Anthropometric and Somatotype Profiles of Wushu Taolu Athletes: A Comparative Study

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ABSTRACT

Wushu is one of the martial arts styles where an athlete's performance can be greatly influenced by their physical attributes and somatotype. The present study aims to determine the anthropometric characteristics and event-wise comparison of the anthropometric somatotype of Taolu athletes. A total of 27 male Taolu athletes were selected from Chang, Nan, and Taiji Group, aged 14 to 23 years. Selected anthropometric measurements were taken following a standard testing protocol and standard instruments. The Heath and Carter Method of Somatotyping (1967) determined somatotypes. ANOVA and post-hoc analysis were applied for statistical significance and event-wise comparison (Significance level at 0.05). Significant differences were found in height (p=0.023) and arm span (0.009) among the groups, with Taiji athletes being the tallest (170.50 ± 4.89 cm) and Chang athletes having the longest arm span (175.50 ± 5.63 cm). No significant differences were observed in weight, BMI, or height trochanterion. Somatotype analysis revealed that Nan athletes had the highest endomorphy (3.79 ± 0.60) and mesomorphy (5.21 ± 1.05) values, indicating greater fat mass and muscularity, respectively. While Taiji athletes had the highest ectomorphy value (2.31 ± 0.74), reflecting a leaner physique. The mean somatotype classification for Chang, Nan, and Taiji athletes was balanced mesomorph (2.6 – 4.8 – 2.6), endomorphic mesomorph (3.7 – 5.2- 2.0), and mesomorph-ectomorph (2.3 – 3.8 – 3.6), respectively. The findings indicate that different Taolu events are suited to particular physical builds, which may have important implications for athlete training and selection strategies.

Keywords: Anthropometric characteristics, Somatotype, Endomorphy, Mesomorphy, and Ectomorphy.

INTRODUCTION

Wushu is an ancient Chinese martial art initially developed for hunting and self-defense against predators, serving both safety and livelihood purposes (Chathuranga & Peera, 2023). Wushu incorporates a range of internal and

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external exercises, with fighting movements as its primary features (Wushu Association of India, 2024). Wushu, also known as Kung fu, is the official collective term for the Chinese martial arts. It has a long history that can be traced back to China's Shang Dynasty (1600–1046 BC) (Chinese Wushu Research Institute,1997). Wushu consists of a multitude of distinct styles and schools (Han et al. 2021). Wushu is deeply intertwined with Chinese culture, seamlessly integrating ancient Chinese philosophical concepts and religious elements, such as yin and yang, Buddhism, and Taoism (Lorge, 2012). Its unique and captivating content has attracted practitioners and enthusiasts from around the world. Wushu competitions are divided into two main categories: Taolu (Routines Competition) and Sanda (Fighting Techniques or Free-Fighting Competition) (Chinese Wushu Association, 2008).

Taolu is the structured routine practice component of Wushu, consisting of choreographed moves based on attack and defense principles. These routines include various techniques like hand and leg movements, jumps, stances, and both bare-handed and weapon-based approaches. Taolu can be performed individually, in groups, or as duels, emphasizing both technical proficiency and artistic expression. Common Taolu events are categorized into Chang (Long Range Boxing), Nan (Southern Style Boxing), and Taiji (Grand Ultimate Style). Each group includes specific events, but the most common and known events are Changquan (Long range boxing), Daoshu (Northern style Broadsword), Jianshu (Straight Sword), Gunshu (Cudgel), Qiangshu (Spear). Similarly, under the Nan group are Nanquan (Southern Style Boxing), Nandao (Southern Broadsword), and Nangun (Southern Cudgel). Taiji group consists of Taijiquan (Grand Ultimate Fist) and Taijijian (Grand Ultimate Sword) events. Recently, Taijishan (Fan) has been added to various competitions (International Wushu Federation, 2019).

Conversely, Sanda, also known as Sanshou, is the sparring component of wushu. It is a full-contact combat sport that combines elements of traditional wushu techniques with modern combat techniques. Sanda involves striking and kicking techniques, throws, sweeps, takedowns, and grappling. The sport offers weight categories for both men and women, with seven weight categories for women and eleven weight categories for men. This ensures fair competition and allows athletes to compete against opponents of similar size and weight (International Wushu Federation, 2024).

Prior studies show that physical characteristics play a crucial role in achieving success in most sports. The body's structure provides the basis for enhancing movement techniques and specific physical fitness. It is well recognized that an athlete's body composition greatly influences their potential to achieve elite performance levels (Slankamenac et al., 2021; Malina et al., 2004; Charzewski et al., 1991). However, very little scientific literature is available on the physical attributes of Wushu players. Physical fitness of wushu athletes exhibits high flexibility and better balance ability (Huang et al., 2016). Wushu seems

to be a highly anaerobic combat sport. Low body fat, high flexibility, leg anaerobic power, isometric strength, and moderately high arm anaerobic power seem to be important for successful competitive performance (Artioli et al., 2009). In Taolu, empirical experience suggests that an athlete's height and limb dimensions, such as arm and leg length, provide significant advantages by enabling optimal leg raises, visually appealing movements, and accurate stylistic expressions (International Wushu Federation, 2023). Limb length aids athletes in maximizing speed and force application, as described by lever and radius of rotation mechanics (Hall, 2012). Taolu athletes are characterized by their muscular build with more muscle mass found in their lower limbs, proportionate upper and lower body lengths, and reduced body fat (Tang et al., 2021).

Moreover, somatotype is one of the measures to describe the morphological profile. Carter and Heath (1990) suggested that somatotype and sports success are positively correlated. Further, in combat sports, the mesomorphic component has been described as the most relevant to performance (Franchini et al., 2011; Yoon J., 2002). Research studies on the somatotype and anthropometric traits of wushu athletes are still in their early stages. Thus, the present study aims to find out the anthropometric characteristics of Wushu Taolu athletes, and event-wise comparison of the anthropometric somatotype.

METHODOLOGY

The present cross-sectional study was conducted on 27 Taolu male athletes aged from 14 to 23 years who participated in the Wushu selection trial held at NSNIS Patiala. Selected athletes had at least 4 years of professional training experience and participation in at least national-level competitions. All anthropometrical measurements were taken at the Sports Anthropometry Lab. NSNIS Patiala, following a standard testing protocol of the International Society for Advancement of Kinanthropometry (ISAK Manual, 2019) using standard instruments. Informed written consent was acquired from each subject.

Anthropometrical Measurements:

To determine somatotypes, ten required measurements were taken as follows: body height and body mass, bi-epicondylar breadths of humerus and femur, four skinfold measurements (triceps, supraspinal, subscapular, and medial calf), and two girths (arm and calf). Body height (cm) and body weight (kg) were determined using a calibrated Digital BMI Machine (SECA 284, Seca Deutschland, Germany) working with a precision of 0.1 kg, and 0.1 cm respectively, and BMI value in the device was recorded. Skinfolds were taken on the right side of the body using the calibrated GPM Skinfold caliper (DKSH Switzerland Ltd.), accurate to 0.2 mm; circumference measurements (cm) were obtained with a flexible measuring tape (Hoechstmass, West Germany); bi-epicondylar diameters of the femur and humerus (cm) were measured using a vernier caliper (Holtain Ltd., UK). Apart from this, height trochanterion (cm), and arm span (cm) were taken using a calibrated anthropometer (GPM,

Bachenbülach, Switzerland). Somatotypes were determined using the Carter and Heath method (1967).

Endomorphy = -0.7182 + 0.1451(X)-0.00068 (X^2) + 0.0000014(X^3)
Where, X = Sum of triceps, subscapular, and supraspinale skinfolds.
[For obtaining height corrected Endomorphy, X is multiplied with 170.18 and divided by height of subject].

Mesomorphy = (0.858 x Humerus breadth) + (0.601 x Femur breadth + (0.188 x corrected Arm Girth) + (0.161 x corrected Calf Girth) - (0.131 x height) + 4.5
Where, corrected arm Girth = Flexed Arm Girth - triceps skinfold (cm), and
corrected Calf Girth = Max. Calf Girth - medial calf skinfold (cm)
Ectomorphy = HWR x 0.732 - 28.58
Where, HWR = height (cm) / cube root of weight (kg)
If, HWR < 40.75 but > 38.25, then Ectomorphy = HWR x 0.463-17.63
If, HWR < or = 38.25, then Ectomorphy = 0.1

Statistical Analysis

The data obtained are presented as mean, standard deviation, and range. ANOVA and post-hoc (Bonferroni) analysis were applied for statistical significance and event-wise comparison SPSS statistics software version 20 was used to conduct analyses. The level of significance was set at 0.05.

RESULTS

Table 1 shows the detailed summary of the mean ± SD along with the ranges for various anthropometric variables, offering insights into the physical characteristics and somatotype of the wushu athletes. The sample size of 27 athletes, ages ranging from 14 to 23 years, presented a relatively younger group with a mean age of 19.26 ± 2.97 years. The mean values for height, weight, and BMI are 168.16 ± 5.73 cm, 60.80 ± 7.62 kg, and 21.46 ± 2.21, respectively.

The mean of somatotype components viz. endomorphy, mesomorphy, and ectomorphy are 2.84 ± 0.86, 4.65 ± 0.91, and 2.81 ± 1.09 respectively. Overall somatotype classification of Taolu

Table 1: Descriptive statistics for anthropometric variables of Wushu athletes (N=27)

Variables	Mean ± SD	Range	Variance
Age (yrs.)	19.26 ± 2.97	14 - 23	8.815
Height (cm)	168.16 ± 5.73	152.5 - 176.6	34.516
Weight (Kg)	60.80 ± 7.62	40.35 - 73.5	59.103
BMI (Kg/m^2)	21.46 ± 2.21	16.16 - 26.26	4.876
Arm span (cm)	172.41 ± 6.86	153.8 - 186.9	47.020
Height trochanterion (cm)	87.24 ± 4.11	80 - 95	17.333
Endomorphy	2.84 ± 0.86	1.15 - 4.75	0.745
Mesomorphy	4.65 ± 0.91	3.0 - 6.65	0.821
Ectomorphy	2.81 ± 1.09	0.41 - 5.51	1.187

SD= standard deviation

Table 2: Event-wise comparative analysis of Taolu athletes

Variables	Chang (N=12) Mean ±SD	Nan (N=07) Mean ±SD	Taiji (N=08) Mean ±SD	F-value	p-value	Post-hoc
Height	169.50±4.75	163.14±6.30	170.50±4.89	4.420	0.023 *	Nan Vs Chang, Taiji
Weight	62.67±5.26	60.43±11.04	58.25±7.61	0.789	0.466 NS	----
BMI	21.81±1.50	22.50±2.98	20.00±1.77	3.122	0.62 NS	----
Arm span	175.50±5.63	166.14±7.08	173.25±5.03	5.731	0.009**	Nan Vs Chang, Taiji
Height trochanterion	87.83±3.90	84.14±4.25	89.00±3.33	3.254	0.056 NS	----
Endomorphy	2.64 ± 0.63	3.79 ± 0.60	2.31 ± 0.74	10.565	0.001**	Nan Vs Chang, Taiji
Mesomorphy	4.88 ± 0.64	5.21 ± 1.05	3.81 ± 0.48	7.986	0.002**	Taiji Vs Chang, Nan
Ectomorphy	2.68 ± 0.79	2.04 ± 1.20	3.68 ± 0.85	6.082	0.007**	Taiji Vs Chang, Nan

***=p<0.05, ** =p< 0.01, NS: non-significant, SD= standard deviation**

athletes was found to be **balanced mesomorph** (2.8- 4.6 - 2.8).

The dataset compares the somatotype characteristics of different events of Taolu athletes: Chang (N=12), Nan (N=07), and Taiji (N=08), shown in Table 2. Among the three events, Taiji athletes were the tallest at 170.50 ± 4.89 cm, and Nan was the smallest at 163.14 ± 6.30 cm. While Chang athletes have the longest arm span (175.50 ± 5.63 cm), followed by Taiji (173.25 ± 5.03cm), and the smallest was Nan (166.14 ± 7.08 cm). Statistically significant difference among the three groups was found for height (p=0.023) and arm span (p=0.009). Post-hoc analysis shows a significant difference between Chang & Nan, and Nan & Taiji for both height and arm span. Weight, BMI, and Height trochanterion do not show significant differences. However, Taiji shows the longest leg length (89.00 ± 3.33 cm), followed by Chang (87.83 ± 3.90 cm), and the shortest in Nan (84.14 ± 4.25 cm).

As far as the somatotype component is concerned, all three components show highly significant differences. The endomorphy value for Nan seems to be high, 3.79 ± 0.60, followed by Taiji with a means value of 2.31 ± 0.74 and Chang with 2.64 ± 0.63, with a significant difference (p= 0.001). and post-hoc analysis shows a significant difference between Nan with Chang and Taiji. Mesomorphy component observes Nan having a high mean value of 5.21 ± 1.05 and the least in Taiji at 3.81 ± 0.48 with a significant difference (p= 0.002). While Taiji has the highest mean value of 3.68 ± 0.05, followed by Chang at 2.68 ± 0.79 and Nan at 2.04 ± 1.20 in the ectomorphy component, with a significant difference (p=0.007). Further, post-hoc analysis

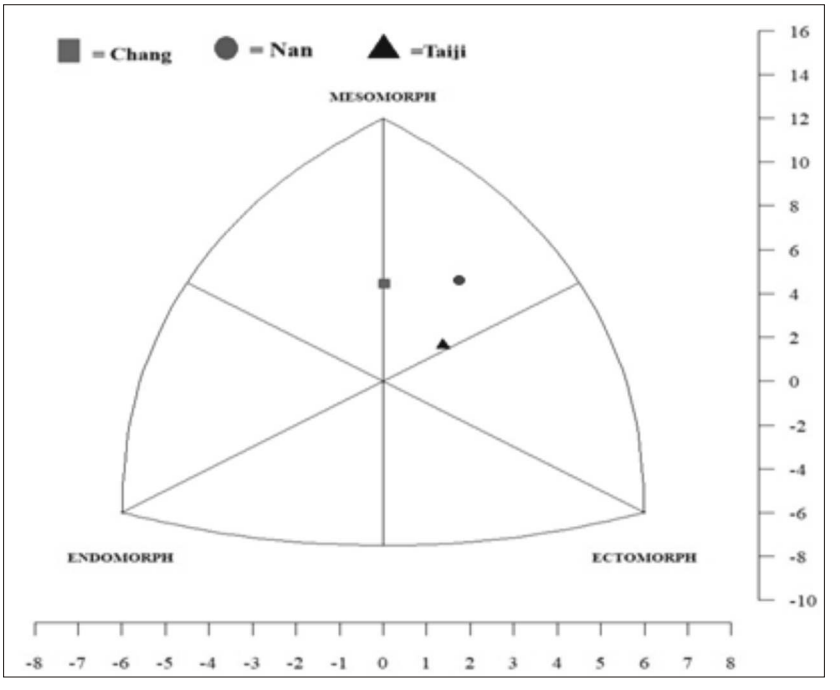

Fig.1: Somatochart of Wushu Taolu Athletes

shows a significant difference of Taiji with Chang and Nan in mesomorphy and ectomorphy components.

The mean somatotype classification of Chang, Nan, and Taiji events was found to be balanced mesomorph (2.6 – 4.8 – 2.6), endomorphic mesomorph (3.7 – 5.2- 2.0), and mesomorph- ectomorph (2.3 – 3.8 – 3.6), respectively. Fig. 1 depicts the event-wise somatochart of wushu taolu athletes using R Programming for Somatoploting (Nandikolmath, D. et al 2024).

DISCUSSION

` This study analyzed the somatotype characteristics of Taolu athletes across three events: Chang, Nan, and Taiji. Results indicate that Taiji athletes were the tallest with an average height of 170.50 ± 4.89 cm, while Nan athletes were the shortest at 163.14 ± 6.30 cm. Chang athletes, on the other hand, exhibit the longest arm span at 175.50 ± 5.63 cm, followed by Taiji (173.25 ± 5.03 cm) and Nan (166.14 ± 7.08 cm). The significant differences in height ($p=0.023$) and arm span ($p=0.009$) between Chang vs. Nan, and Nan vs. Taiji, suggest that these physical dimensions may play a crucial role in the performance requirements of each event (Slankamenac et al., 2021; Malina et al., 2004). The longer arm span observed in Chang athletes might provide a competitive advantage in movements that require greater reach and fluidity, whereas the taller stature of Taiji athletes could be beneficial for the aesthetics and flow of Taiji forms (International Wushu Federation, 2023).

No significant differences were found in weight, BMI, and height

trochanterion among the groups. However, Taiji athletes exhibit the longest leg length (89.00 ± 3.33 cm), which could be advantageous for the balanced, flowing movements characteristic of Taiji. The leg length differences, although not statistically significant, still point towards a trend where Taiji athletes have longer legs compared to Chang and Nan athletes (International Wushu Federation, 2023).

There were notable variations in the somatotype components among the groups. Nan athletes had the highest endomorphy value (3.79 ± 0.60), indicating a relatively higher fat mass as compared to Taiji (2.31 ± 0.74) and Chang (2.64 ± 0.63) athletes. In terms of mesomorphy, Nan Athletes also showed the highest value (5.21 ± 1.05), depicting a more muscular physique, followed by Chang and Taiji, with significant differences (p=0.002). The higher mesomorphy in Nan Athletes could be the reflection of the higher hypertrophy which may further depict the higher explosive power and muscular strength required during Nan training routines (Tang et al., 2021; Franchini et al., 2011; Yoon, 2002; Marinho, et al., 2016). Taiji athletes demonstrated the highest ectomorphy value (3.68 ± 0.05, at p=0.007), indicating a leaner body structure, followed by Chang (2.68 ± 0.79) and Nan (2.04 ± 1.20) athletes. The leaner physique of Taiji athletes aligns well with the endurance and flexibility needed for Taiji movements (Huang et al., 2016; Artioli et al., 2009).

Overall somatotype classification of Taolu athletes was found to be balanced mesomorph. Further, somatotype classification elucidates the differences among the three groups. Where the Chang athletes were classified as balanced mesomorphs, Nan athletes as endomorphic mesomorphs, and Taiji athletes as mesomorph-ectomorphs. These classifications suggest that each event favors a distinct physical build, balanced muscularity for Chang, a combination of muscularity and higher fat mass for Nan, and a leaner, more flexible build for Taiji.

The present study has some limitations. The study sample consisted of male wushu Taolu athletes aged 14-23 years and participation in at least national-level competitions, which restricts the generalizability of the findings to broader groups, i.e., older populations, individuals with obesity, sedentary individuals, and even from a gender perspective. Additionally, factors such as limited sample size, and Taolu event of wushu specifically further constrain the study's scope.

CONCLUSION

The findings of the study concluded that weight, BMI, and height trochanterion had no significant differences across the groups. Taiji athletes are found to be the tallest and Chang athletes have the longest arm span. Somatotype analysis revealed that Nan athletes had the highest endomorphy and mesomorphy values, indicating greater fat mass and muscularity, respectively, while Taiji athletes had the highest ectomorphy value, reflecting a leaner physique. The mean somatotype classification for Chang, Nan, and Taiji athletes was balanced mesomorph, endomorphic mesomorph, and mesomorph-ectomorph,

respectively. These findings suggest that each Taolu event favors specific physical builds, with potential implications for training and selection processes. Future research could further explore how these physical characteristics influence performance outcomes and injury risks in Taolu athletes.

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