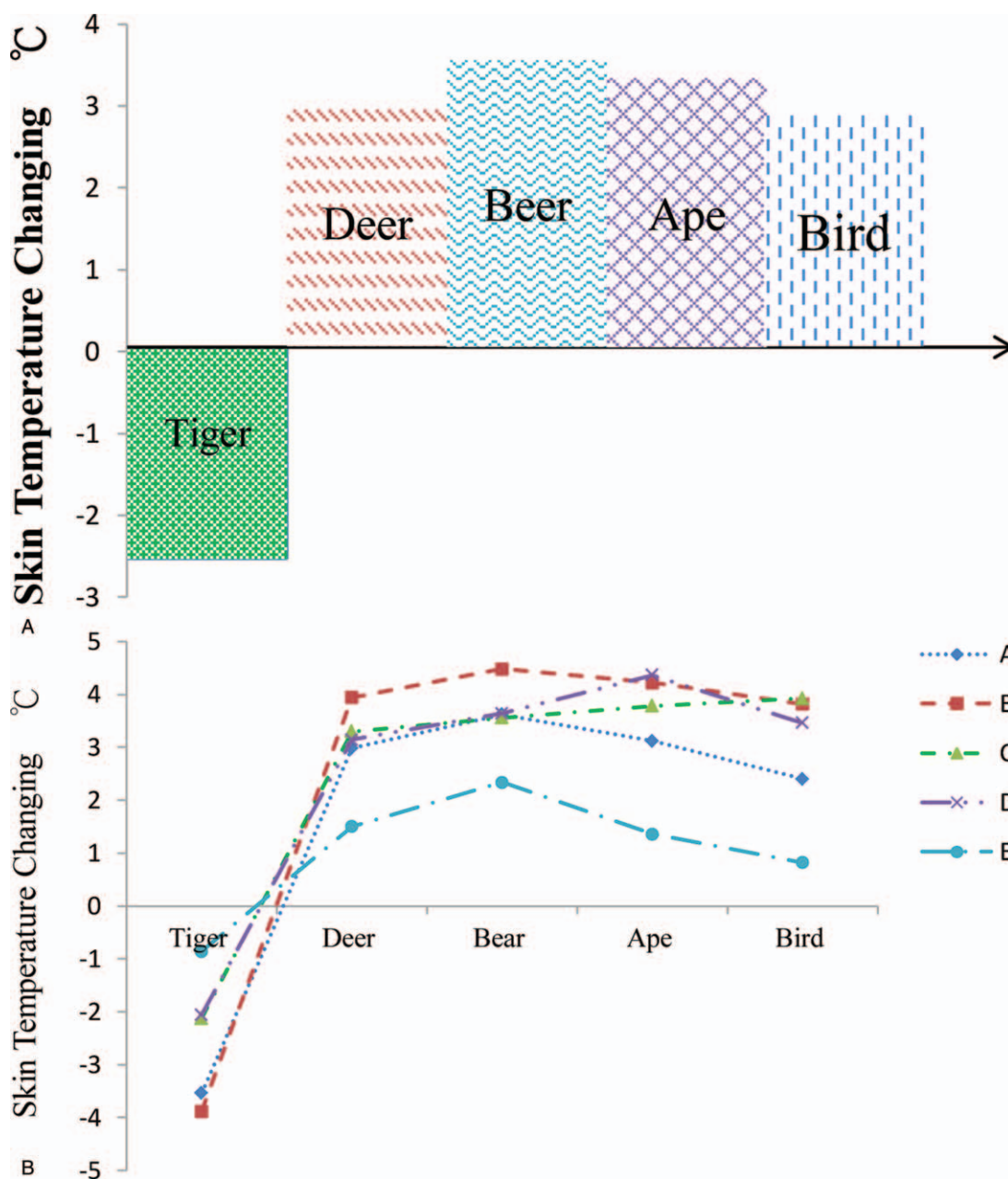


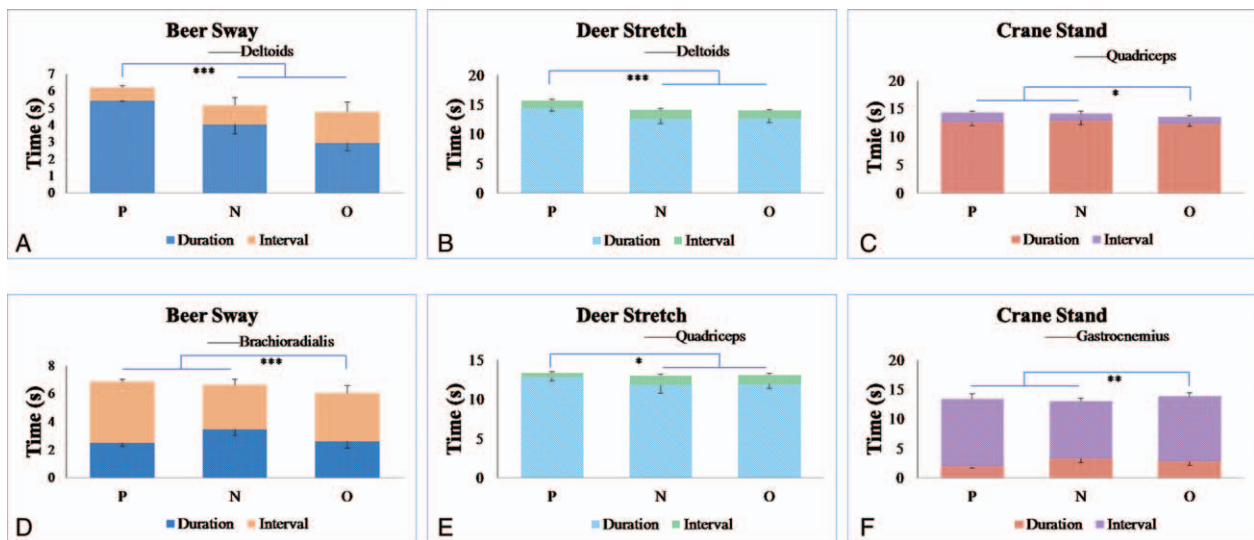
Figure 3. Skin surface temperature changes during the 5 kinds of movements in Wuqinxi exercise (A) and the changing records on the each 5 (A-E) areas (B).

Table 2

Muscles activity monitoring on different actions of Wuqinxi exercise (N = 30 or 15).

Locate Actions	Groups	Muscle activity monitoring on arms						Muscle activity monitoring on legs					
		Deltoids			Brachioradialis			Quadriceps			Gastrocnemius		
		Durations	Intervals	iEMG mv/s	Durations	Intervals	iEMG, mV/s	Durations	Intervals	iEMG mv/s	Durations	Intervals	iEMG mv/s
Bear sway	P	5.47 ± 0.07	0.77 ± 0.10	0.06 ± 0.01*	2.49 ± 0.25	4.38 ± 0.20	0.03 ± 0.01	—	—	—	—	—	—
	N	4.06 ± 0.58†	1.11 ± 0.45*	0.09 ± 0.02	3.48 ± 0.46*	3.16 ± 0.40*	0.03 ± 0.01	—	—	—	—	—	—
	O	2.98 ± 0.49*	1.83 ± 0.55*	0.09 ± 0.01	2.61 ± 0.48‡	3.42 ± 0.52*	0.04 ± 0.01†	—	—	—	—	—	—
Deer stretch	inP	14.45 ± 0.51†	1.32 ± 0.21*	0.08 ± 0.01	—	—	—	12.83 ± 0.42*	0.61 ± 0.11*	0.09 ± 0.01	—	—	—
	N	12.65 ± 0.77	1.53 ± 0.19*	0.09 ± 0.01†	—	—	—	11.86 ± 1.06	1.22 ± 0.19	0.07 ± 0.01*	—	—	—
	O	12.72 ± 0.75	1.36 ± 0.11	0.10 ± 0.02‡	—	—	—	11.96 ± 0.54	1.17 ± 0.21*	0.09 ± 0.01*	—	—	—
Crane stand	P	—	—	—	—	—	—	12.70 ± 0.70†	1.73 ± 0.20*	0.05 ± 0.01*	1.97 ± 0.30	11.51 ± 0.82	0.01 ± 0.01
	N	—	—	—	—	—	—	12.92 ± 0.75†	1.24 ± 0.42	0.08 ± 0.01†	3.29 ± 0.70*	9.79 ± 0.46*	0.02 ± 0.01†
	O	—	—	—	—	—	—	12.40 ± 0.52	1.19 ± 0.22	0.07 ± 0.01	2.81 ± 0.70	11.07 ± 0.60	0.03 ± 0.01*

P: the group of professional Wuqinxi practice athletes; N: the group of the students with almost no exercise practice; O: the group of the other-sport athletes; \*\* † ANOVA: \*P < .001; †P < .01; ‡P < .05.



**Figure 4.** Comparison of movements' duration time between the professional group and nonprofessional groups by using the records of iEMG values. (P: professional group; N: nonprofessional group; O: group of other sport exercises. T-test: \*\*\* $P < .001$ ; \*\* $P < .01$ ; \* $P < .05$ . N=30 or 15).

professional group and the interval time was significantly prolonged. Table 2 also showed that the quadriceps had an opposite performances on the actions of crane stand that the interval time of the professional group is significantly reduced. The interesting is that the iEMG values of the professional group obviously always lower than the nonprofessional groups in all the test items. Consider all of the above results, it is easy to analyze and reveal that the professional *Wuqinxi* exercise athletes have paid more attention to their coherence of actions and also the repeated relaxation of each part of muscles in the process of their *Wuqinxi* exercise. In addition, from the analysis of the iEMG values, we found that *Wuqinxi* exercise have made the athlete better control their muscles to have a good way to contraction and keeping balance. Moreover, we also analyze the activity time of each muscle in every movements.

As shown in Figure 4A, B, and D, activity time of deltoids and brachioradialis of *Wuqinxi* professional group is significantly higher than nonprofessional group, especially the other sports athletes. This indicated that the movement of *Wuqinxi* is different from other the other traditional sports such as taekwondo, taichiquan but balanced training for muscle system. Activity time of quadriceps of *Wuqinxi* professional group is not significant

different from the nonprofessional group (Fig. 4C or E). And the activity time of gastrocnemius of the other sports group is significant higher than the *Wuqinxi* professional group (Fig. 4F). This result indicated again that *Wuqinxi* movement is not only a nervous exercise but a relaxing sport, especially in the last movement of bird imitation.

### 3.3. *Wuqinxi* improves the physical quality indexes

Although all the above results proved that practicing *Wuqinxi* exercise for a long time could improve the physique and health of female college students though improving the microcirculation and balancing muscles. However, we still did not know if the *Wuqinxi* exercise could promote the physical quality in a short time and which is the important advantage concerned by the public. So we planned and arranged a 15 weeks short-term trail of *Wuqinxi* exercise on 8 primary practitioners of female college students. In this investigation, the changes of body and the improvements of the physical function were the statistical indexes we focused on, as shown in Table 3, we can see clearly that there were some significant improvements in physical function, their improvements in lung capacity, 800 m run, and the performance

**Table 3**

**Promoting of physical quality after a short-term training of *Wuqinxi* exercise (N=8).**

NO.	Classify	Indexes	Begin	End	P
1	Body shape	Height, cm	162.68 ± 2.05	163.01 ± 2.05	.379
2		Weight, kg	53.01 ± 2.63	52.66 ± 1.55	.373
3		Waist, cm	67.27 ± 2.47	66.57 ± 2.38	.287
4		Fat percentage, %	24.61 ± 0.82	24.57 ± 0.56	.453
5		Abdominal skinfold, mm	14.67 ± 0.28	14.44 ± 0.15	.028*
6	Body function	Lung capacity, mL	2690.63 ± 26.41	2770.75 ± 27.22	.000***
7		Pulse rate, b/min	75.91 ± 1.47	73.11 ± 1.73	.002**
8		Sitting Flexion, cm	9.63 ± 0.43	12.01 ± 1.11	.000***
9		800 m run, seconds	236.22 ± 13.51	210.84 ± 8.72	.000***
10		Set-ups, times	50.32 ± 2.64	59.33 ± 2.88	.000***
11		Grip strength, kg	22.76 ± 2.53	25.08 ± 2.63	.047*

T-test: \* $P < .05$ ; \*\* $P < .01$ ; \*\*\* $P < .001$ .

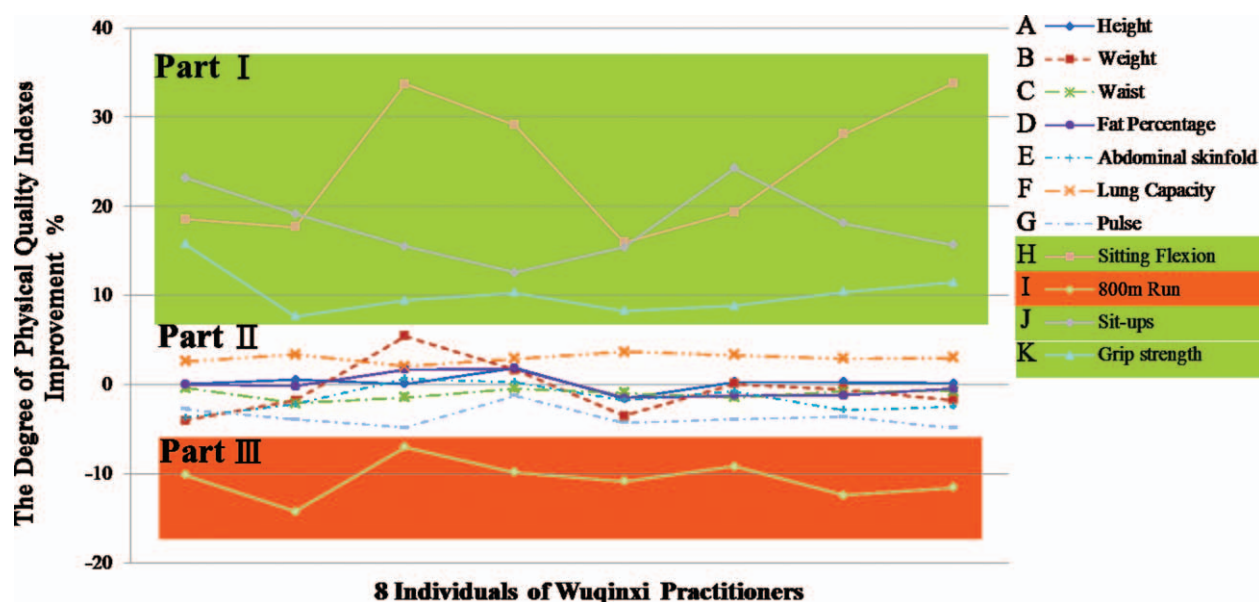


Figure 5. Records of the 11 physical quality indexes (A–K) showed the improvement of physical fitness for each of the individuals of *Wuqinxi* practitioners.

of push-ups demonstrated that a 15 weeks short-term trail of *Wuqinxi* exercise could improve breathing intensity, strength and flexibility of limbs. And because of the significant improvement of their pulse rate, we believed that the contribution of this slow movements to heart function is also cannot be underestimated. Besides, we also noticed that a short-term *Wuqinxi* exercises was difficult to significantly improve body shape, but interestingly, we found that the abdominal skinfold was significantly improved in the respondents. Moreover, everyone's detailed records of the observed indicators have explained the more positive significance of *Wuqinxi* exercise, as shown in Figure 5 (part I and III), the performances of speed of 800 m run, setting flexion, set-ups and grip strength have a comprehensive promotion for each of the participants. These individual records of physical quality indicators have further indicated the positive effect of *Wuqinxi* exercise in the promotion of sports ability. These results also provided a theoretical basis data for the development of short-term training of *Wuqinxi* exercise.

#### 4. Discussions

Firstly, the smooth progress of our work was benefit to our innovative action arrangements. As a form of sport with a wide range of practitioners, *Wuqinxi* has multiple sets of exercises for practitioners of different ages. For example, the elderly in the community are suitable for soothing movements, but young students are suitable for coherent and rhythmic competitive routines.<sup>[18]</sup> However, the basic movements of the *Wuqinxi* are composed of 5 typical animal movements of imitations. We have fully studied the movement characteristics of the 5 kinds of animals, and then arrange a combination of 5 birds in action for female college students combined with the *Wuqinxi* competition routines. The new routine focuses on the strength of legs and the ligament exercise, while we also take care of the training of one-leg balance, and this concept is reflected in the imitation of various animal movements. Such as the jumping of the apes, the standing of the crane, the walking of the black bear, etc., which may play an important role in enhancing cardiovascular

function,<sup>[19]</sup> And we considered that it has an implications on women's confidence, liveliness and graceful characters. Instead, we also removed the complex, high-intensity physical training actions, such as tiger springs. We believed that such an action arrangement can retain female college students, thus adding an interesting event to the university physical education class. In fact, the benefits of such an action arrangement were far more than improving the interest of female college students in sports. With the increase of exercise time, they were particularly proud of their physical progress. At the same time, they were willing to devote themselves to the teaching of junior students which provided a broader platform for their social skills, speaking ability and team cooperation.

The screening of participants (samples) in different test items is also important in this investigation. As mentioned above, we have registered more than 1000 students' information. However, some of them are long-term exercisers; other people have to give up exercise for other reasons on their halfway. Therefore, this survey has taken a long time and energy. On the other hand, in the initial stage of the investigation, we designed the collection of blood samples, and this decision made our volunteers less and less, so our investigation had to be limited to the nondamage detection such as general physical examinations or body surface temperature detection. In addition, in order to maintain a logic, interest and integrity of the survey, we designed the trial project to make it simple and convenient for data collection. The experience of this survey provides important information that the development of modern data collection technology for physical health is very important and urgent for future physical education.

Our survey has showed that the practice of *Wuqinxi* plays a significant role in improving the physical fitness and balance of the female college students. But we also found that other modern sports have more or less a similar promotion in physical function.<sup>[20]</sup> However, what needs to be pointed out here is the actions originated from ancient *Wuqinxi* did change the sports behavior of female college students in the physical education class in Chinese Medicine University. In addition to the improvement of physical data, our level of physical education has made

remarkable progress after the implementation of *Wuqinxi* regular education which may lay a good physical foundation for female college students to adapt the future stressful career after their graduation.

Our investigation is very meaningful for our physical education, but the obvious deficiency is that we have not done an in-depth research and discussion on specific physiological promoting effects on *Wuqinxi*. In fact, we have noticed some influences of *Wuqinxi* exercises on some common physiological and pathological improvements. For example a common phenomenon is that many female college students' dysmenorrhea<sup>[21]</sup> was relieved after practicing *Wuqinxi*. Skin surface temperature shows that the abdomen and small abdomen are fully athletic and massaged which may be one of the important factors for relieving dysmenorrhea.<sup>[22]</sup> Besides, we also found that the symptoms of compulsive spondylitis were also relieved, which may be associated with exercise-induced immunosuppression.<sup>[23]</sup> Modern medical science still has limitations on the understanding of immune diseases, but *Wuqinxi* exercise may be a scientific reason for immune regulation because of its regulation of energy metabolism, endocrine and nerve excitability. Next, we planned to recruit those more 2 types of volunteers with dysmenorrhea or immune disorders, to participate in our study on *Wuqinxi* rehabilitation.

Moreover, we also made a follow-up visit to *Wuqinxi* professional athletes and long-term practitioners. It is interesting that they have a broader employment orientation than other medical students, and it seems that their academic or career promotion is faster than others. Nevertheless, the data we obtained from these visits are relatively subjective, and there is also no comparison of tracking visits for the time being as a control group. So, more behavioral tracking visits on *Wuqinxi* practitioners should be carried out, especially in this form of exercise, which is undoubtedly very important to medical students in China, should be studied and objectively reported on the effects of medical students' thinking and behavior.

## 5. Conclusions

Chinese kungfu contains too many movements and so that it produced a large number of practice forms which are being admired by tens of thousands of enthusiasts all over the world. *Wuqinxi* exercise is the only one of practice form used to preserve traditional action essentials of the directly imitation of animal movements, and still been promoted by medical colleges and local governments. However, while highlighting the commercialization of cultural elements, the value of excellence in healthcare, rehabilitation and health care has been underestimated in China today. Modern urban life is full of various forms of physical exercise which is usually easy to be found in community parks and gyms, especially in university stadiums in China. Unfortunately, it seems that the girls are still marginalized in such an open era which advocates equality between men and women for more than 70 years. So we have to re-check the direction and the teaching content of Physical Education. Most of the Chinese female college students naturally tend to participate in soft mass sport activities, which is the main reason leading to female college students take limit participation in the modern sports practice. Our research was based on a general college physical education developed in all medicine college, which benefits at least twenty thousand young women every year. In this study, we comprehensively investigated and evaluated the improvement of physical quality for female college students. Especially we have been

mobilizing female college students for nearly 10 years to take part in this survey, and professional training and exercise ensured the positive value of our data in analysis of promotion of physical quality. Results we obtained have directly indicated that short-term *Wuqinxi* practice can significantly enhance or improve of limb strength, muscle function, pulmonary function, and cardiac function, as well as maintaining or improving their body statures, and the long term observation showed that *Wuqinxi* exercise could increase the gastrointestinal peristalsis and visceral massage, which can effectively alleviate menstrual discomfort in female college students, and has a strong role in promoting the immune system and digestive system. Besides, the collective movement is full of interaction of each other and the lots of imitation of animal expressions that also plays a positive role in improving the female college students IQ and EQ and effectively preventing the occurrence of depression. For further investigation, the improvement of educational psychology will be concerned in *Wuqinxi* teaching process. And because of a large number of international cooperation in teaching is always under the way, so female students of different educational backgrounds from different countries and cities will participate in the investigation of *Wuqinxi* practice and more test data of teaching and sport training will be collected and analyzed for further college teaching development.

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## Author contributions

CC and DP designed the investigation and recruited volunteers; BZ and CC performed the experiments and analyzed the data and wrote the paper; MY and CH choreographed the set of movements and performed the first part of the experiments.

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