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Research Article
Anthropometric and Motor Performance Characteristics of Nigerian Badminton Players

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Abstract

Background and Objective: Anthropometric indicators of body size and proportions, physique and body composition are important factors in physical performance and fitness. The study examined the relationship between anthropometric and motor performance characteristics of Nigerian national badminton players. **Materials and Methods:** Height, weight, skinfolds, arm span and chest width, sit and reach, running speed, push-up, sit-up, vertical jump height and long jump length were taken from 29 participants (20 males and 9 females), including six national players. The Statistical Package for Social Sciences (SPSS) version 20.0 software was used to determine the descriptive, multiple correlation coefficient (r) and independent t-test statistics. An alpha level of 0.05 was used for all statistical significance. **Results:** There was significant correlations between height and running-speed ($r = 0.44$, $p = 0.02$), push-up ($r = 0.48$, $p = 0.01$), sit-up ($r = 0.58$, $p = 0.00$) and vertical-jump ($r = 0.72$, $p = 0.00$); percentage of body fat and sit-and-reach ($r = 0.55$, $p<0.05$), running-speed ($r = 0.65$, $p = 0.00$). Apart from flexibility ($t = 0.7$, $p = 0.43$), male players demonstrated superior health and motor fitness compared to female players. Similar trend was noted for the national in contrast to the provincial level players ($t = 1.7$, $p = 0.09$). **Conclusion:** A significant correlation exists between some anthropometric characteristics' and motor performance characteristics in badminton players. Except, flexibility, male players had superior anthropometric and motor fitness compared to female players. Also, the national players exhibited satisfactory anthropometric and motor fitness parameters compared to the provincial badminton players. The findings of this study should inform trainers, coaches and sport scientists in the designing and training programme to enhance badminton performance.

Key words: Racket sport, explosive power, muscular endurance, flexibility, percent body fat, badminton players

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

In badminton, anthropometry and motor performance ability of players seems to be the most vital determinants of success[1-3]. Anthropometric measurements have the potential to quantify the relationship between bone mass, body structure[4,5], physical characteristics and individual players' sporting abilities[6-8], thereby providing the basis for evaluating sport performance[9]. Anthropometric measurements are often used to classify players according to their respective age or level of performance. Height is an advantage in executing attacking strokes in badminton[10].

Body composition is an important aspect of fitness[11]. Similarly, in sports where body weight has to be lifted repeatedly against gravity, such as in badminton; extra mass in the form of fat would be disadvantageous[11]. It has been established that excess percentage of body fat (%BF) is detrimental to health and that the %BF required for excellence in performance differs between males and females and varies from sport to sport[12]. Furthermore, long arms are advantageous in badminton that involves jumping to reach a shuttle at the highest possible point when descending for a better stroke as in a smash and drop shot[13,14].

Explosive power is crucial to good court movement and correct positioning on the court[15]. Running Speed (RS) is needed in badminton in moving to and from the shuttlecock. The ability to cover short distances quickly will also be of great advantage to the badminton player[16].

Badminton players requires tremendous physical ability, most especially agility, aerobic capacity and explosive power[17], for successive and improved performance. To achieve this, it is imperative to ascertain the specific attributes and factors that contribute to playing ability[17]. Anthropometric characteristics are closely linked with motor performance characteristics as body size and proportions, physique and body composition are important factors in physical performance and fitness. However, there is paucity of information on the anthropometric and motor performance profile of Nigerian National badminton players. This present study examined the relationship between anthropometric and motor performance characteristics of Nigerian national badminton players.

MATERIALS AND METHODS

Participants: This prospective, descriptive and cross-sectional study involved 29 (20 men and 9 women: Aged 21.24±6.41 years) conveniently selected badminton players from the Northern states of Nigeria. All the players participated at the 2010 Commonwealth Games selection trials. The ethics committee of Bayero University gave approval for the study (BUK/SPS/PHE/09/0005). Informed consent was obtained from participants prior to data collection. Data was collected at the Package B, National Stadium, Abuja, Nigeria during the 2010 Commonwealth Games trials.

Measurement procedures

Body composition: Anthropometric variables [weight (kg), height (cm), skinfolds (mm) chest width (cm) and arm span (cm)] were measured according to the protocols of International Society for the Advancement of Kinanthropometry[18]. Height was measured as the perpendicular distance between the vertex of the head and the feet. A calibrated vertical stadiometer (Seca Portable 217 Seca, UK) was used to measure stature to the nearest 0.1 cm. Weight was measured in light clothing without shoes using a calibrated digital electronic weighing scale (Seca 813, Seca, UK) to the nearest 0.1 kg. Body mass index was derived by dividing the weight in kilogram (kg) by the height in meter-square (m^2). Skinfold thickness was measured using Harpenden skinfold caliper and surgical pen marker (Creative Health Product, MI, USA) by grasping a fold of skin and the underlying subcutaneous tissue at the site to be measured. The fold was pulled away from the underlying muscle and the jaws of the calipers were placed on either side of the site at a depth of approximately 1 cm away from the edge of the thumb and finger. The measurement was recorded with a required accuracy of less than 1.5 mm. Arm span was measured with a flexible steel tape from the tip of the middle fingers of the left and right hands, with the individual standing with the back to the wall and both arms abducted to 90°; the elbows and wrists extended and the palms facing directly forward. Readings were taken to the nearest 0.1 cm.

Flexibility: The sit-and-reach test was conducted indoors using a sit-and-reach box supplied with a tape measure using the procedures outlined in the ACSM manual[19]. The purpose of this test was to assess the flexibility of the lower back and hamstring. The participant was instructed to sit with legs together and extended in front so that the feet (shoes off) touched the first step. Both knees were held together and flat on the floor. The task was to perform the furthest possible front bend with arms extended and hands on top of each other, palms facing downward. The maximal reach distance was recorded in centimeters after three trials.

Muscular fitness

Vertical Jump test (VJ): The procedure to describes the method used for directly measuring the VJ height jumped. Similarly, the Long Jump (LJ) test, the average of three best jumps, marking the difference between the length of the standing lunge and the maximum LJ length as described by Haff and Triplett[20] was recorded in in centimeters. Both VJ and LJ scores were converted to watts (W) using Sayers' PAPw formula[21]. Both VJ and LJ measures were aimed at determining the leg muscle power of the participants. The sit-ups (SU) test (2 min), push-up test (PU) (1 min) and Running Speed (RS) were assessed using the SISA protocol[22]. These tests were used to determine trunk, abdominal and upper body endurance of the participants.

Running Speed (RS) tests: Running speed testing was performed to determine acceleration, maximum RS and sped endurance using a set distance of 35 m dash[23]. The time taken to cover the distance was recorded in seconds.

Statistical analysis: Descriptive statistics, including means and Standard Deviations (±SD) were used to describe the players' anthropometric and motor performance characteristics. Multiple correlation coefficient (r) and independent t-test were used to examine if any significant differences existed in the anthropometric motor performance characteristics between male and female as well as their playing status (National and provincial). For all statistical analyses the level of significance was set at $p \leq 0.05$. Data were analyzed using IBM Statistical Package for Social Sciences (SPSS) version 20.0 for windows (SPSS Inc., Armonk, NY, USA)[24].

RESULTS

The anthropometric and motor performance characteristics of the participants stratified by gender are displayed in Table 1. The mean values for weight, height, BMI, AAL, muscular endurance, PU and SU were 60.6±5.8 kg, 173.2±8.7 cm, 20.4±2.9 kg m^2, 136.6±7.5 cm, 38.0±14.4 ×/1 min and 73.6±20.2 ×/2 min, respectively (Table 1). The explosive powers of the study participants obtained were 3779.8±1309.3 W (50.9±10.2 cm) for VJ and 3925.5±1260.8 W (53.3±9.4 cm) for LJ. The male (177.9±4.9 cm) were significantly taller than the women ($p<0.05$) (Table 1). Male players had a substantially lower mean %BF (9.3±1.2%) than the female players (12.6±1.5%) ($t = 6.5$; $p<0.05$). There was a significant difference ($p = 0.00$) in BMI between the male (19.1±2.3 kg m^2) and female (23.2±1.9 kg m^2) players, with the females having higher BMI values.

The males (140.0±6.3 cm) had a higher mean AAL than the females (129.2±3.5 cm), thus, indicating a significant difference ($t = 4.78$; $p<0.05$). Similarly, the national (138.2±9.6 cm) players had higher AAL values than the provincial (136.3±7.1 cm) players, respectively. There was no significant gender difference ($t = 0.7$; $p = 0.43$) in SR. The male (4.6±0.3 sec) players had a significantly ($t = 4.3$; $p<0.05$) faster RS than the female (5.3±0.4 sec) players. Likewise, the male (42.8±13.3 ×/1 min for PU and 80.4±18.3 ×/2 min for SU) players had significantly ($p<0.05$) superior performances in the PU and SU tests than the female (27.3±10.7 ×/1 min for PU and 58.8±16.7 ×/2 min for SU) players. The male (4104.6±1081.7 and 3946.8±1294.2 W) players had a mean higher VJ and LJ power value than the females (1294.2±978.4 and 3885.9±1209 W). The male players had significantly higher VJ scores than the female players ($t = 7.3$; $p<0.05$) (Table 1).

The mean values between national and provincial level badminton players (Table 2) demonstrated no significant difference ($t = 0.03$; $p = 0.97$) between the national (173.3±13.0 cm) and provincial (173.1±7.6 cm) players. Similarly, there was no significant difference ($t = 0.13$; $p>0.05$) between the national and provincial players according to playing status. The national (16.5±2.5 cm) players were more flexible compared to the provincial (13.7±3.7 cm) players (Table 2).

Also, the national (57.2±11.6 ×/1 min for PU and 94.0±15.6 ×/2 min for SU) players had substantially better PU and SU performances than the provincial (33.0±10.3 ×/1 min for PU and 68.3±18.0 ×/2 min for SU) players ($p<0.05$). However, their LJ performances were not substantially different ($t = 0.4$; $p>0.05$). The national (4215.4±1453.6 and 4701.0±1144.0 W) players had significantly ($p<0.05$) higher mean VJ and LJ power than the provincial (3669.0±1222.8 and 3717.6±1071.1 W) players (Table 2).

Correlation between anthropometric and motor performance characteristics of the participants as shown in Table 3. Comparatively, there was a significant correlation between height and motor performance characteristics on all the variables with the exception of SR (0.07) and LJ (0.06) ($p>0.05$). Except, LJ (0.26; $p = 0.18$), there was significant correlations between %BF and motor performance characteristics in all the variables. A correlation was also found between AAL and motor performance characteristics, with the exception of SR ($r = 0.05$) and LJ ($r = 021$).

There was no significant correlation between weight and motor performance characteristics (SR, RS, PU, SU, VJ and LJ) ($r = 0.07$, 0.04, 0.99, 0.12, 0.11 and 0.24; $p>0.05$). Similarly, there was no significant correlation between BMI and

Table 1: Anthropometric and motor performance characteristics of the participants stratified by gender

Variables	Sex	n	$\bar{x}$	SD	t-value	Df	p-value
Height (cm)	Female	9	162.5	4.8	7.83		
	Male	20	177.9	4.9		27	0.00*
	Total	29	173.2	8.7			
Weight (kg)	Female	9	61.2	4.5	0.36		
	Male	20	60.4	6.5		27	0.72
	Total	29	60.6	5.8			
Body fat (%)	Female	9	12.6	1.5	6.5		
	Male	20	9.3	1.2		27	0.00*
	Total	29	10.3	2.0			
Body mass index (kg m^2)	Female	9	23.2	1.9	4.58		
	Male	20	19.1	2.3		27	0.00*
	Total	29	20.4	2.9			
AAL (cm)	Female	9	129.2	3.5	4.78		
	Male	20	140.0	6.3		27	0.00*
	Total	29	136.6	7.5			
SR (cm)	Female	9	15.1	4.3	0.7		
	Male	20	13.9	3.3		27	0.43
	Total	29	14.3	3.6			
RS (sec)	Female	8	5.3	0.4	4.3		
	Male	20	4.6	0.3		26	0.00*
	Total	28	4.8	0.5			
Muscular endurance (PU) [×/1 min]	Female	9	27.3	10.7	3.1		
	Male	20	42.8	13.3		27	0.00*
	Total	29	38.0	14.4			
Muscular endurance (SU) [×/2 min]	Female	9	58.8	16.7	3.0		
	Male	20	80.4	18.3		27	0.00*
	Total	29	73.6	20.2			
Explosive power (VJ) [W]	Female	9	1294.2	978.4	7.3		
	Male	20	4104.6	1081.7		27	0.00*
	Total	29	3779.8	1309.3			
Explosive power (LJ) [W]	Female	9	3885.9	1209.0	0.4		
	Male	19	3946.8	1294.2		26	0.67
	Total	29	3925.5	1260.8			

*Significant at 0 .05 levels, SR: Sit and reach, BMI: Body mass index, AAL: Average arm length, PU: Push-up, VJ: Vertical jump, LJ: Long jump, RS: Running speed, SU: Sit-up, DF: Degree of freedom

Table 2: Mean values between national and provincial level badminton players

Variables	Status	n	$\bar{x}$	SD	t-value	Df	p-value
Height (cm)	Provincial	23	173.1	7.6	0.03	27	0.97
	National	6	173.3	13.0			
Weight (kg)	Provincial	23	60.7	6.1	0.13	27	0.89
	National	6	60.3	5.1			
Body fat (%)	Provincial	23	10.6	2.0	1.61	27	0.12
	National	6	9.1	1.9			
BMI (kg m^2)	Provincial	23	20.4	2.6	0.12	27	0.91
	National	6	20.5	4.3			
AAL (cm)	Provincial	23	136.3	7.1	0.55	27	0.58
	National	6	138.2	9.6			
SR (cm)	Provincial	23	13.7	3.7	1.73	27	0.09
	National	6	16.5	2.5			
RS (sec)	Provincial	22	4.9	0.4	3.57	26	0.00*
	National	6	4.3	0.3			
Muscular Endurance (PU) [×/1 min]	Provincial	23	33.0	10.3	4.99	27	0.00*
	National	6	57.2	11.6			
Muscular Endurance (SU) [×/2 min]	Provincial	23	68.3	18.0	3.18	27	0.00*
	National	6	94.0	15.6			
Explosive Power (VJ) [W]	Provincial	23	3669.0	1222.8	2.12	27	0.04*
	National	6	4215.4	1453.6			
Explosive Power (LJ) [W]	Provincial	22	3717.6	1071.1	5.53	26	0.00*
	National	6	4701.0	1144.0			

*Significant at 0.05 level, SR: Sit and reach, BMI: Body mass index, AAL: Average arm length, PU: Push-up, VJ: Vertical jump, LJ: Long jump, RS: Running speed and SU: Sit-up, DF: Degree of freedom

Table 3: Correlation values between anthropometric and motor performance characteristics

S/No.	Variables	R	p-values
a1	Height vs. sit and reach	0.02	0.92
a2	Height vs. speed	0.44	0.02*
a3	Height vs. push-up	0.48	0.01*
a4	Height vs. sit-up	0.58	0.00*
a5	Height vs. vertical Jump	0.72	0.00*
a6	Height vs. long Jump	0.06	0.76
b1	Weight vs. sit and reach	0.07	0.70
b2	Weight vs. speed	0.04	0.86
b3	Weight vs. push-up	0.99	0.61
b4	Weight vs. sit-up	0.12	0.55
b5	Weight vs. vertical Jump	0.11	0.57
b6	Weight vs. long Jump	0.24	0.23
c1	%BF vs. sit and reach	0.55	0.00*
c2	%BF vs. speed	0.65	0.00*
c3	%BF vs. push-up	0.66	0.00*
c4	%BF vs. sit-up	0.55	0.00*
c5	%BF vs. vertical Jump	0.77	0.00*
c6	%BF vs. long Jump	0.26	0.18
d1	BMI vs. sit and reach	0.06	0.77
d2	BMI vs. speed	0.35	0.07
d3	BMI vs. push-up	0.26	0.17
d4	BMI vs. sit-up	0.32	0.09
d5	BMI vs. vertical Jump	0.59	0.00*
e1	AAL vs. sit and reach	0.05	0.81
e2	AAL vs. speed	0.39	0.04*
e3	AAL vs. push-up	0.43	0.02*
e4	AAL vs. sit-up	0.53	0.00*
e5	AAL vs. vertical Jump	0.61	0.00*
e6	AAL vs. long Jump	0.21	0.28

*Significant at 0.05 level, %BF: Percentage of body fat, BMI: Body mass index, AAL: Average arm length

motor performance characteristics on all the variables. However, a significant correlation exist between BMI and VJ power (0.59; $p<0.00$) (Table 3).

DISCUSSION

The study revealed that the average heights of badminton players are higher than the standard badminton net height; and had lower body weight; therefore, the players could be described as having a height and weight advantage for better performance. The height of the badminton players obtained in this present study is consistent with elite females' badminton players studied elsewhere[25-27]. Similarly, the values obtained for the male players mimic those of elite players in Abian-Vicen *et al.*[25] study (177.94±6.0) but are lower than that of elite players with values of 184.6±6.01 and 182.0±4.6 cm, reported elsewhere[10,28], respectively. The male players were taller than elite players and junior players reported mean heights in other studies: 172.4±5.3[29], 160.4±6.8[30], 166.4±5.6[25] and 165.5±5.3cm[31]. Therefore, the players in this study could be described as having a height advantage.

The weight of the male badminton players in this study is lower than that of elite badminton players reported in several studies[10,29,32] whose values were 67.9±3.6, 71.65±5.7 and 80.7±9.05 kg, respectively. The players' weight in the current study is also lower than those obtained in studies on sub-elite male badminton players who weighted 77.5±5.9 kg[28] and junior players whose body mass were 61.1±16.6 and 63.5±4.9 kg[27,31], respectively. Similarly, the weight of the female badminton players in this study is similar to that reported for elite female badminton players[25,26]. Excess body weight would be detrimental in moving swiftly around the court as well as when jumping to smash the shuttle.

Also, the BMI and %BF of the players are in a normal range for good performance. The BMI of the male badminton players in this study is lower than that of elite badminton players[10,25,28], with reported mean values of 23.6±1.96, 21.5±2.7 and 23.4±1.6 kg m^2, respectively and junior players[27] (20.56±3.39 kg m^2) but comparable to the value[30] of 18.9±2.05 kg m^2. Previous studies[25,27] have reported the BMI of female players as 22.3±2.2, 21.63±1.25 kg m^2, respectively. The finding of this study demonstrates a significant gender difference ($t = 4.58$, $p = 0.00$) in BMI, with no corresponding difference observed between national and provincial players. Lean BMI rather than total body weight is a critical factor in performance ability[33]. Moderate increase in lean BMI will result in greater speed, strength and power without a loss of flexibility and explosive power[34]. Therefore, badminton players with a high lean muscle mass would be able to generate higher force for jumping while playing[14]. The BMI plays an important role in sports like badminton which require repeated lifting of the body against gravity in movement during play[35]. The %BF value obtained among the male players in this present study is similar to that of elite players reported in another study (9.59±3.31%)[10], but higher than the BMI values of 8.2±1.7[29] and 8.35±1.44%[26]. Other studies[25,27,28,31] have reported higher values than those obtained in this study. Top competitive players tend to have low %BF as the negative impact of excess %BF would increase the energy expended in moving around the court[14]. Similarly, few studies have assessed the length and circumference of the arm and legs, which could be advantageous in the ability to cover the court[17,28,36].

The present study revealed a strong disparity between the male and female ($t = 4.78$, $p = 0.00$) in AAL, but there was no difference between the national and provincial players ($t = 0.55$, $p = 0.58$) in this regard. Although, data on AAL tend to be scarce, especially for badminton players, the AAL for national and international badminton and squash players ranged from 1.2-1.56 and 1.1-1.47 m for male and female, respectively[14]. The values obtained in the current study falls within these ranges.

In this study, the players' trunk flexibility values were 15.1±4.3, 13.9±3.3, 13.7±3.7 and 16.5±2.5%, respectively for female, male, provincial and national badminton players, with no significant differences across the various categories. Flexibility is relevant to jumping, swimming, racket and most team sports[37]. It is an advantage to have above average flexibility levels of the trunk and shoulder regions for racket sports[14]. Greater flexibility of the trunk and stroke arm is undoubtedly an important factor as well as hip and hamstring flexibility[38]. High levels of flexibility are also needed so that the players are able to position themselves to hit the shuttlecock more powerfully[25]. Adequate levels of flexibility would allow a player to perform the various strokes efficiently as much retrieval are made with the spine and shoulder joint in hyperextension and the hips and hamstrings fully flexed when lunge jumps are made at the net. It also allows for more fluent stroking when forced to stretch[13] and facilitates explosive power on the court[35].

The running distances covered in this study was 35 m in 4.6±0.3, 5.3±0.4, 4.3±0.3 and 4.9±0.4 sec for male, female, national and provincial players, respectively. The results further indicated significant gender differences as male players had superior speed compared to the female ($t = 4.3$, $p = 0.00$). Running speed and peak speed is needed in badminton for moving to and from the shuttle; and to cover short distances quickly are of great advantage for the badminton player[16,39]. Compared to normative data[40] on tennis players, the females were below average in PU's and above average in SU's whereas the males were above average for both PU's and SU's. Further, this normative data[40] reported push-up values ranging from 36-42 for males and 33-38 for females and the sit-up values ranged from 44-52 for males and 38-46 for females. The PU and SU values for males were lower compared to the squash racket players mean values of 45 and 80 repetitions for PU's and SU's, respectively[41]. Dynamic and strong upper body endurance are required to withstand the repetitive nature of striking the shuttle[15].

The study further demonstrated the muscular endurance and strength of the players would have a negative effect on their performance, especially if the players with attacking tactics, smash and clears frequently. Well-developed strength and endurance of the trunk muscles plays an important role in badminton as trunk movements are large, repetitive and varies. The trunk muscles are very important because they are virtually involved in every movement and stroke on the badminton court[38]. They performed an important stabilizing and balancing function for all braking and PU's and are directly involved in stroke production. Without sufficient trunk development in terms of strength and endurance, strokes will lack power and control[42]. A vital aspect of badminton is player's ability to exert muscular force at high speed[35] and badminton places a great demand on explosive power[38]. An explosive player will typically be able to jump high, change direction quickly and will generally appear to be swift and mobile on the badminton court, due to ability to combine coordination and muscular properties[38] and will have a significantly improved and reduced reaction in the response-time during movements.

The vertical jump of the players in this present study is judged to be satisfactory in comparison with previous studies[36,38]. The VJ value in the study, corresponds with those obtained from local league, national league and elite level badminton players, which ranged from 55-75 cm[38], whereas 60-70 cm is the minimum range for the lunge jump for male badminton players[38], however, the females had lower values in comparison. The minimum range for the lunge jump for female players is 35-45 cm[38], which is consistent with the data observed for the female participants in this study. The female players would not be at a great disadvantage with regards to their LJ power performance as their value only falls within the normal range for female badminton players. It would be rather advantageous for the male players as horizontal explosiveness is important in taking lunge jumps to execute net shots. A greater horizontal explosiveness will result in the player being able to reach the shuttlecock faster and thus force a speedier pace of play. Explosive power also helps in reaching un-anticipated shots, where a quick, explosive movement to a relatively far distance has to be executed.

CONCLUSION

A significant correlation exists between some anthropometric characteristics' and motor performance characteristics in badminton players. The male players had superior anthropometric and motor performance qualities than the female players. However, the female players were more flexible, which could be attributed to either bone structure or genetic difference. A similar beneficial trend was noted for the national players, in contrast to the provincial badminton players. The badminton trainers, coaches, sport scientists and team involved with designing the badminton training programme should take cognizance of the players' anthropometric and motor performance variables into consideration in order to achieve high performance.

SIGNIFICANCE STATEMENTS

This study reveals significant correlation exists between selected anthropometric characteristics and body composition (height and percentage of body fat) and motoric performance (running-speed, vertical-jump, push-up, sit-up and sit-and-reach) in badminton players. Future research should examine the likely factors responsible for the gendered dimension in anthropometric and motor performance of badminton players. The finding of this study further confirm that scientific physical conditioning and training principles are important for optimal performance in badminton; and thus, should be followed in designing the training protocol for badminton players.

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