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Correlations of Back Strength with Selected Anthropometric Traits and Performance Tests in Elite Indian Volleyball Players

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ABSTRACT

The purpose of the preseny study was to estimate the back strength and its correlations with selected anthropometric traits and performance tests in elite Indian volleyball players. Four anthropometric traits viz. height, weight, BMI and right lower extremity length, two body composition parameters, viz. percent body fat and percent lean body mass, three performance tests, viz. sit and reach test, illinois agility test and vertical jump test, and back strength were measured on randomly selected 75 elite Indian volleyball players (40 males and 35 females) aged 18–25 years. An adequate number of controls (n = 90, 53 males and 47 females) were also taken from the same place for comparisons. In results, one way analysis of variance showed significant between-group differences ($p \leq 0.006$ - 0.001) in all the variables between volleyball players of both the sexes and controls. In volley players, significantly positive correlations ($p \leq 0.01$) were found between back strength and height, weight, right lower extremity length, percent lean body mass and vertical jump test, whereas significantly negative correlations ($p \leq 0.01$) were found with percent body fat and illinois agility test. In conclusion, it may be stated that back strength had some strong positive correlations with three anthropometric traits, one body composition component and one performance test in elite Indian volleyball players.

Keywords: anthropometric characteristics, back strength, performance test, elite Indian volleyball players.

INTRODUCTION

Volleyball is an intermittent sport. It requires players to participate in frequent short bouts of high-intensity exercise, followed by periods of low-intensity activity [16,28]. The high intensity bouts of exercise, coupled with the total duration of the match requires players to have well-developed aerobic and anaerobic alactic (ATP-CP) energy systems [21]. As a result, volleyball players require well-developed speed, agility, upper-body and lower body muscular power, and maximal aerobic power [28].

In fact, muscular strength, endurance and flexibility are important components of healthy back functions. A number of studies reveal that muscle strength is critical to health and well-being [15,20,1,22]. Several external factors, viz. altitude [23], position of exerting strength [25], diet [10] and internal factors, viz. age, sex [19], height, weight [24] etc. influence the maximum force that can be exerted by a muscle [3].

In different playing positions of volleyball, a great amount of strength of the back muscles is required. Mechanical factors play an important role in the etiology of degenerative processes and injuries to the lumbar spine. The maximum capacity of the back muscles must be known if assessments are to be made of muscle endurance followed by muscle fatigue during playing conditions [18]. However, the anatomical and biomechanical structures of the back are extremely complex and consequently, accurately measuring back muscle strength is problematic outside of a

research setting. If a relationship exists between back strength and easily obtainable anthropometric or strength measurements, coaches and trainers could make reliable estimates using simple methods in the field.

Several studies have examined the relationships between anthropometric and physiological characteristics of volleyball players [8,9]. But information relating to back strength and its association with anthropometric traits in volleyball players is lacking, especially in Indian context. So the present study was planned.

MATERIALS AND METHODS

Participants

The present cross-sectional study is based on randomly selected 75 elite Indian volleyball players (40 males and 35 females) aged 18–25 years (mean age 21.07 years, ± 2.38) from the inter-university volleyball competitions organized in Guru Nanak Dev University, Amritsar, Punjab, India in 2011. The participating teams were Punjabi University, Patiala, Punjab University, Chandigarh, Guru Nanak Dev University, Amritsar, Kurukshetra University, Kurukshetra, Himachal Pradesh University, Himachal Pradesh and Delhi University, Delhi. An adequate number of controls (n = 90, 53 males and 47 females, mean age 21.06 years, ± 2.34) with no particular athletic background were also collected from the same place for comparisons. The age of the subjects were recorded from the date of birth registered in their respective institutes. A written consent was obtained from the subjects. The data were collected under natural environmental conditions in morning (between 8 AM. to 12 noon). The study was approved by the local ethics committee.

Anthropometric measurements

Four anthropometric variables, viz. height (HT), weight (WT) and BMI and right lower extremity length (RLEL), two body composition parameters, viz. percent body fat (%BF) and percent lean body mass (%LBM), one physical parameter, viz. back strength (BS) and three performance tests viz. sit and reach test (S & RT), ilinoise agility test (IAT) and vertical jump test (VJT) were taken on each subject. Anthropometric variables of the subjects were measured using the standard techniques [17] and were measured in triplicate with the median value used as the criterion.

The height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, and 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. Right lower extremity length was measured vertically from iliospinale posterior to the floor by anthropometer in cm. Percent body fat was assessed using skinfold measurements taken from four sites, viz. biceps, triceps, subscapular and suprailiac using Harpenden skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) to the nearest 0.2 mm, and using the Durnin and Womersley [5] skinfold equation. Percent lean body mass was calculated subtracting percent body fat from 100.

Back strength measurement

Back strength were measured using a back-leg-chest dynamometer. After 3 minutes of independent warm-up, the subject was positioned with body erect and knees bent so that grasped-hand rests at proper height. Then straightening the knees and lifting the chain of the dynamometer, pulling force was applied on the handle. The body would be inclined forward at an angle of 60 degrees for the measurement of back strength. The strength of the back muscles was recorded on the dial of the dynamometer as the best of three trials in kg. Thirty seconds time interval was maintained between each back strength testing.

Sit and reach test

The subject was asked to warm up properly and then made to sit on the floor with feet placed against the inner side of the box. With one hand over the other, the tips of the two middle fingers on top of one another, the subject was then asked to slowly stretch forward without bouncing or jerking and slide fingertips along the 20- inch scale as far as possible. The test was repeated thrice and best reading was recorded in inches.

Illinois agility test

Before the actual test started, the subject warmed up thoroughly and lied face down on the floor at the "start" point with his/her head facing the "start", legs out straight, feet together and arms by side . On the command the subject jumped to his/her feet and negotiated the course around the cones to the "finish" point as fast as possible. The total time taken from when the command was given to the subject till the time when he/she passed the "finish" point was recorded as the score for the trial. Best of the three readings in seconds to 2 decimal points was recorded.

Vertical jump test

An adequate warm up with several easy jumps proceeded with a few minutes rest, which also served the purpose of reviewing the jumping technique of the subject. The subject was told to bend the knees immediately prior to the jump (countermovement technique) which activates the stretch-shortening cycle in the muscles, resulting in greater power production in the legs. While resting, the subject was asked to stand with side toward wall and reach up as high as possible keeping the feet flat on the ground to mark the standing reach height. As and when the subject was ready, with colour on the distal part of his/her third finger (of right hand), he/she was asked to jump up as high as possible using both arms and legs to assist in projecting the body upwards and touch the wall at the highest point of the jump. The subject performed multiple attempts with short rests until a plateau or decrease in performance was observed and the best score was recorded in cms. The "net height" was calculated by subtracting the standing reach height from the jump height in cm.

Statistical analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. One way analysis of variance was tested for the comparisons of data among elite Indian volleyball players and controls, followed by post hoc Bonferroni test. Pearson's correlation coefficients were applied to establish the relationships among the variables measured. Linear regression was also done for further analysis. Data were analyzed using SPSS (Statistical Package for Social Science) version 17.0. A 5% level of probability was used to indicate statistical significance.

RESULTS

Descriptive statistics of back strengh, selected anthropometric, body composition component traits and performance tests in elite Indian volleyball players and controls were given in Table 1. In volleyball players, significant sex differences ($p \leq 0.006$ - 0.001) were noted in all the variables studied, except S & RT. When male volleyball players were compared with their control counterparts, statistically significant differences ($p \leq 0.002$ - 0.001) were found in all the variables studied, except BMI, %BF and %LBM. Female volleyball players had also significant differences ($p \leq 0.01$ - 0.001) in all the variables studied, except BMI, RLEL, %BF, %LBM and BS.

Bivariate correlations of back strength and anthropometric traits and performance tests were examined in elite Indian volleyball players in Table 2. Back strength had significantly positive correlations ($p \leq .01$) with HT, WT, RLEL, %LBM and VJT, whereas significantly negative correlations were found in %BF and IAT. In case of IAT significantly positive correlation ($p < 0.01$) was found only with %BF but negative correlations ($p < 0.01$) with HT, WT, RLEL, %LBM and BS. For VJT, significantly positive correlations ($p < 0.01$) were reported with HT, WT, RLEL, %LBM and BS and negative correlations ($p < 0.01$) were found with %BF and IAT.

(Table 3) showed the linear regression analysis of dependent variable as back strength with respect to other independent variables. Back strength was found to be significantly correlated with HT (R^2=0.297), WT (R^2=0.488), RLEL (R^2=0.614), %BF (R^2=0.278), %LBM (R^2=0.280), IAT (R^2=0.564) and VJT (R^2=0.532).

DISCUSSION

In volleyball, teams compete by manicures handling the ball above the head, height is considered to be the most important physical attribute. In the present study, the mean height of the male players (181.93 cm, ± 7.83) was greater than the male volleyball players of West Bengal, India (173.10 cm ± 4.19) [2], but lesser than the English (191.00 cm ± 5.0) [4], while in female players, the mean height (159.67 cm, ± 5.83) was lesser than the American (176.70 cm, ± 4.60) [6] and Japanese (168.70 cm, ± 5.89) [27] female volleyball players. In the study, significantly greater body weight among volleyball players might be disadvantageous for them in attaining a good jumping height as they have to lift a greater weight.

In the present study, elite Indian volley ball players (both males and females) have significantly higher mean values for back strength than their control counterparts. These differences were probably due to regular physical exercise and strenuous training programs of thye volleyball players. It was found too, that back strength had significantly positive correlations ($p<0.01$) with HT, WT, RLEL, %LBM and VJT and negative correlations ($p < 0.01$) with %BF and IAT in elite Indian volleyball players. The findings of the study reflected that the above mentioned variables had significant contributions for the back strength of the players (RLEL 61%, IAT 56%, VJT 53%, WT 49%, HT 30%,%BF and %LBM 28% each). In fact, jumping and landing require geeat amount of back strength in volleyball players. Strong back muscles help to lift the body in jumping as well as proper landing. To avoid game specific

injuries and greater success in game, estimation of back strength is essential. As per the requirements of the players, strengthening exercises of the back muscles should be provided to the players in the training programs. The findings of the present study followed the same line showing strong positive correlations of back strength and selected anthropometric variables in elite Indian cricketers [14], Indian field hockey players [12], Indian adolescents [13] and physical laborers [22].

Body composition greatly affects the energy-related physical strength and skill in various sports [11]. In volleyball players, the estimated % body fat was lower than controls in both sexes which followed the findings of Tsunawake et al. [26] and Filaire et al. [7]. These differences between players and controls might be due to regular physical exercise and prolonged training effect.

The limitations of the study were the less sample size and consideration of players only from inter-university level competitions. In future studies, all these limitations would be taken care.

Table 1. Descriptive statistics of various anthropometric and physiological characteristics in Indian inter-university volleyball players

Variables	VM (n=30)		CM (n=30)		VF (n=30)		CF (n=31)		F value	P value
	aMean	SD	Mean	SD	Mean	SD	Mean	SD		
HT (cm)	181.39	7.33	171.10	4.38	162.3	5.83	157.85	5.38	30.92	<0.001
WT (kg)	78.60	6.63	67.22	7.41	56.00	6.97	51.36	7.96	47.95	<0.001
BMI (kg/m^2)	23.42	4.38	22.98	3.41	21.31	2.76	20.65	3.33	4.31	<0.006
RLEL (cm)	106.92	8.67	97.94	3.47	91.00	3.81	91.14	4.68	54.01	<0.001
%BF	18.91	7.82	19.45	0.66	23.73	3.78	25.81	4.56	19.58	<0.001
%LBM	81.09	5.87	81.55	5.38	74.27	3.78	75.19	4.56	19.58	<0.001
S& R T (sec.)	12.25	4.87	7.40	7.26	12.33	5.19	5.44	7.58	8.82	<0.001
IAT	14.56	0.73	16.31	1.39	19.07	1.26	18.21	1.42	8.82	<0.001
VJT (cm)	51.37	8.39	42.87	6.47	29.72	7.20	24.83	7.21	77.06	<0.001
BS (kg)	165.00	8.84	124.03	9.91	71.02	9.95	67.97	9.98	87.63	<0.001

VM = volleyball males, CM = control males, VF = volleyball females, CF = control females, HT = Height, WT = Weight, BMI = Body mass index, RLEL = right lower extremity length, %BF = percent body fat, %LBM = percent lean body mass, S&RT = ait & reach test, IAT = illinois agility test, VJT =vertical jump test, BS = back strength.

Table 2. Inter-correlation matrix of dominant handgrip strength and selected anthropometric characteristics in elite Indian volleyball players

Variables	HT	WT	BMI	RLEL	%BF	%LBM	S & RT	IAT	VJT	BS
HT		0.586**	-0.141	0.575**	-0.595**	0.587**	0.054	-0.608**	0.555**	0.545**
WT	0.650**		0.410**	0.780**	-0.281*	0.283*	-0.130	-0.679**	0.742**	0.699**
BMI	0.233	0.883**		0.163	0.624**	-0.615**	-0.191	-0.150	0.221	0.155
RLEL	0.873**	0.526**	0.132		-0.488**	0.486**	-0.028	-0.728**	0.729**	0.784**
%BF	-0.499**	0.214	0.578**	-0.443**		-1.000**	-0.171	0.617**	-0.473**	-0.527**
%LBM	0.482**	-0.219	-0.562**	0.452**	-1.000**		0.171	-0.617**	0.473**	0.527**
S& RT	-0.108	0.185	0.325*	-0.231*	0.168	-0.164		-0.065	0.068	-0.071
IAT	-0.397**	-0.428**	-0.322*	-0.255*	0.210	-o.209	-0.124		-0.753**	-0.751**
VJT	0.606**	0.497**	0.292*	0.530**	-0.440**	0.439**	0.155	-0.545**		0.729**
BS	0.752**	0.652**	0.373**	0.600**	-0.425**	0.431**	0.184	-0.631**	0.735**	

*Upper triangle correlations for Elite Indian volleyball players and lower triangle correlations for controls; * Significant at 0.05 level (2-tailed); ** Significant at .01 level (2-tailed).*

Table 3. Linear regression of dependent variable as back strength with respect to other independent variables

Variables	R^2	F	Sig.
HT	0.297	24.455	<0.001
WT	0.488	55.337	<0.001
BMI	0.024	1.426	NS
RLEL	0.614	92.354	<0.001
%BF	0.278	22.305	<0.001
%LBM	0.280	22.308	<0.001
S&RT	0.005	0.293	NS
IAT	0.564	76.091	<0.001
VJT	0.532	65.860	<0.001

CONCLUSION

The findings of the present study may be concluded that significant between-group differences ($p \leq 0.006$ - 0.001) was found in all the variables between volleyball players of both the sexes and controls. In volley players, significantly positive correlations ($p \leq 0.01$) were found between back strength and height, weight, right lower extremity length, percent lean body mass and vertical jump test, whereas significantly negative correlations ($p \leq 0.01$) were found in percent body fat and illinois agility test. The data presented in the present study carry immense practical application and should be useful in talent identification in volleyball and training program development of the game.

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