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Correlations of back strength with some anthropometric variables in volleyball players

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Abstract
The purpose of the present study was to estimate the back strength and its correlations with selected ant anthropometric variables in volleyball players. Five anthropometric variables viz, height, weight, BMI, knee height and length of femur, two body composition parameters, viz. percent body fat and percent lean body mass, and back strength were measured on randomly selected 199 volleyball players (108 males and 9l females) aged 19–25 years. An adequate number of controls (n = 188, 103 males and 85 females) were also taken from the same place for comparisons. In results, one way analysis of variance showed significant between-group differences ($p \leq 0.001$) in all the variables between volleyball players of both the sexes and controls. In volley players, significant positive correlations ($p \leq 0.01$) were found with percent body fat. In conclusion, it may be stated that back strength had some strong positive correlations with selected anthropometric variables in volleyball players.

Keywords: anthropometric characteristics back strength 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 (Kunstlinger *et al*. 1987; Viitasalo *et al*. 1987) [14, 25]. 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 (Polglaze and Dawson 1992) [18]. As a result, volleyball players require well-developed speed, agility, upper-body and lower body muscular power, and maximal aerobic power (Viitasalo *et al*. 1987) [25].

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 (Kraus and Hirschland 1953; McDonangh and Davies 1984; Astrand and Rodahl 1986; Roy and Pal 2001) [13, 17, 1, 19]. Several external factors, viz, altitude (Ruff and Strughold 1942) [20], position of exerting strength (Teraoka 1979) [22], diet (Keys *et al*. 1950) [10] and internal factors, viz, age, sex (Mathiowetz *et al*. 1985) [16], height, weight (Schimdt and Toews 1970) [21] etc. influence the maximum force that can be exerted by a muscle (Berne and Levy 1983) [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. 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 (Fleck *et al*. 1985; Fry *et al*. 1991) [8, 9]. But information relating to back strength and its association with anthropometric variables 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 199 volleyball players (108 males and 91 females) aged 19 to 25 years 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, Panjab University, Panjab and Delhi University, Delhi. An adequate number of controls (n = 188, 103 males and 85 females) 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
five anthropometric variables, viz, height (HT), weight (WT), BMI (kg/m^2), knee height (cm), length of femur (cm), two body composition parameters, viz. percent body fat (%BF) and percent lean body mass (% LBM) and one physical parameter, viz, back strength (BS) were taken on each subject.

Anthropometric variables of the subjects were measured using the standard techniques (Lohmann *et al*. 1988) [15] 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. Knee height and length of femur was recorded in ems. 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 Wornersley (1974) [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.

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 strength and selected anthropometric variables in volleyball players and controls were given in Table 1. In volleyball players, significant sex differences ($p \leq 0.001$) were noted in all the variables studied, except BMI. When male volleyball players were compared with their control counterparts, statistically significant differences ($p \leq 0.001$) were found in all the variables studied, except WT, BMI, and KH. Female volleyball players also had significant differences ($p \leq 0.001$) in %BF and %LBM with their control counterparts.

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

Variable	VM (n=30)		CM (n=30)		VF (n=30)		CF (n=31)		F value	P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
HT (cm)	181.93	6.37	170.60	5.88	160.47	6.053	159.175	6.05	12.93	0.001
WT (kg)	69.09	9.98	64.38	8.03	5.97	7.64	51.83	8.97	10.15	0.001
BMI (kg/m^2)	20.67	2.46	22.15	3.56	19.81	2.76	20.46	3.80	5.441	0.006
KH (cm)	44.95	1.66	44.40	1.53	40.43	1.52	40.04	1.54	1.82	0.093
LOF (cm)	43.34	3.24	41.67	2.17	39.54	1.93	39.20	2.84	1.87	0.095
%BF	16.44	3.85	24.50	4.75	23.46	5.24	31.97	9.58	15.61	0.001
%LBM	83.56	3.85	75.50	5.57	76.54	5.24	68.01	9.59	14.74	0.001
BS (kg)	164.74	8.74	130.40	7.37	70.01	8.66	68.08	9.28	86.63	0.001

VM = volleyball males, CM = control males, VF = volleyball females, CF = control females, HT = Height, WT = Weight, BMI = Body mass index, KH = knee height, LOF = length of femur, %BF = percent body fat, % LBM = percent lean body mass, BS = back strength.

Bivariate correlations of back strength with selected anthropometric variables were examined in volleyball players in Table 2. Back strength had significantly positive correlations ($p \leq .01$) with HT, WT, KH, LOF and % LBM, whereas significantly negative correlations were found in %BF.

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

Variables	HT	WT	BMI	KH	LOF	%BF	%LBM	BS
HT		0.583**	–0.145	0.123	0.131	–0.595**	0.587**	0.545**
WT	0.50**		0.410**	0.199	0.087	–0.281*	0.283*	0.699*
BMI	0.233	0.883		0.054	0.062	0.624**	–0.615**	0.155
KH	0.341**	0.231*	0.133		0.422**	0.111	0.124	0.209*
LOF	0.339**	0.289*	0.163	0.398**		0.149	0.165	0.388**
%BF	–0.499**	0.214	–0.562**	0.194	0.182	–0.963**		0.527**
BS	0.752**	0.652**	0.373**	0.726*	0.297*	–0.425**	0.431**	

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

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, ± 6.37) was greater than the male volleyball players of West Bengal, India (173.10 cm ± 4.19) (Bandhyopadhyay 2007) [2], but lesser than the English (191.00 cm ± 5.0) (Duncan *et al*. 2006) [4], while in female players, the mean height (160.47 cm, ± 6.05) was lesser than the American (176.70 cm, ± 4.60) (Feris *et al*. 1995) and Japanese (168.70 cm, ± 5.89) (Tsunawake *et al*. 1995) [23] 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, volleyball 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 the volleyball players. It was found too, that back strength had significantly positive correlations ($p<0.01$) with HT, WT, KH, LOF and %LBM and negative correlations ($p<0.01$) with %BF in volleyball players. The findings of the study reflected that the above mentioned variables had significant contributions for the back strength of the players. In fact, jumping and landing require great 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 cricketers (Koley *et al*. 2010) [12] and physical laborers (Roy and Pal 2001) [19].

Body composition greatly affects the energy-related physical strength and skill in various sports (Kitagawa *et al*. 1974) [11]. In volleyball players, the estimated %BF was lower than controls in both sexes which followed the findings of Tsunawake *et al*. (1995) [23] and Filaire *et al*. (1998) [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.

Conclusion

From the findings of the present study, it may be concluded that significant between-group differences ($p\leq0.001$) was found in all the variables between volleyball players of both the sexes and controls. In volley players, significantly positive correlations ($p\leq0.01$) were found between back strength and height, weight, knee height, length of femur and percent lean body mass, whereas significantly negative correlations ($p\leq0.01$) were found in percent body fat. The data presented in the present study carry immense practical application and should be useful in training program development of the game.

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