

Study on the Influence and Difference of Taijiquan and Five-animal Exercises on College Students' Ankle Muscle Strength

¹ShangQi Nie, ²Biao Ma, ³Jeho Song

^{1,2} Ph.D. program Dept. of Physical Education, WonKwang Univ., Korea

³Prof., Dept. of Sports Science, WonKwang Univ., Korea

sjhao@wku.ac.kr

Abstract

The physique and health status of Chinese college students have received a generous concern in recent years. The physical condition of Chinese college students is not good and this phenomenon is especially obvious among female college students, which has been an disputable fact. This study starts from exercise intervention to study the concrete influence of taijiquan (a kind of traditional Chinese shadow boxing) and five-animal exercises on human body balance ability; the study uses experimental apparatus to measure the specific impact of exercise intervention on human body balance ability; meanwhile, the study also applies data analysis to longitudinally study whether the two studied sports items affect body balance, and whether there is difference in terms of the influence of two sports items on human body balance ability. The conclusions are as follows: firstly, 24-style taijiquan and five-animal exercises can improve ankle muscle strength, and the focus and degree of the improvement are different; secondly, five-animal exercises have a better improvement effect on the flexor and extensor muscles of ankle joint and 24-style taijiquan is in the second place. Moreover, compared with 24-style taijiquan, there is no significant difference in terms of the improvement caused by five-animal exercises; thirdly, 24-style taijiquan has a better effect on the improvement of internal rotation and evertors muscle strength. Compared with 24-style taijiquan, five-animal exercises have no significant difference in terms of the improvement degree.

Keywords:: Taijiquan, Five-animal exercises, Ankle muscle strength, Human body balance ability

1. Related Theoretical Research

1.1 Current Status of College students' Physique

In recent years, the physique and health status of Chinese college students have been widely concerned. In 2007, the No. 7 document released by CPC Central Committee and the State Council pointed out, "the monitoring of physical health shows, teenagers' physical ability indexes like endurance, strength, speed, etc. continue to decline, the detection rate of students in poor vision is always high, the proportion of overweight and obese teenagers in urban areas increases significantly, and the nutritional status of some rural teenagers needs to be improved urgently. If these problems can not be effectively solved, they will affect teenagers' healthy growth seriously, even influencing the future of the country and nation." [1]

1.2 The Effect of Ankle Muscle Strength on Human Body Balance Ability

Zhu Congde et al [2]. studied the relevance between the ankle strength of middle aged and elderly women and their balance ability, and found, for the women aged 40 - 69, their ankle muscle strength is not the main cause that affects their static balance ability. Therefore, in the study on the relation between muscle strength and balance ability, it is necessary to further explore the effect of the increase and decrease of strength of different joints and muscles on human body balance ability. Previous studies at home and abroad have shown that, muscle strength can affect balance ability and people with poor muscle strength have poor balance ability; strength exercises can improve human body balance ability [3, 4], and meanwhile, ankle strength is the determinant of human balance ability [5].

2. Research Object and Method

2.1 Research Object

This study takes the 2017 college students who chose martial arts as their elective course of public physical education in Fujian Normal University, and studies the influence and difference of taijiquan (taijiquan mentioned in this paper refers to 24-style taijiquan) and five-animal exercises on college students' balance ability.

2.2 Research Method

2.2.1 Literature Review

Based on the needs of the study, the author searches CNKI database, the database of master's and doctoral dissertations in China as well as Google Scholar to collect the domestic and overseas literature which is related to the influence of ankle muscle strength on human body balance ability and the influence of the practice of taijiquan and five-animal exercises on human body balance ability. After the search and analysis, the related materials provide the theoretical basis for the study.

2.2.2 Experimental Method

By testing the college students before and after participating in the practice of 12-week taijiquan and five-animal exercises, statistical analysis method is adopted to compare the changes of the related indexes of balance ability before and after the practice and explore the effect of taijiquan and five-animal exercises on improving human ankle muscle strength as well as whether there is difference in terms of the influence of the two sports items on ankle muscle strength.

Testing index: relative peak torque (PT/BW) - peak torque per unit weight. Since the index excludes the influence of body weight on torque, the comparison of the strength of different individuals seems to be very important.

Testing instrument: HUMAC NORM multi-joint muscle strength isokinetic test training system produced by CMSI

2.2.3 Mathematical Statistics

The author analyzes the collected data and adopts SPSS19.0 mathematical statistics software to conduct one-way ANOVA F-test on the obtained data to observe whether there is significant difference between experimental group and control group and whether there is significant difference between the experimental groups.

3. Results and Analysis

3.1 Comparison between the Experimental Group and the Control Group

3.1.1 Comparison between the Experimental Group and the Control Group of 24-style Taijiquan

We can see from <Table 1> and <Table 2>, group statistics show that the mean of all muscle strength indexes of taijiquan group is significantly greater than that of the control group, which indicates that the muscle strength of extensor, flexor, internal rotation and evertors of ankle joint in Taijiquan group are better than those in control group. The independent sample test shows, the absolute value of T value is much greater than 2.441, so $p < 0.01$. It is regarded that the extensor strength, flexor strength, internal rotation muscle strength and evertors strength of ankle joint in the Taijiquan group are better than those of the control group, and the difference is highly significant.

Table 1. Group Statistics

	Group	N	Mean Value	Standard Deviation	Standard Error of the Mean
Relative peak torque of right foot anterior and posterior extensors	Control group	10	20.50	6.416	2.029
	Taijiquan group	10	38.40	8.195	2.591
Relative peak torque of right foot anterior and posterior extensors	Control group	10	17.20	6.877	2.175
	Taijiquan group	10	30.90	5.131	1.622
Relative peak torque of left foot anterior and posterior extensors	Control group	10	25.80	8.917	2.820
	Taijiquan group	10	42.00	6.766	2.140
Relative peak torque of left foot anterior and posterior flexors	Control group	10	10.40	3.921	1.240
	Taijiquan group	10	21.30	6.201	1.961
Relative peak torque of right foot internal rotation muscles	Control group	10	19.10	4.175	1.320
	Taijiquan group	10	36.40	9.324	2.948
Relative peak torque of right foot evertors	Control group	10	12.40	3.596	1.137
	Taijiquan group	10	26.00	9.250	2.925
Relative peak torque of left foot internal rotation muscles	Control group	10	14.00	3.944	1.247
	Taijiquan group	10	30.10	10.268	3.247
Relative peak torque of left foot evertors	Control group	10	9.10	1.792	.567
	Taijiquan group	10	22.20	11.745	3.714

Table 2. Independent Sample Test

		Levene test of variance equation		T test of mean equation						
		F	Sig.	t	df	Sig.(bilateral)	Mean difference	Standard error value	95% confidence interval for difference	
									Lower limit	Upper limit
Relative peak torque of right foot anterior and posterior extensors	Equal variances assumed	.332	.572	-5.439	18	.000	-17.900	3.291	-24.815	-10.985
	Equal variances not assumed			-5.439	17.020	.000	-17.900	3.291	-24.843	-10.957

Relative peak torque of right foot anterior and posterior flexors	Equal variances assumed	2.212	.154	-5.050	18	.000	-13.700	2.713	-19.400	-8.000
	Equal variances not assumed			-5.050	16.649	.000	-13.700	2.713	-19.433	-7.967
Relative peak torque of left foot anterior and posterior extensors	Equal variances assumed	1.771	.200	-4.577	18	.000	-16.200	3.540	-23.636	-8.764
	Equal variances not assumed			-4.577	16.783	.000	-16.200	3.540	-23.675	-8.725
Relative peak torque of left foot anterior and posterior flexors	Equal variances assumed	2.985	.101	-4.698	18	.000	-10.900	2.320	-15.775	-6.025
	Equal variances not assumed			-4.698	15.206	.000	-10.900	2.320	-15.840	-5.960
Relative peak torque of right foot internal rotation muscles	Equal variances assumed	6.916	.017	-5.355	18	.000	-17.300	3.231	-24.087	-10.513
	Equal variances not assumed			-5.355	12.470	.000	-17.300	3.231	-24.310	-10.290
Relative peak torque of right foot evertors	Equal variances assumed	10.845	.004	-4.334	18	.000	-13.600	3.138	-20.193	-7.007
	Equal variances not assumed			-4.334	11.660	.001	-13.600	3.138	-20.460	-6.740
Relative peak torque of left foot internal rotation muscles	Equal variances assumed	15.042	.001	-4.629	18	.000	-16.100	3.478	-23.408	-8.792
	Equal variances not assumed			-4.629	11.599	.001	-16.100	3.478	-23.708	-8.492
Relative peak torque of left foot evertors	Equal variances assumed	14.138	.001	-3.487	18	.003	-13.100	3.757	-20.994	-5.206
	Equal variances not assumed			-3.487	9.419	.006	-13.100	3.757	-21.542	-4.658

3.1.2 Comparison between the Experimental Group and the Control Group of Five-animal Exercises

We can see from <Table 3> and <Table 4>, group statistics show that the mean of all muscle strength indexes of five-animal exercise group is higher than that of the control group, which indicates that the strength of extensor, flexor, internal rotation muscle and evertors in five-animal exercise group are better than those in control group. The independent sample test shows, T value of relative peak torque of extensor and flexor of ankle joint is obviously greater than 2.441, so $p < 0.01$. It is regarded that the relative peak torque of internal rotation muscles and evertors of the ankle joint in five-animal exercise group are better than those of the control group, and the difference is highly significant.

Table 3. Group Statistics

	Group	N	Mean Value	Standard Deviation	Standard Error of the Mean
Relative peak torque of right foot anterior and posterior extensors	Control group	10	20.50	6.416	2.029
	Five-animal exercise group	10	46.10	7.622	2.410
Relative peak torque of right foot anterior and posterior flexors	Control group	10	17.20	6.877	2.175
	Five-animal exercise group	10	32.80	6.070	1.919
Relative peak torque of left foot anterior	Control group	10	25.80	8.917	2.820

and posterior extensors	Five-animal exercise group	10	41.80	7.627	2.412
Relative peak torque of left foot anterior and posterior flexors	Control group	10	10.40	3.921	1.240
	Five-animal exercise group	10	23.80	10.433	3.299
Relative peak torque of right foot internal rotation muscles	Control group	10	19.10	4.175	1.320
	Five-animal exercise group	10	25.10	7.490	2.369
Relative peak torque of right foot evertors	Control group	10	12.40	3.596	1.137
	Five-animal exercise group	10	15.80	4.803	1.519
Relative peak torque of left foot internal rotation muscles	Control group	10	14.00	3.944	1.247
	Five-animal exercise group	10	19.20	6.443	2.037
Relative peak torque of left foot evertors	Control group	10	9.10	1.792	.567
	Five-animal exercise group	10	12.00	4.110	1.300

Table 4. Independent Sample Test

		Levene test of variance equation		T test of mean equation						
		F	Sig.	t	df	Sig.(bilateral)	Mean difference	Standard error value	95% confidence interval for difference	
									Lower limit	Upper limit
Relative peak torque of right foot anterior and posterior extensors	Equal variances assumed	.259	.617	-8.125	18	.000	-25.600	3.151	-32.219	-18.981
	Equal variances not assumed			-8.125	17.491	.000	-25.600	3.151	-32.233	-18.967
Relative peak torque of right foot anterior and posterior flexors	Equal variances assumed	.611	.444	-5.378	18	.000	-15.600	2.901	-21.694	-9.506
	Equal variances not assumed			-5.378	17.727	.000	-15.600	2.901	-21.701	-9.499
Relative peak torque of left foot anterior and posterior extensors	Equal variances assumed	.069	.796	-4.312	18	.000	-16.000	3.711	-23.796	-8.204
	Equal variances not assumed			-4.312	17.578	.000	-16.000	3.711	-23.809	-8.191
Relative peak torque of left foot anterior and posterior flexors	Equal variances assumed	9.509	.006	-3.802	18	.001	-13.400	3.525	-20.805	-5.995
	Equal variances not assumed			-3.802	11.493	.003	-13.400	3.525	-21.117	-5.683
Relative peak torque of right foot internal rotation muscles	Equal variances assumed	2.548	.128	-2.213	18	.040	-6.000	2.712	-11.697	-.303
	Equal variances not assumed			-2.213	14.101	.044	-6.000	2.712	-11.812	-.188
Relative peak torque of right foot evertors	Equal variances assumed	.241	.630	-1.792	18	.090	-3.400	1.897	-7.386	.586

	Equal variances not assumed			-1.792	16.679	.091	-3.400	1.897	-7.409	.609
Relative peak torque of left foot internal rotation muscles	Equal variances assumed	3.918	.063	-2.177	18	.043	-5.200	2.389	-10.219	-.181
	Equal variances not assumed			-2.177	14.915	.046	-5.200	2.389	-10.294	-.106
Relative peak torque of left foot evertors	Equal variances assumed	5.208	.035	-2.046	18	.056	-2.900	1.418	-5.879	.079
	Equal variances not assumed			-2.046	12.303	.063	-2.900	1.418	-5.981	.181

3.2 Comparison of Index Differences between Experimental Groups

It can be shown from <Table 5> and <Table 6>: from the mean difference of ankle muscle strength index, five-animal exercise group is higher than taijiquan group in terms of peak torque of flexor and extensor of right foot and left foot. It is considered five-animal exercise group is better than taijiquan group in terms of both the relative peak torque of flexor and extensor. From the perspective of significance, compared with five-animal exercise group, the significance of taijiquan group P is higher than 0.05, so it is thought that taijiquan group and five-animal exercise group have no significant difference. In terms of the relative peak torque of left foot internal rotation muscles and evertors, and right foot internal rotation muscles and evertors, taijiquan group is higher than five-animal exercise group, so it is regarded that taijiquan group is superior to five-animal exercise group in terms of both the relative peak torque of internal rotation muscles and the relative peak torque of evertors. From the perspective of significance, compared with taijiquan group, the significance of five-animal exercise group is lower than 0.05, so it is considered that taijiquan group and five-animal exercise group have significant difference in terms of both the relative peak torque of internal rotation muscles and the relative peak torque of evertors.

Table 5. ANOVA

		Square sum	df	Mean square	F	Significance
Relative peak torque of right foot extensor	Between groups	1575.267	2	787.633	10.023	.001
	Intragroup	2121.700	27	78.581		
	Total	3696.967	29			
Relative peak torque of right foot flexor	Between groups	460.867	2	230.433	7.332	.003
	Intragroup	848.600	27	31.430		
	Total	1309.467	29			
Relative peak torque of left foot extensor	Between groups	923.467	2	461.733	7.240	.003
	Intragroup	1722.000	27	63.778		
	Total	2645.467	29			
Relative peak torque of left foot flexor	Between groups	496.067	2	248.033	4.602	.019
	Intragroup	1455.300	27	53.900		
	Total	1951.367	29			
Relative peak torque of right foot internal rotation muscles	Between groups	692.600	2	346.300	5.246	.012
	Intragroup	1782.200	27	66.007		
	Total	2474.800	29			
Relative peak torque of right foot evertors	Between groups	529.800	2	264.900	5.687	.009
	Intragroup	1257.700	27	46.581		
	Total	1787.500	29			
Relative peak torque of left foot internal rotation	Between	660.200	2	330.100	4.905	.015

muscles	groups					
	Intragroup	1817.000	27	67.296		
	Total	2477.200	29			
Relative peak torque of left foot evertors	Between groups	568.800	2	284.400	5.119	.013
	Intragroup	1500.000	27	55.556		
	Total	2068.800	29			

Table 6. Multiple Comparison

LSD

Dependent variable	(I) Group	(J) Group	Mean difference (I-J)	Standard error	Significance	95% confidence interval for difference	
						Lower limit	Upper limit
Relative peak torque of right foot extensor	Taijiquan group	Five-animal exercise group	-7.700	3.964	.063	-15.83	.43
Relative peak torque of right foot flexor	Taijiquan group	Five-animal exercise group	-1.900	2.507	.455	-7.04	3.24
Relative peak torque of left foot extensor	Taijiquan group	Five-animal exercise group	-3.800	3.571	.297	-11.13	3.53
Relative peak torque of left foot flexor	Taijiquan group	Five-animal exercise group	-2.500	3.283	.453	-9.24	4.24
Relative peak torque of right foot internal rotation muscles	Taijiquan group	Five-animal exercise group	11.300*	3.633	.004	3.84	18.76
Relative peak torque of right foot evertors	Taijiquan group	Five-animal exercise group	10.200*	3.052	.002	3.94	16.46
Relative peak torque of left foot internal rotation muscles	Taijiquan group	Five-animal exercise group	10.900*	3.669	.006	3.37	18.43
Relative peak torque of left foot evertors	Taijiquan group	Five-animal exercise group	10.200*	3.333	.005	3.36	17.04

*. The significance level of the mean difference is 0.05.

4. Discussion

4.1 Comparative Analysis of Taijiquan Group and Control Group

The mean value of ankle muscle strength of the taijiquan group is obviously lower than that of the control group. The independent sample test shows: the absolute value of T value is much greater than 2.441, so $p < 0.01$. Thus, it is thought that the ankle muscle strength of the taijiquan group is improved compared with that of the control group. This may be because taijiquan is characterized by its low center of gravity and the practitioner's legs are always in a half squat position. Moreover, the practitioner's center of gravity can not fluctuate up and down, but is basically at the same level. This fully trains the muscle strength of human lower limbs, especially the toe flexor, dorsiflexion, internal rotation and eversion of the ankle joint. Therefore, 24-

style taijiquan can improve the ankle muscle strength and the indexes of the ankle muscle strength are better than that of the control group.

4.2 Comparative Analysis of Five-animal Exercise Group and Control Group

All the ankle muscle strength of five-animal exercise group is superior to that of the control group, and both its ankle muscle strength and that of the control group have significant difference. Compared with the indexes of the control group, the muscle strength indexes of the flexor and extensor of ankle are highly significant; the internal rotation muscle strength and evertors strength of ankle joint have significant difference in comparison to that of the control group.

Five-animal exercises include 12 movements, respectively, commencing form and regulating of breathing, tiger lifting, tiger rush, deer resistance, deer running, bear turn, bear shake, ape raising, ape picking, bird stretching, bird fly and drawing qi (energy of life) to its origin. Tiger lifting of five-animal exercise requires the practitioner's eyes to follow his hands and it can move the practitioner's upper limbs, neck and eyes; moreover, the lowering and raising of head can improve the practitioner's brain vestibular perception. The set action of tiger rush is beneficial to the movements of spine and waist muscles. The movement "rush" has a very high requirement for the strength of lower limbs, and the requirement for ankle flexor strength is particularly obvious. Deer resistance is usually the turn of body and refers to big range movements of body joints like ankle, knee, hip, waist, chest, neck, etc., and it is especially obvious for left and right ankle movements. Deer running has a higher requirement for the strength of lower limbs, for the practitioner needs to arch back and lower the center of gravity; moreover, the practitioner's turn between front and rear has a great influence on the range of motion of the ankle joint.

4.3 Comparative Analysis Taijiquan Group and Five-animal Exercise Group

By analyzing the data of Taijiquan group and five-animal exercise group, the two groups do not have significant difference in terms of ankle flexor and extensor strength, but five-animal exercise group has a higher mean value; however, Taijiquan group and five-animal exercise group have significant difference in terms of left and right internal rotation and eversion muscle strength, but the mean value of Taijiquan group is higher than that of five-animal exercise group.

This may be because the center of gravity of the practitioner who does Taijiquan exercise moves more, and the practitioner needs more movements in different positions, so the training on ankle joint is more comprehensive. In comparison to five-animal exercises, taijiquan does not have obvious movement pause and it is more intensified in terms of the training of ankle flexor and extensor, so the improvement of ankle flexor and extensor strength is more obvious.

From the analysis of ankle muscle strength indexes, ankle muscle strength indicators include two parts, respectively, flexion and extension strength in anteroposterior direction and the muscle strength of internal rotation and evertors in left and right directions. There are many movements in front and back directions in taijiquan, such as parting the wild horse's mane on both sides, brushing knee and twisting step on both sides, stepping back and whirling arms on both sides, grasping the bird's tail on both sides, striking the opponent's ears with both fists, etc. All the lunges in these movements can train ankle flexors and extensors, but due to the different degrees of the drop of center of gravity when doing taijiquan exercise, the training intensity on ankle flexors and extensors is also different. The movements like "tiger rush", "deer resistance", "bear shake" and "bird fly" in five-animal exercises have a larger training intensity on ankle flexors and extensors. Compared with taijiquan exercise, the range, strength and exercise time of the movements of five-animal exercises are longer. Thus, although there is no significant difference in terms of the indexes of ankle flexors and extensors, the indexes of five-animal exercise group are higher than those of taijiquan group. There are lots of movements of turning the waist left and right in taijiquan exercise and all of them are the movements of knee bending, so it has a better improvement effect on the internal rotation muscle strength and evertors strength of ankle joint is superior to that of five-animal exercise group, and the two groups have significant difference.

5. Conclusions

Firstly, 24-style taijiquan and five-animal exercises can improve ankle muscle strength, but the focus and degree of the improvement are different;

Secondly, five-animal exercises have a better improvement effect on the ankle flexor and extensor muscle strength and 24-style taijiquan is in the second place. Moreover, compared with 24-style taijiquan, there is no significant difference in terms of the improvement degree from five-animal exercises;

Thirdly, 24-style taijiquan has a better effect on the improvement of internal rotation and evertors muscle strength of ankle joint. Compared with 24-style taijiquan, five-animal exercises have no significant difference in terms of the improvement degree.

6. Suggestions

Firstly, students should pay attention to learning movement standards first in their learning process, and they should strictly follow the quality standards of the movements so as to achieve a better training effect.

Secondly, the students can lay more emphasis on the weaker parts in accordance with their own ability in the process of practice.

Thirdly, students should concentrate on the standards of the movements when they learn taijiquan, Yijinjing (bone and tendon changing) and five-animal exercises. The center of gravity of taijiquan beginners can be a little higher; the practitioners should fully shrink and stretch their body when they practice Yijinjing; moreover, they should relax physically and mentally, and combine with breathing to improve their physical functions.

Fourthly, taijiquan and five-animal exercises have different emphasis in terms of their influence on the body balance ability of college students, and the difficulty of learning them is also different. In comparison to five-animal exercises, taijiquan has more complicated movements and it has a higher requirement on physical coordination. Moreover, it needs more time to learn taijiquan. Thus, people can choose the sports item according to their own situation.

Fifthly, the practitioners who learn taijiquan and five-animal exercises need to stick to long-term exercise and do not rush for success. They can adjust their body's center of gravity to regulate the amount of exercise in the process of practice, so they not only can choose the appropriate amount of exercise, but also can achieve a better exercise effect.

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