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Research Article

COMPARING THE MAIN ANTHROPOMETRIC AND BIOMECHANICS INDICES OF ELITE MALE ADULT WUSHU ATHLETES IN TWO TAOLU AND SANDA PARTS

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ABSTRACT
Objective: The aim of the current study was to compare the main anthropometric, biomechanical indicators of Wushu elite athletes in both Taolu (execution form) and Sanshou (fighting), respectively. ***Methods:*** From among 20 elite champions who participated as subjects in this study, 33 anthropometric and 11 biomechanical measurement parameters were taken. To determine the normality of the data, the Kolmogorov-Smirnov test, the mean and standard deviation to describe the data, the multiple correlation coefficient for reducing overlapping data, the factor analysis of information to determine the principal components of data, and to compare Indicator variables independent t-test at 0.05 significance level was used. ***Results:*** About 6 main anthropometric indicators for Sanda and 9 main anthropometric indicators for Taolu were obtained. Weight, sitting height, waist circumference, arm circumference, hip circumference, width of humerus, pelvis width, body fat percentage, body mass index, showed significant difference ($p \leq 0.05$). From biomechanical properties, 5 main indicators for Sanda, and 4 for Taolu were extracted. Between indicators of stamina-strength of leg muscles, posterolateral left semi-dynamic balance, anterior right semi-dynamic balance, and medial right semi-dynamic balance, significant difference was observed ($p \leq 0.05$). ***Conclusion:*** Based on results when assessing the performance of Wushu athletes in two fields of Sanda and Taolu, it is recommended to consider the variables presented. Also compare test results of elite Wushu athletes with others to determine strengths and weaknesses.

Keywords: *Anthropometric Main Indicators, Biomechanics Main Indicators, Elite, Wushu*

INTRODUCTION
Wushu is a collective term for martial arts and this sport is one of the most prominent traditional sports in China that many other Asian martial arts (like judo, karate) are originated from it. Wushu was introduced since 1990 as a competitive sport under international law and rules of the IOC, in Talou (form execution) in the 10 sections and Sanda. The researchers emphasize that a combination of many factors (genetic and environmental) are effective in athletes' achieving the highest level of performance in performing sports skills at elite level. According to the latest findings in Physical Education and Sports Science, selection of the proper human resources is most important factor in improving the quality and quantity of sports skills. Therefore, it seems that this issue is necessary for better and more accurate understanding of talents to enhance the quality of sports and athletes. In order to identify the mechanisms that lead to prosperity in the sport, we must study on a group of talented athletes that are at a higher level of performance than their peers are.

This is just achieved by comparing non-elite and elite athletes. Anthropometric characteristics are of determining indices in the analysis of people to describe the growth and physical characteristics and to describe the growth and physical structure. Studies have shown that each sport needs athletes with special physical features such as anthropometric, physiological, and biomechanical characteristics. Success in many of the sports, directly or indirectly, in addition to body size and body composition is relevant to physical fitness. Recent studies have shown that muscle strength of Kung Fu athletes is more than in sedentary individuals or individuals with more controlled activities and muscle strength and speed in people with more experience in Kung Fu is more than in the beginners. It seems that martial arts is highly dependent

on anaerobic ability. It also seems that for successful competitive performance there is need for low body fat, high flexibility, anaerobic power leg, isometric strength, and relatively high anaerobic arm strength.
Chaabène and colleagues examined the physiological and anthropometric characteristics by offering scientific recommendations for education and training amateur boxers. Studies show that male boxers at the elite level are determined with mesomorph body composition and with high muscle mass and low body fat levels. One of the keys to success for a boxer in a fight is a superior muscle strength in both the upper and lower limbs. The studies have indicated that high level of performance in boxing is associated with isometric strength. Chaabène and colleagues examined the physical and physiological characteristics of elite karate athletes in scientific research available. Due to the explosive power test that was done between elite and beginner karate athletes, there were differences in maximal strength. Explosive power capacity is critical in elite karate athletes and with vertical jump test, it has been shown that there is a difference in the maximum power and speed between elite and amateur karate athletes. Due to performing faster technique, response time is an important factor in elite karate athletes and there was a significant difference in amateur and elite athletes. Artioli and colleagues examined the physiological and functional characteristics and strength changes of Wushu (Kung Fu) of the Brazil Olympic. According to the results it seems that martial arts is highly dependent on anaerobic. It also seems that for successful competitive performance there is need for low body fat, high flexibility, anaerobic power leg, isometric strength, and relatively anaerobic strength of arm. Gaeini and colleagues examined the relationship between body characteristics (height, weight, body fat percentage, body mass index, lower limb length, and upper limb length) and physiological characteristics (aerobic capacity, anaerobic power, agility, flexibility, speed and balance) and body composition of male Taekwondo elites with their success. Taekwondo athletes' success was reported due to the success in Asian countries and international competitions. The results showed that there is a significant relationship balance, flexibility of the waist, and anaerobic power with the success of elite taekwondo athletes. In addition, there was no significant relationship between age and weight, height and length of the leg, aerobic power, speed, agility, flexibility forward sand success. Rasli and Bagheri examined the relationship between some anthropometric characteristics of the upper and lower extremities with physiology of Iran's karate elites. The results showed that there was a significant positive relationship between anthropometric variables weight, sitting height, lower limb length, shoulder width, head circumference and leg circumference, arm circumference, wrist circumference, leg wrist circumference, elbow width, the width of the femoral condyle epithelium with physiological variables of karate athletes of the country. Shokrollahi studied the talent finding of Taekwondo Women. According to PCA test results, acceleration, range of motion in the hip abduction move, response time and dynamic balance in the outward front were determined as the main biomechanical parameters, chest circumference, waist circumference, hip circumference, height of ilio pesoas from the ground, hip width, height and weight to height ratio as main anthropometric parameters, flexibility, agility, strength and endurance of the abdominal muscles were determined as the main physiological parameters. According to independent T test results, it was seen that in the age group 9-10years there was a significant difference among the elite and non-elite among all measured variables (except for range of motion in moving away) and the results showed that, one can seek talent in this field. Jafari and colleagues described and determined the relationship between anthropometric and physiological characteristics with Taekwondo athletes' success. To evaluate anthropometric characteristics they used height, weight, body fat percentage, body mass index, arm length and leg length, to assess the physiological characteristics, they used the indices of agility (4×9m), flexibility forward (bending forward test), speed (20 meter dash test), balance (Stork test), response (response assessment test), aerobic capacity (shuttle run test) and anaerobic power (Bosco test).The results showed a significant correlation between BMI, speed, anaerobic power, agility, body fat percentage and reaction time with success of elite taekwondo women (18). Napradit and Pantaewan studied relationship between physical fitness and anthropometric characteristics of the Royal Thai Army personnel. The correlation coefficient between body mass index and waist circumference ($p < 0.001$, 0.147) was better than the body mass index and waist-hip ratio ($p < 0.001$, 0.553). Number of push-ups on the ground and standing showed a negative

correlation with body mass index and 2 km run was positively correlated with body mass index. Finally, subjects with increased body mass index were in low levels of physical fitness.

Despite research in the field of Wushu, there is no comprehensive information of anthropometry and biomechanics characteristics of elite Wushu in Taolu and Sanda parts and in attention to these indices is ignored in most research papers. Thus, the aims of this study is to compare the main anthropometric indices (weight, height, body composition, body fat percentage, body circumference, length/height of organs, the width of the extremities) of elite male adult Wushu athletes in Taolu and Sanda parts and to compare the original biomechanical indices (static and dynamic balance, speed, power and endurance of muscle, reaction time, agility and flexibility, and feet power) of elite male adult Wushu athletes in Taolu and Sanda parts. Today, Wushu has had a good and formidable appearance at international level, and it is possible to advance the field by assessment and comparison of the main anthropometric and biomechanical indices of national team Wushu athletes.

MATERIALS AND METHODS

Methodology

Twenty adult males Wushu athletes of the national team, who were going to take part in the competitions of the Asian Games, South Korea (Incheon-2014), took part in the study by purposive sampling.

Of this number, 10 were in Taolu (form execution) with an average height of 168.80±7.19 cm and a weight of 67.50±6.36 kg and 10 other were in Sanda (fight) with an average height of 174.80±8.25 cm and weight of 77.30 ±8.96 kg and were studied.

Height, weight, and length of the body organs, the width of the extremities, fat percentage (WHR), (BMI), were assessed as anthropometric indices, flexibility, endurance of leg and body muscle, anaerobic power (vertical jump), agility (9×4), speed (36 m), acceleration, response (visual examination), maximum palm power (using the dynamometer), standing balance (stork test), semi-dynamic balance (Y test), dynamic balance test (Modification Bass Test of Dynamic Balanc) were measured as biomechanical parameters. Scales, meters, caliper, plaster, calipers, stopwatch, body composition set, mats, cones, dynamometer, questionnaire, measuring is the equipment of the present study.

To test normality of the data, Kolmogorov-Smirnov test, to describe the data, mean and standard deviation, to reduce overlapping parameters, multiple correlation, to determine the principal components, factor analysis, and to compare the main indicators obtained independent T-TEST statistical methods in the two groups were used at a significant level 0.05.

RESULTS AND DISCUSSION

Results

Using multiple correlation coefficient to reduce overlapping parameters of anthropometric data, it was observed that in Sanda group, there is a linear overlap between sitting with standing heights and the length of the two extended hands, circumference of the arm and contracting arm circumference, waist circumference with WHR, and in Talou group, there is a linear overlap between standing and sitting heights, hand length with arm length.

After elimination of overlapping data, factor analysis was used to determine the main parameters. Weight, arm length, hip circumference, humerus width, ratio of waist to hip, shoulder width to Sanda and sitting height, forearm length, calf length, head circumference, arm circumference, forearm circumference, wrist width, body fat percentage, body mass index for Talou were seen as the main anthropometric indices. As seen, mean, standard deviation and significance level for the main anthropometric indices are shown in Table 1.

In anthropometric characters, the results of comparison of the main anthropometric indices among elite adult male athletes in both Sanda and Taolu suggest that weight, forearm length, calf length, head circumference, the contracting arm circumference, shoulder width, wrist width, and body mass index in the study in Sanda group is more than in Talou group and in sitting height index, waist to hip ratio, body fat percentage for Talou group is more than for Sanda group.

Table 1 shows mean, standard deviation and significance level for anthropometric parameters

Group Index		Sanda		Taolu		The level of significance
		Average	The standard deviation	Average	The standard deviation	
	(Cm)Stature	174/80	8/25	168/80	7/19	**0/011**
	*(Kg)Weight	77/30	8/96	67/50	6/36	**0/100**
Length	*Sitting height	91/82	3/43	91/90	3/31	**0/037**
(Cm)organs	Length forearm	25/55	1/15	25/20	0/80	**0/443**
	Arm's length	32/05	1/89	31/91	2/05	**0/876**
	Length both hands	180/30	8/45	174/20	10/35	**0/166**
	Length hand	77/70	4/16	76/10	4/55	**0/423**
	Thigh length	38/08	2/96	36/15	2/26	**0/118**
	Tibia length	49/47	2/75	47/93	1/76	**0/155**
	Length a leg	103/40	5/48	99/50	5/25	**0/120**
Environment	Head	57/90	2/46	55/90	0/99	**0/029**
(Cm)organs	Circumference					
	Environment chest	96/70	5/27	92/30	3/71	**0/045**
	Upper arm environment	29/55	1/98	28/79	1/93	**0/398**
	Environment of contracting arm	34/31	2/77	32/53	2/09	**0/123**
	environment	30/90	1/79	28/40	0/96	**0/001**
	*Forearm environment wrist	18/10	0/99	17/30	0/48	**0/034**
	*Waist	73/81	6/03	70/56	5/01	**0/206**
	Thigh circumference	58/40	4/97	56/30	2/71	**0/256**
	environment knee	38/70	1/63	37/10	1/10	**0/019**
	environment shank	37/32	2/50	37/09	3/47	**0/867**
	environment ankle	26/50	1/84	25/70	1/56	**0/309**
	environment arch of the foot	27/30	0/94	26	0/94	**0/007**
	Pelvic *perimeter	91/89	5/48	87/02	4/81	**0/049**
Width	Shoulder width	43/08	2/55	41/34	2/83	**0/167**
(organs Cm)	Chest width	29/45	1/85	27/71	2/26	**0/076**
	Width *humerus	7/59	0/47	7/15	0/33	**0/027**
	*Width pelvis	30/13	2/82	27/41	1/83	**0/020**

	Width knee	10/86	0/53	10/22	0/59	**0/020**
	Width ankle	8/19	0/49	7/69	0/69	**0/081**
	Wrist Width	6/43	0/43	6/14	0/26	**0/088**
Fat	*Fat percentage	10/66	2/32	14/32	3/13	**008/0**
WHR	Ratio waist to hip	0/801	0/02	0/809	0/03	**0/576**
BMI Kg square) (meter	Body Mass *(BMI)Index	25/22	1/49	23/78	1/49	**0/044**

** Statistically significant difference at 0.05 level*

In using multiple correlation coefficient for the reduction of biomechanical parameters, it was observed that in Sanda group, there is linear overlap between the left foot in the anterior (y test) with the right foot in anterior and in Talou group, there is a linear overlap between the left foot in the anterior (Y test) with the right foot in the anterior and medial, left foot in the medial (Y test),right foot in the anterior with right foot medial (Y test), right foot in the posterior medial with posterolateral right foot (Y test), the left foot in the anterior left foot (Y test), soby removing overlapping data for main indices analysis factor analysis was used. The maximum power, speed run, the right foot to the posterior external (Y test), right foot in the anterior (Y test), the left foot to the posterior external (Y test) for Sanda, and leg strength and endurance, static balance, right foot the posterolateral (Y test), right foot in the anterior (Y test) for Taolu are considered as the main biomechanical indices.

As can be seen, mean, standard deviation and significance level for the main biomechanical parameters are shown in Table 2. About the biomechanical properties, the results of comparison of the main biomechanical indices between elite adult male Sanda and Talou athletes confirms that in the indices, leg power or maximum power, static balance in Taolu is better than Sanda and were the same in speed index, in the index of semi-dynamic balance in the right anterior, Sanda is better and in the right medial frontal and posterolateral left and posterior right Talou is better.

Table 2 shows the mean, standard deviation, and significance level values for biomechanical parameters

Group Index		**Sanda Average**	**The standard deviation**	**Taolu Average**	**The standard deviation**	**The level of significance**
Trunk (Cm)forward	Flexibility	37/30	6/75	46/60	5/75	**0/004**
Curl-number)ups (in 60 seconds	Endurance Trunk)Power (muscles	64/40	5/71	59/90	5/62	**0/093**
Jump both sides number) (in 60 seconds	Endurance Leg)Power *(muscles	109/90	20/09	126/40	9/91	**0/032**
Vertical (Cm)Jump	Anaerobic power	51/20	7/03	64/90	5/46	**0/000**
(Second) 4*9	Agility	8/64	0/31	8/38	0/32	**0/079**
Run 36 (m/s)m	Speed	6/77	0/30	6/7	0/38	**0/628**
$\frac{\Delta v}{\Delta t}(\frac{m}{t^2})$	Acceleration	1/27	0/11	1/27	0/14	**1/000**

Visual reaction	Reaction	394/60	64/28	463/80	83/27	**0/052**
Power tiller	*Max Power	0/54	0/06	0/62	0/12	**0/135**
(Second)Stork	*Static balance	54/40	16/66	64/90	12/93	**0/133**
Bass	Dynamic equilibriums	90	6/53	91/10	6/40	**0/708**
Semi-dynamic balance	*Right anterior	79/90	8/02	87/80	5/94	**0/022**
	Posterior Right *internal	95/40	7/98	102	3/85	**0/030**
	Right *posterolateral	94/60	7/01	101/80	4/51	**0/014**
	Left of anterior	79/20	7/65	85/10	7/32	**0/095**
	Left posterior internal	90/72	10/79	102	3/77	**0/006**
	Left *posterolateral	92/82	6/56	100/70	2/11	**0/002**

** Statistically significant difference in (0.05) level*

Discussion

The main objective of this study was to compare the main anthropometric, biomechanical indicators of Wushu elite male adults athletes in Taolu and Sanda that were examined in the form of multi sub-purposes. The first aim of the study was to compare the main anthropometric indicators of adult male elite Wushu athletes in Taolu and Sanda.

According to the main findings of this study, there was a significant difference in comparing main anthropometric indices of elite Wushu athletes in Taolu and Sanda elite athletes in weight, sitting height, waist circumference, forearm circumference, hip circumference, humerus width, pelvis width, body fat percentage and body mass index.

No studies similar to the results of the current study was found to compare and examine its results. However, the results of anthropometric characteristics were consistent with the findings of Chaabene and colleagues who studied the physiological and anthropometric characteristics of amateur boxers. Moreover, the results were consistent with research by Chaabene and colleagues who studied the physical and physiological characteristics of elite karate athletes.

The results are consistent with the findings of Rasoli and Bagheri who examined the relationship between some anthropometric characteristics of lower and upper limbs with physiology of Iran's elite karate man, and in line with the results of the examination of Shokrollahi who examined anthropometric characteristics in finding talents in taekwondo women athletes (17). In addition, the results are consistent with the results of Jafari *et al.*, that described and determined the relationship between anthropometric and physiological characteristics with the success of taekwondo athletes and with the results of Napradi and Pantaewan who studied the relationship between physical fitness and anthropometric characteristics of the Royal Thai personnel is somehow similar.

In all generalized research different martial arts are studied. It seems that, as Sanda tournament takes place in various weights, the difference in weight is normal. Body mass index and hip circumference, waist circumference and forearm refer to the nature of aerobic and sitting height, humerus width, pelvis width is influenced by heredity.

Another goal of the study was to compare the main biomechanical indices of elite adult male Wushu in Taolu and Sanda. According to this study, there is a significant difference in main biomechanical indicators properties between the characteristics of endurance - leg muscle strength, semi-balance of left foot on the posterolateral dynamic, semi-dynamic balance right anterior, right posterior dynamic balance, half anterior posterolateral dynamic balance right ($P \leq 0.05$). The results were consistent with Chaabane *et al.*, findings who studied physiological and anthropometric characteristics of amateur boxers. The results were also in

line with the findings of Chaabene and colleagues who investigated the physical and physiological characteristics of elite karate athletes.

The results are also in line with some parts of the results of Artioli and colleagues who examined the specific physiological and functional changes in Brazil's Olympic Wushu athletes'' strength. And come to the conclusion that for competitive performance there is need for low body fat, flexibility, anaerobic power and endurance of foot and leg, muscle strength and anaerobic power and relatively high arm strength.

These results did not match about the flexibility index, which is probably because of differences in the testing the subjects and gender and difference in the health of the subjects. On the other hand, the results are consistent with research findings of Gaeini *et al.,* who determined the relationship between body characteristics (physiological characteristics: aerobic capacity, anaerobic power, agility and flexibility, and speed) and body composition of elite male Taekwondo with their success. It seems that due to the nature of the sport and specialized training that Talou athletes due to dramatic movements and consecutive jumps, semi-dynamic balance indicator in the right medial, posterior and left-right posterolateral and endurance - the strength of leg muscles have received more attention. However, in Sanda due to being aggressive of and move forward to fight, the semi-dynamic balance of right anterior index is more important.

In this study, although it was tried to control the conditions properly, there were genetic differences and different motivation of participants for participation in the research as well as individual and psychological condition of the subjects that were out of control.

Conclusion

According to our results, it can be said that there is a significant difference in the main anthropometric and biomechanical indices of elite Wushu athletes in Taolu and Sanda parts. Indicators of balance, endurance – leg strength in biomechanical properties cause differences in the two groups between and is an important index in Talou. In anthropometric characteristics (weight, limb length, body mass index) is significant in Sanda.

According to the results when assessing the performance of Wushu athletes in Sanda and Talou, it is recommended to pay attention to the introduced variables. For better performance of training, ongoing assessments of the anthropometric, biomechanical and physical status of Wushu athletes should be conducted, and test results of other Wushu athletes should be compared with elite Wushu athletes to determine strengths and weaknesses. The results of these tests can be the basis for talent finding at early ages.

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