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CORRELATIONS OF HANDGRIP STRENGTH WITH SELECTED ANTHROPOMETRIC VARIABLES IN INDIAN JUNIOR AND SENIOR BADMINTON PLAYERS

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ABSTRACT

The purpose of this study was to estimate the handgrip strength and to search its correlations with selected anthropometric variables in purposely selected 125 Indian junior and senior badminton players aged 12 – 25 years. For this purpose, fifteen anthropometric variables, such as height, weight, body mass index, upper arm circumference, triceps skinfold, humerous biepicondylar diameter, upper arm length, forearm length, total arm length, hand length, hand breadth, arm muscle girth, arm muscle area, arm fat area and arm fat index and right and left handgrip strength were measured on the various Badminton Academies in Hyderabad, Telangana, India. The results showed significant sex differences ($p < 0.040$-0.001) in majority of the anthropometric variables studied in the players. Both in male and female players, dominant and non-dominant handgrip strength had significantly positive correlations ($p< 0.015$ - 0.001) with height, weight, BMI, upper arm circumference, triceps skinfold, humerus biepicondylar diameter, upper arm, forearm and total arm length, hand length and breadth, and significant negative correlations ($p< 0.015$ - 0.001) with arm muscle girth and arm muscle area. In conclusion, it may be stated that handgrip strength may be used as one of the indicating factors for physical strength of the badminton players.

INTRODUCTION

Badminton is a highly explosive sport, involving a unique movement technique over a relatively small court area [1]. It is an intermittent sport characterized by long bouts of high intensity exercise interspersed with rest periods [2] and enteils vigorous movement of both the lower and upper body musculature [3]. It requires quick sprints, stops, starts, jumps, rapid changes of direction, twisting, stretching, smashing, clearing, dropping, and tactically trying to outmaneuver the opponent. The sport demands quick anticipation and response to movements of the opponent, the shuttle, footwork and stroke production [4].

Handgrip strength is a forceful flexion of all the fingers with a maximal voluntary force that subject is able to exert under normal bio kinetic conditions [5, 6]. The strength of one's own grip plays a key role in injury prevention and strength development [7-10]. It is often used as an indicator of overall physical strength of an individual [11], hand and forearm muscles performances [12], as a functional index of nutritional status [13-18] and physical performance [19]. Handgrip strength is a physiological variable that is affected by a number of factors including age, gender and body size. Strong correlations between grip strength and various anthropometric traits, (weight, height, hand length etc.) were reported earlier [6,14, 16, 20- 23].

In fact, anthropometry has been defined as the measurement of morphological parameters of human [24]. It was reported that a battery of anthropometric and morphological tests could distinguish between players of different ability in the same sport [25-27].

Little literature related to anthropometric profiles and physiological variables in badminton players are available [28-34]. But literature related to handgrip strength and its association with anthropometric variables in badminton players is scanty, especially in Indian context. Thus, the present study was planned with the objectives to estimate the handgrip strength and its correlations with selected anthropometric variables in Indian junior and senior badminton players of both the sexes.

MATERIALS AND METHODS

The present cross-sectional study was based purposely selected 125 junior and senior badminton players aged 12 – 25 years (mean age 15.28 ±2.65) from the various Badminton

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Academies in Hyderabad, Telangana. As it was well understood about the significant differences in handgrip strength and selected anthropometric variables between sports persons and their control counterparts, no attempt has been made in the present study to collect the control samples for comparison. The age of the subjects was determined from the records of their respective academies. A written consent was obtained from the subjects. The data was collected under natural environmental conditions. The study was approved by institutional ethical committee.

Anthropometric Measurements

Fifteen anthropometric variables, such as height (HT), weight (WT), body mass index (BMI), upper arm circumference (UAC), triceps skinfold (TSK), humerous biepicondylar diameter (HBD), upper arm length (UAL), forearm length (FAL), total arm length (TAL), hand length (HL), hand breadth (HB), arm muscle girth (AMG), arm muscle area (AMA), arm fat area (AFA) and arm fat index (AFI) were measured on each subject using standard techniques [35].

The height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm. Weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg. BMI was then calculated using the formula weight (kg)/height^2 (m)^2. Upper arm circumference was measured by steel tape in cm.

Triceps skinfold was measured by Harpenden skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) to nearest 0.2 mm. Humerous biepicondylar diameter was measured by sliding caliper in cm. Upper arm length, forearm length and total arm length were measured by first segment of anthropometer in cm. Hand length and hand breadth was measured by sliding caliper in cm. Muscle girth, Arm muscle area, arm fat area and arm fat index were calculated using standard methodologies [36] as: arm muscle girth (cm) = G arm - (π *Skinfold triceps*); arm muscle area (cm^2) = [G arm - ((π *Sf tri*)] /4(4π; arm area = (cm^2) = (G arm)^2 / 4 π; arm fat area (cm^2) = arm area - arm muscle area; arm fat index = arm fat area / arm area.

Handgrip Strength Measurement

The grip strength of both right and left hands was measured using a standard adjustable digital handgrip dynamometer (Takei Scientific Instruments Co., LTD, Japan) at standing position with shoulder adducted and neutrally rotated and elbow in full extension. The dynamometer was held freely without support, not touching the subject's trunk. The position of the hand remained constant without the downward direction. The subjects were asked to put maximum force on the dynamometer thrice with 30 seconds recovery period from both sides of the hands. The maximum value was recorded in kilograms.

Statistical Analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured variable. Student's t - test was used for the comparison of the variables studied between the two sexes of the players. Pearson's correlation coefficients were applied to establish the correlations of right and left handgrip strength with the variables measured. Data were analyses using SPSS (Statistical Package for Social Science) version 20.0. A 5% level of probability was used to indicate statistical significance.

RESULTS

Table 1 showed the descriptive statistics of handgrip strength and anthropometric variables in Indian junior and senior badminton players and controls. Significant sex differences ($p < 0.040$-0.001) were found in dominant and non-dominant handgrip strength ($t = 3.316$ and 2.788 respectively), BMI ($t = 2.083$), triceps skinfold ($t = 5.877$), forearm and total arm length ($t = 3.062$ and 2.948 respectively), hand length ($t = 3.993$), arm muscle girth ($t = 6.242$), arm muscle area ($t = 6.082$), arm area ($t = 6.229$), arm fat area ($t = 6.230$) and arm fat index ($t = 5.526$).

Distribution of handgrip strength in various sports events reported earlier were given in table 2. Severe variations are there in handgrip strength both in male and female players among these sports events, as there were age group differences, also differences in training protocol.

Table 3 showed the correlation coefficients of dominant and non-dominant handgrip strength with the selected anthropometric variables in Indian junior and senior badminton players.

Both in male and female players, dominant and non-dominant handgrip strength had significantly positive correlations ($p< 0.015$ - 0.001) with height, weight, BMI, upper arm circumference, triceps skinfold, humerus biepicondylar diameter, upper arm, forarm and total arm length, hand length and breadth, and significant negative correlations ($p< 0.015$ - 0.001) with arm muscle girth and arm muscle area.

Table 1 Descriptive statistics of handgrip strength and various anthropometric variables in badminton players

Variables	Male players		Female players		t-value	p-value
	Mean	SD	Mean	SD		
Dominant handgrip str. (kg)	26.43	8.14	20.72	4.82	3.316	<0.001
Non-dominant handgrip str. (kg)	24.42	8.13	19.63	4.89	2.788	<0.006
Age(years)	14.60	2.62	15.28	2.65	1.121	0.265
Height(cm)	160.00	11.43	155.52	9.17	1.783	0.078
Weight(kg)	46.56	11.65	46.80	10.05	0.091	0.928
BMI (kg/m²)	17.92	2.52	19.15	2.58	2.083	<0.040
Upper arm circum. (cm)	9.59	1.35	9.58	1.07	0.033	0.974
Triceps skinfold(mm)	14.45	3.75	19.60	4.00	5.877	<0.001
Hum. biepicon. dia.(mm)	7.29	0.79	7.03	1.15	1.268	0.208
Upper arm length (cm)	26.12	2.63	25.48	2.82	1.042	0.300
Forearm length (cm)	22.79	2.12	21.36	1.70	3.062	<0.003
Total arm length(cm)	71.83	5.49	68.36	3.71	2.948	<0.004
Hand length (cm)	17.61	1.03	16.53	1.01	3.993	<0.001
Hand breadth (cm)	6.58	6.97	6.56	1.07	0.091	0.928
Arm muscle girth (cm)	35.78	11.09	51.96	11.86	6.242	<0.001
Arm muscle area (cm²)	71.39	20.32	100.27	21.71	6.082	<0.001
Arm area (cm²)	1100.29	688.05	2225.73	1040.03	6.229	<0.001
Arm fat area (cm^2)	1171.68	708.13	223.26	1061.50	6.230	<0.001
Arm fat index	1.08	0.02	1.05	0.01	5.526	<0.001

Table 2 Distribution of handgrip strength in various events

Events	Gender	Age-group (years)	n	Dominant Handgrip strength (kg)		Non-dominant Handgrip strength (kg)		Sources
				Mean	SD	Mean	SD	
Kabaddi	Males	12-18	67	36.17	7.60	34.67	7.94	Koley and Kaur, 2015 [37]
	Females		62	19.31	4.74	17.62	4.22	
Volleyballl	Males	18-25	30	47.15	7.93	-	-	Koley and Bijwe, 2014 [38]
	Females		30	29.41	6.35	-	-	
Volleyball	Males	18-25	38	43.66	5.88	42.33	6.17	Koley and Singh, 2012 [39]
	Females		25	24.21	3.64	23.60	4.44	
Volleyball	Females	18-25	101	27.04	2.64	24.10	2.66	Koley and Kaur, 2011 [40]
Softball	Males	18-25	121	41.40	6.20	-	-	Koley and Santhosh, 2011 [41]
	Females		122	26.60	4.50	-	-	
Wrestling	Male s freestyle	18-30	88	49.41	8.81	-	-	Singh and Koley, 2013 [42]
	Males greco-roman		61	47.46	10.33	-	-	
	Females freestyle		63	36.66	6.25	-	-	
Cycling	Males	18-24	31	44.06	6.23	-	-	Koley and Jain, 2013 [43]
	Females		26	28.41	4.03	-	-	
Hockey	Males state		25	36.65	3.88	37.77	3.40	Sharma *et al*., 2012 [44]
	Male national		35	36.03	4.95	36.57	4.67	
Handball	Females	18-25	101	30.01	3.86	26.80	3.69	Koley *et al*., 2011 [45]
Basketball	Males	18-25	35	37.49	8.41	36.99	8.27	Koley *et al*., 2011 [46]
	Females		25	24.78	4.85	24.20	3.51	
Cricket	Males	17-21	103	35.86	7.07	35.41	6.68	Koley and Yadav, 2009 [21]
Badminton	Males	12-25	78	26.43	8.14	24.42	8.13	Present study
	Females		47	20.72	4.82	19.63	4.89	

Table 3 Correlation coefficients of handgrip strength with selected anthropometric variables in Indian badminton players

Variables	Dominant handgrip strength				Non-dominant handgrip strength			
	Males		Females		Males		Females	
	r	p	r	p	r	p	r	p
HT	0.841	0.001	0.621	0.001	0.807	0.001	0.625	0.001
WT	0.828	0.001	0.866	0.001	0.770	0.001	0.758	0.001
BMI	0.561	0.001	0.770	0.001	0.504	0.001	0.663	0.001
UAC	0.640	0.001	0.688	0.001	0.597	0.001	0.549	0.001
TSK	0.274	0.015	0.498	0.011	0.284	0.012	0.235	0.257
HBD	0.491	0.001	0.258	0.213	0.464	0.001	0.241	0.247
UAL	0.653	0.001	0.309	0.133	0.651	0.001	0.245	0.238
FAL	0.728	0.001	0.196	0.347	0.675	0.001	0.183	0.382
TAL	0.778	0.001	0.372	0.067	0.747	0.001	0.301	0.143
HL	0.610	0.001	0.439	0.028	0.571	0.001	0.291	0.158
HB	0.627	0.001	0.247	0.233	0.612	0.001	0.189	0.366
AMG	-0.213	0.061	-0.464	0.015	-0.229	0.044	-0.195	0.349
AMA	-0.241	0.034	-0.480	0.015	-0.255	0.025	-0.214	0.305
AFA	0.204	0.074	0.425	0.034	0.231	0.042	0.162	0.439
AFI	-0.174	0.127	-0.505	0.010	-0.163	0.153	-0.229	0.272

HT = height, WT = weight, BMI = body mass index, UAC = upper arm circumference, TSK = triceps skinfold, HBD = humerus biepicondylar diameter, UAL = upper arm length, FAL = forearm length, TAL = total arm length, HL = hand length, HB = hand breadth, AMG = arm muscle girth, AMA = arm muscle area, AFA = arm fat area and AFI = arm fat index.

DISCUSSION

Badminton is a popular racquet sport and is also an Olympic sport. It is an endurance sport played at all levels of society and at all ages. The grip affects the angle of the racquet face when it hits the shuttlecock and influences the pace, spin, and placement of the shot. Players use various grips during play, including the continental (handshake grip), eastern grip, and western (usually for forehand grips) grips. Most players change grips during a match depending on the shot they are hitting; for example, slice shots and serves call for a continental grip. The main shots used in badminton are forehand and backhand. It is an intermittent endurance sport which requires excellent eye-hand coordination too [1-4].

In the present study, significant sex differences were found in dominant and non-dominant handgrip strength, BMI, triceps skinfold, forearm and total arm length, hand length, arm muscle girth, arm muscle area, arm area, arm fat area and arm fat index.

These differences were due to morphological and physiological differences between the two sexes. Differences in training protocol in male and female badminton players might be also one of the causes.

Significant positive correlations of both right and left handgrip strength were found with height, weight, BMI, upper arm circumference, triceps skinfold, humerus biepicondylar diameter, upper arm, forearm and total arm length, hand length and breadth. Such type of correlations of handgrip strength with anthropometric variables and performance tests were also reported in other sports too [20-23]. In fact, all the hand and arm muscles are responsible for the generation of handgrip force and, the hand and arm anthropometry has a close affinity to handgrip strength [47].

In the present study, small sample size was a limitation which would be taken into account in our future studies.

CONCLUSIONS

The findings of the present study have immense practical application in selection of talents in badminton players. It would be beneficial to the badminton players in term of optimizing training programs separately for male and female players.

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