

Effect of Core Strength Training on Wushu Performance: A Systematic Review

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Abstract

Core strength training has a conspicuous effect on the performance of Wushu. The primary purpose of this paper is to summarize the effect of core strength training on Wushu Sanda, traditional Wushu routines, and competitive Wushu routines. Heretofore, there is no systematic evaluation report on the performance of Wushu's core strength. Extant literature shows that core strength training can promote the performance of Sanda and set Wushu. However, the lack of influence of core strength training is the most noteworthy challenge associated with competitive Wushu routine. In the current literature, there are insufficient conclusions on the influence of core strength training on Wushu performance. In recent years, the development direction of competitive Wushu routines has been dominated by high-difficulty movements. If there is a lack of high-difficulty movements in competitive Wushu routines, athletes will not have good results in competitions. This has necessitated a rigorous literature review to evaluate the influence of core strength training on the performance of Wushu.

Keywords: Core strength training, Wushu, Sanda, Performance.

I. INTRODUCTION

Core strength training has become a vital form of athletic training recognized by coaches and athletes. It was proposed by American scholars in 2005 [1]. It can help improve the waist strength and spine stability of Wushu athletes, which in turn can improve the explosive power, movement speed, and movement balance ability of Wushu athletes [2].

Core strength training refers to the training of deep and shallow muscles in the core area of the human body. The trunk, especially the waist position of the human body, is a critical anatomical part of the human movement system. It is a link connecting the upper and lower limbs of the human body. It plays a

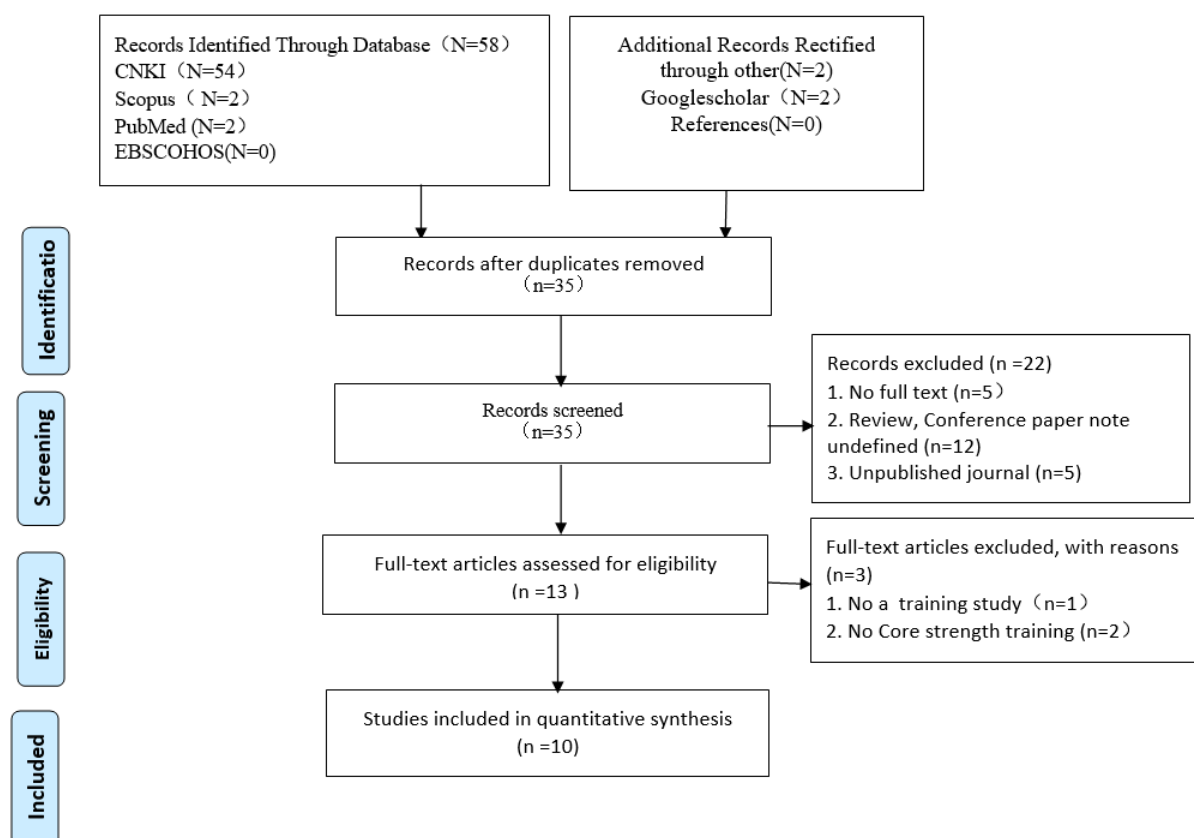
prime role in stabilizing and balancing the body's center of gravity, cooperating in participation, and transmitting power [32]. Core strength training enhances the core strength of athletes through muscle, nerve, and other aspects. The methods, contents, and means of core strength training are relatively affluent. Wushu is a more complex whole-body sport and is largely dependent on human trunk muscle groups, which is reflected in the strength level of muscle groups (strength, explosive power, and endurance) and the ability to participate in sports to maintain body static and dynamic balance. It selectively strengthens the strength of trunk muscle groups, and their collaborative training of Wushu athletes, will receive the anticipated effect [40].

Core strength training is beneficial for improving the stability of the core area of the athletes, improve the control ability of the air body posture, improve the control ability of the limbs, prevent injury, and help improve the technical level and performance of the athletes [21]. The lack of core strength in Sanda can cause the speed of the punch and kick to decrease, whereas the inadequacy of core strength in traditional Wushu can lead to a decrease in waist strength. Furthermore, the lack of stability in movements and the inadequacy of core strength in competitive Wushu routines can lead to the inconsistency in

athletes' movements, the decline in the level of exercise, and the loss of balance and stability for challenging movements [25].

Although the benefits and effects of core strength training have been analyzed in the literature, the scientific evidence corroborating these effects on Wushu performance is minimal. It is crucial to analyze the scientific evidence on the potential benefits of core strength training before assessing its effects on Wushu. Therefore, the purpose of this systematic review can be described as the effectiveness of the core strength training on Wushu performance [10].

Fig. 1 Flowchart describing the systematic review of articles included in the analysis



2. Results

The search results were screened and read by establishing inclusion criteria and exclusion criteria. This systematic review contains 10 studies describing the influence of core strength training on the performance of Wushu.

2.1 Study selection

The search results were imported into a published software for a systematic review, and two independent reviewers performed a blind review process. Any differences were resolved by means if a consensus. The search produced 60 papers, in addition to two more identified using additional records of Google Scholar (in total 62). By manual selection, repetitive

articles (n = 29) and inappropriate (n = 21) articles were eliminated. Inclusion criteria can be described as follows:

1. Participants have training experience in any Wushu properties (Wushu Sanda properties, Wushu fitness properties, Wushu competition properties).
2. The dependent variable is the core strength, while the independent variable is the performance of Wushu (body stability, movement balance ability, drill level, and movement difficulty).
3. Interventions are experimental studies (randomized controlled trials, comparative trials, single-group trials).

4. The intervention period is more than four weeks.

5. The article has the data for one or more parameters, namely: attack, body stability, movement balance ability, drill level, and movement difficulty

The article is published in a peer-reviewed journal. The first four criteria were adopted because neuromuscular adaptation had been observed in individuals without core strength training in less than four weeks; The remaining 10 papers are reserved for full-text reading. Finally, 10 studies were used in the final review on the performance of Wushu.

Table 2. *Research Describing Wushu performance*

Study	Location, year	Study type (Methodology)	Sample size	Intervention	Session duration (length of intervention)	Participant details: age range in years (mean) sex	Outcome
Chu Long	Beijing, China, 2015	Randomized controlled trial	20	Core strength training and Sanda	8 weeks of training	Age range 23 ± 1 Male (n=20) Female (n=0)	The core strength training can improve the core stability ability of the discrete fighting athletes to increase the movement efficiency of the athletes and improve leg endurance.
Duan Yuan Tao	Chengdu, China, 2016	Randomized controlled trial	24	Core strength training and Sanda	Each session was 3 times a week for 40 minutes for 24 weeks	Age range 17.23 ± 3.11 Male (n=24) Female (n=0)	The core strength training team Wushu Sanda athlete's waist strength punch speed is very fast.
Zheng Nan	Shandong, China, 2012	Randomized controlled trial	10	Core strength training and traditional Wushu routines	40 minutes, 3 times a week, for 8 weeks	Age range 23 Male (n=10) Female (n=0)	Core strength training has a highly conspicuous effect on improving the core stability of athletes and reducing the error rate of difficult movements.
Ding Yi Xuan	Henan, China, 2017	Randomized controlled trial	16	Core strength training and traditional Wushu routines	30 minutes, 4 times a week, for 8 weeks	Age range 20 ± 2 Male (n=16) Female (n=0)	Core strength training can effectively improve the stability and quality of traditional Wushu routines.
Wang Pan	Wuhan, China, 2008	Randomized controlled trial	6	Core stability training and competitive Wushu routines	Three times a week for 30 minutes for 16 weeks	Age range 17 Male (n=6) Female (n=0)	It is feasible and effective to apply the core strength training to the sports training of Wushu routine.

Sun Kang	Shanghai, China, 2017	Experimental study	10	Core stability training and competitive Wushu routines	Practice for 20 minutes 4 times a week for 4 months	Age range 16 Male (n=10) Female (n=0)	Core strength training can improve the balance ability of Wushu students under the condition of foot support and greatly improve the stability of Wushu movements.
Chen Wang	Shanghai, China, 2020	Randomized controlled trial	16	Core stability training and competitive Wushu routines	45 minutes a day, five times a week, for 12 weeks	Age range 23 Male (n=16) Female (n=0)	Core strength training is effective in the physical recovery of injured athletes.
Dai Chao Ping,	Guangzhou, China, 2011	Randomized controlled trial	16	Core stability training and competitive Wushu routines	30 minutes, 3 times a week, for 12 weeks	Age range 14 ± 2 Male (n=16) Female (n=0)	Stability core stability training can effectively improve the balance stability ability and muscle coordination ability of Wushu routine athletes and reduce the failure rate of difficult movement cohesion.
Yang Dan	Beijing, China, 2016	Randomized controlled trial	10	Core stability training and competitive Wushu routines	30 minutes, 3 times a week, for 8 weeks	Age range 20 Male (n=10) Female (n=0)	The addition of core strength training to the traditional core strength training can improve the stability of athletes for completing difficult movements and can improve the body balance ability.
Mao Dan Dan	Fujian, China, 2011	Randomized controlled trial	20	Core Stability training and competitive Wushu routines	30 minutes, 3 times a week, for 12 weeks	Age range 18 Male (n=20) Female (n=0)	Core strength training can effectively improve the balance ability of young Wushu set athletes under the condition of one-foot support.

2.3 Participant Characteristics

A total of 246 participants were included in the studies enumerated in Table 2. Although one study did not report the gender of the participants, all the participants of each study were boys. The average age of the participants of all the studies was 21 years.

The target population of this study is diverse, including two Wushu Sanda athletes [3,5], two traditional Wushu routine athletes [38,40], and six routine competitive athletes [16, 21, 25, 33, 36, 47].

2.4 Intervention characteristics

Intervention features of the 10 included studies are reported from the following aspects: (1) intervention cycle. There are 4 studies reported the intervention for 8- weeks [3, 5, 25, 47], 3 studies reported the intervention for 12-week [21, 33, 36], and, the intervention lasted for 16 weeks with two items in [16, 40]. The intervention lasted for 24 weeks with a single item in [47].

Table 3 Summary of methodological quality assessment scores

Reference	Eligibility criteria	Random allocation	Allocation concealment	Group similar at baseline	Blinded subject	Blinded therapist	Blinded assessor	Follow-up	Intention to treat analysis	Between group comparisons	Point measure and variability	PE Dro score
Chu Long 2015	1	0	1	1	0	1	1	1	0	1	1	8
Duan Yuan Tao 2016	1	1	0	1	0	1	0	1	0	1	1	7
Zheng Nan 2012	1	1	0	1	1	0	1	0	0	1	1	7
Ding Yi Xuan 2017	1	0	1	1	0	1	0	1	0	1	1	7
Wang Pan 2008	1	1	0	1	0	1	0	1	0	1	1	7
Sun Kang 2017	1	1	0	1	0	1	0	1	0	1	1	7
Chen Wang 2020	1	0	0	1	0	1	0	1	0	1	1	6
Dai Chao Ping, 2011	1	0	0	1	1	1	0	0	0	1	1	6
Yang Dan 2016	1	0	1	1	1	0	0	0	0	1	1	6
Mao Dan Dan 2011	1	0	0	1	0	0	0	1	1	1	1	6

2.5 Outcomes

The results of this study are grouped according to the influence of core strength training on the performance of Wushu. The authors of this study have independently categorized the studies in the literature according to different research topics (components). The authors of this study worked on the difference in their standpoints until an agreement was reached. In the included studies, the authors found that core strength training has different effects on the performance of Wushu:

The effect of core strength training on the performance of Sanda (the special quality of Sanda athletes)

The effect of core strength training on the performance of traditional Wushu routines (movement stability and balance ability)

The effect of core strength on competitive Wushu routines (difficult movements and exercise level)

2.5.1 Effect of core strength training on Wushu Sanda performance

Special sports quality refers to the sport's ability related to Sanda that Sanda athletes display through sports training according to their quality and ability [53]. After eight weeks of core strength training (Swiss ball project), the individual indexes of the quality of the exceptional sport of the body in the experimental group were not the same after core strength training. There were observed significant differences in one min flogging and one min punching than before the experiment ($P < 0.01$). There was a significant difference between the sliding index of change direction and the score before the test ($P < 0.05$) [47].

After eight weeks of nuclear stability training (lumbar flexion forward, extension back, right lumbar bridge, and left lumbar bridge), the experimental group of athletes before and after the experiment also exhibited a significant increase in nuclear stability. There were significant differences before and after the experiment ($P < 0.01$). These differences show that core strength training has a significant effect on the body stability of Sanda athletes [47].

2.5.2 Effect of core strength training on traditional Wushu routine performance (movement flexibility and stability)

(i) Effect of core strength training on the flexibility of traditional Wushu routines

The movement flexibility of traditional Wushu is not a simple and isolated upper body movement but is closely combined with the attack and defense of the whole-body movement. Because the waist is the link connecting the upper and lower limbs, the movement should be done up and down to cooperate, step travel, make the whole set of performance, hard and soft aid, fast and slow alternate, waist for the axis, combined with various techniques, leg method and use the twist, pitch, put, fold and other ways, and leading the whole-body attack and defense changes. Core strength training is an excellent way to improve the waist strength of traditional Wushu practitioners to increase their movement flexibility during exercise [27].

(ii) Effect of core strength training on the movement stability of traditional Wushu routines

Balance ability plays an important role in Wushu performance traditional. Core strength training can improve the strength of waist and abdominal muscles of traditional Wushu athletes, and the improvement of waist and abdomen is conducive to enhancing the stability of athletes' movements, so that athletes can better complete movements in the process of training and competition, and easier to achieve good results. Therefore, strengthening the core training of athletes in traditional Wushu routines is conducive to improving the control and balance of the athletes' body and enhancing the perception of their body muscles [30].

2.5.2 Effect of Core Strength Training on Competitive Wushu Routine Performance (Difficult Movements and training level)

(i) Effect of core strength training on primary difficulty movements of competitive Wushu routine athletes

The difficulty movement of Wushu is one of the important ways to improve the appreciation of competitive Wushu. The core strength training can improve the vertical transfer degree of difficulty spinning and flying in competitive Wushu. The most powerful proof is that the transfer degree of whirlwind landing and air turning Angle of the experimental subjects are improved before and after the experiment. This indicates that the 12-week core stability training has specific noticeable effects on the experimental group, making both movements significantly improved to a certain degree [45]. In this study, two primary difficulty skill indexes of competitive Wushu are selected as test indexes for evaluation, namely flying foot and whirlwind foot 360°. After 12 weeks of core strength flexor extension and rotation exercise, the experimental group was significantly improved before and after the experiment ($P < 0.01$), and the two special techniques were improved by 2.07, 2.90, and 2.90, respectively. The cyclone kicks. was the most significant improvement,

which increased from 5.61 ± 1.74 before the experiment to 8.51 ± 1.20 after it. The second most significant improvement was observed to be flying feet. According to the data in the table, the core strength has a significant impact on the difficult elementary movements of competitive Wushu [33]. These differences show that the core strength is conducive to overcoming the primary difficulty of competitive Wushu [39].

(ii) Effect of core strength training on the training level of competitive Wushu athletes

The level of Wushu practice is an integral part of Wushu performance, which can reflect the students' spiritual outlook and master degree of Wushu performance. Among all the studies that were included for review, there are two concerning the influence of core strength on the performance level of Wushu. Through five weeks of core strength training of weight-bearing barbell, weight-bearing squat, and lifting ring, the physical quality and exceptional quality of Wushu students were improved. The Wushu performance was improved by 2.63 ± 0.08 before the experiment and 2.82 ± 0.08 after the experiment, which was improved by 4.13 ($P < 0.001$), which indicates that the core strength has a positive effect on the performance of Wushu [39]. Through six weeks of core strength training (sit-ups, supine back-up, supine, left turn, supine right turn), the physical quality of Wushu athletes was improved, and the Wushu performance of Wushu students was improved from 2.73 ± 0.048 before the experiment to 2.83 ± 0.051 after the experiment ($P < 0.005$). This shows that the core strength can noticeably improve the performance of Wushu [18].

3. Discussion

This review divides Wushu into three types according to their kinds. Which are:

1. Wushu (sanda)
2. Traditional Wushu routines (Movement flexibility and stability)

3. Competitive Wushu routines (Wushu difficulty movements and exercise levels)

3.1 Effect of core strength training on Wushu Sanda athletes

After the experiment, the elongation of the eight directions of the star-shaped test in the experimental group increased, increasing more than 20%. After eight weeks of traditional strength training in the control group, there was a slight increase in the ratio of stretch to leg length in all eight directions. It shows that core strength training is beneficial to improving the stability of Sanda athletes, and the effect is better than traditional strength training [6].

The eight-week core strength training can improve the waist strength and spine stability of Sanda's athletes to increase the movement efficiency and improve the leg endurance, boxing endurance, agility, movement speed, and wrestling strength quality of Sanda's athletes [6].

The experimental results show that after the core strength training, the movement and control ability of the muscle groups in the core area of the body of the athletes significantly improved, especially the overall effect is pronounced after the completion of the motion pattern, and the shaking and vibration of the previous pattern improved considerably [46].

3.2 Effect of core strength training on traditional Wushu routine performance

Core strength training for students of traditional Wushu's torso flexion of shrinking and stretching ability is greatly improved; the traditional Wushu students' sweeping gesture, body posture, and body control stability increase the core strength training to a certain extent and can effectively stimulate the deep little muscle, improve the ability of the core muscles to work together, in order to improve the movement flexibility of Wushu students [44]. It was found that using the core strength method significantly improved the rapid contraction and the maximum muscle strength growth of the trunk flexor and extensor muscles. After core strength training with a balance board, it helps to improve core stability

and provides a stable foundation for body strength [49]. During the intervention, Wushu students are required to use their hands to break the balance. The Swiss ball combines dumbbells and barbells with Wushu students' bare hands to simulate the unbalanced rotation in specific sports so that the rotation force of complex movements can reach balance, which significantly influences the stability of traditional-structure Wushu students [38].

The routine movement is composed of undulation, rolling, continuous, sudden stop, quick turn, and other movements with specific characteristics. The main driver for these movements is the connection of the upper and lower limbs, which comes from a rapid, uninterrupted contraction of the body's core muscle groups [42]. Especially in daily exercise, when the body is tired, the ring function of the core area declines and the connection between the upper and lower limbs is prone to disconnect. These problems can be avoided if an athlete has good core endurance [36]. Therefore, core endurance plays a critical role in Wushu exercise. In core endurance training, the fundamental integrity of the traditional Wushu athletes in the fatigue state of the Wushu exercise, the single movement, the movement transition ability, the campaign running rhythm, the smooth speed, and the flexibility are effectively improved, and the skills of the athletes are remarkably improved [40].

3.3 Effect of core strength training on competitive Wushu routine performance

For greater core strength, the energy of the second half of the whole set of movements can be guaranteed, and there will be no deformation of movements due to lack of physical strength to improve the working efficiency of the athlete's body and ensure the integrity of the whole set of movements [9].

Core strength improves the Wushu participants' nerve-muscle control, improves the onset of force transmission order, makes the power of the Wushu student member action appears more smoothly; in addition, it accelerates the transformation and the connection between

concrete action, makes the action appear more harmonious, more can reflect the style and features of the athlete. Second, the improvement of the core strength of Wushu participants perform actions with crucial support, because the stand or fall of Wushu exercise level mainly depends on when the muscle between the coordination and control of the rapid movement of the center of gravity ability, the core strength and stability of the change is the key of the Wushu athletes' ability to form [40]. The improvement in core strength plays a stabilizing and supporting role in the body posture and direction change in the unstable state of movement, thereby improving the effect of Wushu exercises [9].

Core strength determines the primary difficulty jump movement quality. Using a variety of targeted training, the stability of the primary difficulty of connection and difficult action has significantly increased; to promote students to master the primary difficulty action has a positive role: Wushu students can achieve the best training effect in the shortest possible time [13]. The flying foot can be divided into four stages: run-up, takeoff, air movement, and landing. The enhancement of core strength can significantly change the altitude and movement of Wushu students in the air flight and the stability and movement normalization after landing (50). The complex preliminary movement flying lotus comprises three parts: taking off, flying, and landing.

Through the training of core strength, the physical quality of Wushu students is enhanced, and the air body control ability of Wushu students is improved. During the takeoff, the horizontal speed of the center of gravity of Wushu students gradually decreases, while the vertical speed increases to better complete the movement [51].

4. Conclusion

4.1 Effect of core strength training on core endurance of Wushu Sanda athletes

Core strength training strengthens the control of nerves to muscles and enhances the

functional ability of the core muscle group of athletes, which is conducive to the transmission of power and the play of the overall strength and can enhance the strength of Sanda's athletes.

4.2 Effect of core strength training on traditional Wushu routine performance

After a period of core strength training, the physical quality of traditional Wushu athletes was observed to have changed, waist strength and spine stability were noted to be improved, and the quality of movement also significantly changed. First, the coordination of the upper and lower limbs of the traditional Wushu athletes was observed to be significantly altered, which improves the speed and strength of the traditional Wushu movements. Second, the stability of the traditional Wushu movements remarkably improved, which increases the training level of the traditional Wushu routines. The results show that core strength training can significantly change traditional Wushu athletes' stability, coordination, and strength [46].

4.3 Effect of core strength training on competitive Wushu routine performance

The core strength training to improve the operation quality specifications exercise the level of athletes and the difficulty of movement. Each block level is significant, which in practice level athletes onset of coordination in the practice of a complete set of complete, action conversion connection speed is a very significant increase in the difficulty of movement in the whirlwind. The success rate of the one-horse walk and the aerial swing is very high. The body posture in the air is intact, and the acceleration of the leg in the air is significantly improved. In terms of movement quality, when the athletes complete a single routine, the previous routine shaking and vibration are effectively improved and significantly improved (9).

The development of Wushu is inseparable from core strength training and pays more attention to the coordinated development of the overall quality of the human body than other projects. Its outstanding performance is that the routine

technical action is fast, the load is large, the shape is beautiful, the flight is high, and the landing is stable. Without good core strength training, it is challenging to complete the whole set of technical actions accurately.

From the form of the single action of Wushu, its action is mostly limb movement with the human waist and trunk as the conversion hub. Therefore, great importance is attached to the core strength training of athletes during training.

In Wushu routine sports, athletes are required to have extraordinary strength levels and be able to send and receive strength freely, that is, control ability. The main problem solved by core strength training is to improve the balance ability, movement control ability, and the ability of upper and lower limbs to coordinate work with the improvement of the core area and core strength level of the human body. Therefore, it is feasible to introduce the core strength training theory into the movement training of Wushu routines.

5. Methods

5.1 Protocol and registration

The scheme of this systematic review was developed in accordance with the preferred Systematic Review and Meta-Analysis (PRISMA) guidelines and was registered at the International Prospective Systematic Review Register (PROSPERO). Registration number is CRD42020222183.

5.2 Literature Search Strategy

First, the relevant scholarly articles were searched in English databases, namely PubMed, Scopus, EBSCO HOST, and the Chinese database in the CNKI system. We entered the keywords and words related to "Core Strength Training" OR "Core-Strength Exercise" OR "Core-Exercise" OR "Core Strength" OR "Core-Stability Exercise" OR "Core-Stability Training" OR "Kung Fu" OR "The influence of kung fu" OR "Wushu" OR "Martial Art" "Sanda" OR "Xanda" were

searched for the effect of core strength training on Wushu performance.

Second, the article retrieval system used input in form of keywords for the analysis of the required article title. The title of the article was analyzed and was required to include themes based on core strength training and Wushu performance. Next, the abstracts of the selected articles were examined. The complete text data were extracted as follows: (1) author, keywords (core strength training and Wushu performance), (2) experimental study (single group experiment, randomized controlled trial), (3) core strength training intervention involved Wushu Sanda, traditional Wushu routine samples, and competitive Wushu routine sample.

5.3 Eligibility criteria

We used PICO as the inclusion criteria for this article. This study included the scholarly articles that fulfilled the following criteria: (1) the subject must be a member of the Wushu profession, regardless of subject's occupation, age, or gender, (2) for the experimental studies on the intervention of core strength training with the main goal of improving the performance level of Wushu, (i) the intervention period should be four weeks or more, (ii) the number of participants should be 10 or more, and (iii) intervention items must meet the requirements of Wushu performance, that is, the performance of Wushu (Sanda), traditional Wushu routines (physical stability and movement balance ability), and competitive Wushu routines (Wushu difficult movements and exercise levels). After the selection of articles that fulfilled the inclusion criteria, we evaluated the influence of core forces on Wushu performance, at least one of which can be divided into results.

Table 4 *Eligibility criteria based on PICO study characteristics and search terms*

PICO	Detail
Population	Wushu students (male/female), must be more than 10 subjects
Intervention	Core strength, training more than

four weeks

Comparison	Two or more groups, and single-group trials
Outcome	Wushu (Sanda), traditional Wushu routines (movement flexibility and stability), and competitive Wushu routines (Wushu difficult movements and exercise levels)

5.4 Study selection

In order to identify relevant studies, during the first screening stage, two independent reviewers (Li Long and Li Hu) screened the titles and abstracts of all identified studies in the literature pertaining to the theme in question. After evaluating all other titles and abstracted papers using our predetermined inclusion and exclusion criteria, the irrelevant papers were removed from the current investigation. If for a paper, the title and summary seemed to not provide enough information, its full text was evaluated. In the second screening stage, the full texts of potentially qualified studies were reviewed. In case of any plausible disagreement, a third reviewer (Xiao) was be consulted until a consensus was reached. After evaluating the full text, 10 scholarly articles in the literature fulfilled our inclusion criteria and were included in the systematic evaluation.

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