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Anthropometric, Physical Strength, Body Composition and Performance Test Profiles of Inter-District Level Male Cricketers of Punjab, India

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ABSTRACT The purpose of this study was to evaluate the anthropometric, physical strength, body composition and performance test variables of inter-district level male cricketers of Punjab, India, and the associations of these variables among themselves. To serve this purpose, twenty variables, viz. ten anthropometric characteristics, four physical strength variables, three body composition components and three performance tests were performed on purposively selected 271 inter-district level male cricketers with mean age 21.54 years, ± 3.67, collected from six districts of Punjab, viz. Amritsar (n=53), Bathinda (n=44), Chandigarh (n=42), Jalandhar (n=37), Ludhiana (n=47) and Patiala (n=48). The inter-district male cricket championship was held in Ludhiana in October, 2010. In results, one way analysis of variance showed significant between-group differences ($p \leq .05$ - .000) in weight, BMI, reaction time, curl-up, push-up, triceps, subscapular, abdomen and mid-thigh skinfolds, body density and percent body fat among the cricketers of six districts of Punjab. Majority of anthropometric characteristics and physical strength variables had significantly positive correlations ($p \leq .05$ - .01) with body composition and performance test variables, showing close associations with each other.

INTRODUCTION

Cricket is a popular team game in most Commonwealth countries. In the past it was played solely in a specific season (in Asian countries it was winter and in western countries it was summer). But its popularity has gained tremendous momentum since the last few decades and now it is played throughout the year. The cricketers are exposed to more demanding schedules, with longer period of time for training and practicing (Davies et al. 2008). The increased workload may be one of the contributing factors to the increased incidence of injuries. Thus, research in this field is required to avoid the sports-specific injuries, to excel the performance of the cricketers, to strengthen the training program and to search the talents in the game.

Anthropometric dimensions and morphological characteristics play an important role in determining the success of an athlete (Reco-Sanz 1998; Keogh 1999; Wilmore and Costill 1999). It has been well established that specific physical characteristics or anthropometric profiles indicate whether the player would be suitable for the competition at the highest level in a specific sport (Claessens et al. 1999; Bourgois et al. 2000; Gabbett 2000; Reilly et al. 2000; Ackland et al.2003; Slater et al. 2005). Literature related to the anthropometric and physiological characteristics in cricketers is limited (Jones et al. 1965; Elliott and Foster 1984; Foster and Elliott 1985; Elliott et al. 1986; Stretch 1987; Foster et al. 1989; Stretch 1991; Elliott 2000; Kumar et al. 2007; Stuelcken et al. 2007; Koley and Yadav 2009; Koley et al. 2009; Nande et al. 2009; Koley et al. 2010). Stretch (1987) reported that provincial and international cricketers had a tall, athletic built, with definite morphological differences existing between batsmen, bowlers and all-rounders. The batsmen tended to be shorter and lighter, although possessing greater relative fat mass than the bowlers. The bowlers were found to be tall, with long legs, broad shoulders and a small amount of fat in the thigh and shoulder regions. The all-rounders had larger girth measurements and less relative fat than the batsmen and bowlers. The other characteristics of the all-rounders were similar to those of the other two groups. Again, studying the physical fitness profile of South African university cricketers, Stretch (1991) reported that although the cricketers were superior to sedentary subjects in the aspect of physical fitness, with the exception of flexibility, no significant differences existed between the batsmen, bowlers, all-rounders and wicket-keepers. Fur-

thermore, no significant differences existed between the provincial and non-provincial cricketers. Stuelcken et al. (2007) studied the anthropometric characteristics of elite cricket fast bowlers of Australia considering 7 skinfolds, 7 lengths, 6 breadths and 11 girths measurements and concluded that the male bowlers had larger length, breadth, and girth measurements than their female counterparts.

In Indian context, some literature is available (Kumar et al. 2007; Koley and Yadav 2009; Koley et al. 2009, 2010). Kumar et al. (2007) reported the differences in some anthropometric characteristics between the provinces of Punjab and Uttar Pradesh. Koley and Yadav (2009) and Koley et al. (2009, 2010) reported the association of handgrip strength and leg strength with certain anthropometric characteristics in Indian university level male cricketers. But information relating to relationships of anthropometric characteristics, physical strength, body composition components and performance tests among themselves in cricketers is scanty, especially in the context of inter-district level players. So, the present study was planned. In fact, for searching of talents in the sports, inter-district level competitions are the ideal platforms. In the present study, an attempt has been made to evaluate the anthropometric, physical strength, body composition and performance test variables in the inter-district level cricketers of Punjab and to establish the relationships among these variables.

MATERIALS AND METHODS

Subjects

The present cross-sectional study is based on purposively selected 271 inter-district level male cricketers of Punjab (mean 21.54 years, ± 3.67). The competition was held in Ludhiana, Punjab, India, during April-May, 2010 and the participants were from Amritsar (n=53), Bathinda (n=44), Chandigarh (n=42), Jalandhar (n=37), Ludhiana (n=47) and Patiala (n=48). The age of the subjects were recorded from the date of birth registered in their respective records. 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.

Procedure

A total of twenty characteristics, viz. ten anthropometric, that is, height, weight, BMI, biceps, triceps, subscapular, pectoral, abdominal, supra-iliac and mid-thigh skinfolds, four physical strength variables, that is, right and left handgrip strength, curl-up and push-up, three body composition components, that is, body density, percent body fat and percent lean body mass and three performance tests, that is, flexibility, speed and agility and reaction time, were taken on each subject. Anthropometric characteristics of the subjects were measured using the techniques provided by Lohmann et al. (1988) and were measured in triplicate with the median value used as the criterion.

Anthropometric Measurements

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. Skinfold measurements were taken from seven sites, viz. biceps, triceps, subscapular, pectoral, abdomen,supra-iliac and mid-thigh using Harpenden skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) to the nearest 0.2 mm.All the measurements were taken on the right side of the subject.

Physical Strength Measurements

Handgrip Strength

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 from both sides of the hands. The maximum value was recorded in kilograms. Anthropometric equipment and handgrip dynamometer were calibrated before each assessment. All subjects were tested after

3 minutes of independent warm-up. Thirty seconds time interval was maintained between each handgrip strength testing.

Upper Body Strength

This was assessed by press-ups. The cricketer was asked to do as many press ups as he could in a minute, repeated twice more with a 30 minute interval for full recovery and the best result was recorded.

Abdominal Strength and Endurance

The curl-up measured the muscular strength and endurance of the abdominal and hip-flexor muscles. Abdominal muscle strength is important for core stability and back support.The cricketer was asked to lie on a cushioned, clean surface with knees flexed and feet approximately 12 inches from their buttocks. A partner assisted by anchoring the feet to the ground. The arms were held flat across the chest, with the hands placed on opposite shoulders. The cricketer was asked to raise the trunk, keeping the arms in position, curling up to touch their elbows to thighs and then lowers back to the floor so that the shoulder blades (upper back) touch the floor. The maximum number of sit ups performed in one minute was recorded.

Scoring: The completion of one complete curl up was counted as one. It was taken into account that the subject did not "bounce" off the floor - only correctly performed curl up was counted. The timer began the test by calling out the signal "Ready? Go!" The stop watch was started at the same time, and at the conclusion of one minute the timer called out "Stop" at which counting and the subject stopped.

Body Composition Components

Body density was measured after Jackson and Pollock (1978), using the following formula:

Body density ={1.112 - (0.00043499 X Σ 7 skinfold in mm) + (0.00000055 X (Σ 7 skin fold in mm)^2} - (0.00028826 X age in years)

Percent body fat was calculated after Siri's equation (1956) followed:

Percent body fat = {(4.95/Body density) - 4.50} X 100

Percent lean body mass was calculated subtracting percent body fat from 100.

Performance Tests

Flexibility was measured by traditional sit and reach test (Well and Dillon 1952). In this test, after a brief warm-up, the cricketer was asked to sit on floor with shoes off. Cricketer placed bottom of feet (10 to 12 inches apart) against side of box (approximately 12" or 30 cm high) with knees straight. Tester placed measuring stick on box parallel to cricketer's legs; 15" or 38 cm at edge of box closest to cricketer and end of measuring stick ("0") toward subject. The cricketer placed hand over hand and reaches as far as possible over measuring stick without bending knees. Best of three tries was recorded.

Speed and agility were measured by Batter Speed Test. Using the cricket pitch as the right length and with full batting kit (including bat), the batter took three runs as quickly as possible. The time taken was recorded. Again, it was repeated 3 times with a 5 minutes interval for full recovery.

Reaction time was measured by ruler drop test.A 30cm ruler was held by the examiner between the outstretched index finger and thumb of the cricketer's dominant hand, so that the top of the cricketer's thumb was in level with the zero centimeter line on the ruler. The examiner instructed the cricketer to catch the ruler as soon as possible after it had been released. The examiner released the ruler and the cricketers caught the ruler between their index finger and thumb as quick as possible. The examiner was to record distance between the bottom of the ruler and the top of the cricketer's thumb where the ruler had been caught. The test was repeated 2 more times and the average value was used in the assessment.

The algorithm to calculate the reaction speed was $d = vt + \frac{1}{2}at^2$ where, d = distance in meters, v = initial velocity = 0, a = acceleration due to gravity = 9.81m/s^2 and t = time in seconds. It was needed to manipulate $d = vt + \frac{1}{2}at^2$ to give an algorithm for t = Sqrt (2d/a).

Data Analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. One way analysis of variance was tested for the district-wise comparisons of data among inter-district male cricketers of Punjab, followed by post hoc Bonferroni

test. Pearson's correlation coefficients were applied to establish the relationships among the variables measured. 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 AND DISCUSSION

Descriptive statistics of anthropometric variables in inter-district cricketers of Punjab are shown in Table 1. One way analysis of variance showed significant between-group differences ($p \leq .01$ - .000) in weight, BMI, reaction time, curl-up, push-up, triceps, subscapular, abdomen and mid-thigh skinfolds, body density and percent body fat among the cricketers of the six districts of Punjab.

Table 2 showed the correlation coefficients of the variables among themselves. Among anthropometric characteristics, height had significantly positive correlations ($p \leq .01$) with weight, right and left handgrip strength and percent lean body mass. Weight and BMI had significantly positive correlations ($p \leq .01$) with all the variables studied, except flexibility, speed and agility, reaction time, curl-up, push-upand body density. Among body composition components, percent body fat had significantly positive correlations($p \leq .01$) with all the variables, except height, right handgrip strength, reaction time and curl-up, and percent lean body mass had significantly positive correlations($p \leq .01$) with all the variables, except flexibility, speed and agility, reaction time, curl-up and push-up. Among the physical strength variables, right and left handgrip strength had significantly positive correlations ($p \leq .05$-.01) with all the variables, except almost all the skinfold measurements and percent body fat. Curl-up had positive correlations ($p \leq .05$-.01) with flexibility, both right and left handgrip strength and push-up, whereas, push-up had significantly negative correlations ($p \leq .05$-.01) with speed and agility, both right and left handgrip strength, curl-up and all skinfold measurements and percent body fat. Among performance tests, reaction time had significantly negative correlations($p \leq .05$)only with right handgrip strength, whereas, flexibility had significantly positive correlations($p \leq .05$-.01) with both right and left handgrip strength, curl-up and body density and significantly negative correlations ($p \leq .05$-.01) with speed and agility,all the skinfold measurements and percent body fat. Speed and agility had significantly positive correlations($p \leq .05$-.01) with all the skinfold measurements and percent body fat and significantly negative correlations ($p \leq .05$-.01) with flexibility, both right and left handgrip strength, curl-up, push-up and body density.

Cricket is a field-based endurance game. Although all are required to bat and field during the match, generally, each player possesses specific skills that defines their role and contributes to overall performance of the game (Stuelcken et al. 2007). In the present study, an attempt was made to evaluate the anthropometric, physical strength, body composition and performance test variables in the inter-district level male cricketers of Punjab and to establish the relationships among these variables. In fact, these inter-district level competitions are the ideal platforms to search the budding talents.

Cricketers of Ludhiana district were recorded to be the tallest (189.99 cm) and cricketers of Jalandhar district were the heaviest (72.58 kg) among the participants. Significant between-group differences ($p < .05$ - .000) were found in weight, reaction time, curl-up, push-up, triceps, subscapular and abdominal skinfolds, body density and percent body fat. These differences were might be, due to the smaller sample size and mean age differences. Majority of anthropometric characteristics and physical strength variables had significantly positive correlations with body composition and performance test variables, showing close association with each other. The data could not be compared due to lack of the other reported study of the same level of competitions. However, earlier, Koley and Yadav (2009) reported that in Indian inter-university male cricketers, right handgrip strength had significantly positive correlations with height ($r = 0.383$), weight ($r = 0.498$), BMI ($r = 0.401$), triceps skinfold ($r = 0.278$), subscapular skinfold ($r = 0.266$), percent body fat ($r = 0.401$), arm muscle girth ($r = 0.513$), arm muscle area ($r = 0.506$), arm area ($r = 0.493$), arm fat area ($r = 0.326$), and negative correlation with percent lean body mass ($r = -0.400$). More research is required in this direction.

CONCLUSION

It might be concluded from the present study that anthropometric characteristics, physical strength variables, body composition compo-

Table 1: Descriptive statistics of selected anthropometric, physical strength, body composition and performance test variables in inter-district level male cricketers of Punjab

Variables	*Amritsar (n=53)*		*Bathinda (n=44)*		*Chandigarh (n=42)*		*Jalandhar (n=37)*		*Ludhiana) (n=47)*		*Patiala (n=48)*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
*Age (years)**	21.00	2.87	22.23	2.92	21.43	4.56	21.22	3.36	22.81	4.53	20.63	3.19
Height (cm)	178.88	6.31	180.9	5.70	179.65	7.90	178.4	6.94	180.9	7.62	178.3	7.32
*Weight (kg)**	67.25	9.24	70.16	9.76	68.94	11.57	72.58	10.41	70.90	10.92	66.17	10.07
*BMI (kg/m^2)**	20.99	2.49	21.4	2.42	21.61	3.37	22.74	2.66	21.55	2.47	20.79	2.81
Flexi-bility	8.35	6.82	5.40	7.33	5.12	6.94	6.15	7.36	5.82	6.40	7.83	7.69
Speed and agility	10.54	0.49	10.50	0.45	10.67	0.57	10.44 1	0.49	10.54	0.60	10.51	0.45
Rt hand-grip strength (kg)	47.53	6.29	48.23	6.74	46.38	6.80	47.51	6.05	46.72	8.51	47.19	5.63
Lt hand-grip strength (kg)	46.42	6.12	47.98	5.88	46.19	7.61	48.59	7.11	45.87	8.46	44.98	7.90
*Reaction time (sec)***	0.17 85	0.018 23	0.18 45	0.018 23	0.178 3	0.0186 0	0.17 11	0.017 29	0.18 11	0.018 91	0.17 02	0.019 07
*Curl-ups per minute ***	39.98	6.71	44.48	6.04	42.83	9.19	51.11	9.22	41.85	9.07	45.88	9.37
*Push-ups per minute **	36.70	10.09	39.61	5.44	42.02	15.28	42.22	6.36	34.49	9.01	38.29	13.48
Biceps skinfold (mm)	7.44	2.40	7.95	2.94	8.56	3.67	9.43	3.25	8.28	2.48	8.31	3.15
*Triceps skinfold (mm)**	13.18	3.56	16.00	4.09	15.40	5.18	15.97	4.73	15.39	5.01	13.92	5.10
*Subsca-pular skinfold (mm)**	12.97	2.65	14.19	3.81	13.90	4.16	15.73	3.70	14.51	4.06	13.13	3.95
Pectoral skinfold (mm)	13.14	5.11	15.81	5.81	14.30	6.42	15.76	6.11	15.91	6.67	13.78	5.55
*Abdomen skinfold (mm)***	24.57 7	8.36	26.92 2	9.73	27.35	11.54	31.81 1	11.59	29.50 0	10.43	22.63 3	10.51
Supra-iliac skinfold (mm)	13.64	6.55	15.38	7.36	13.96	6.89	15.91	6.27	13.83	5.15	13.67	6.14
*Mid-thigh skinfold (mm)***	18.58	7.53	24.10	8.22	22.85	8.91	24.54	8.71	23.24	8.60	19.46	7.01
*Body density**	1.067	0.009	1.062	0.010	1.064	0.013	1.060	0.012	1.062	0.012	1.067	0.012
*Percent body fat (%)**	13.84	3.923	16.22	4.576	15.46	5.79	17.17	5.24	16.27	5.41	13.89	5.033
Percent lean body mass (%)	55.6	5.93	57.7	6.20	56.60	7.33	58.42	6.52	58.14	7.27	54.88	6.27

**. ANOVA is significant at the 0.01 level (2-tailed).
* . ANOVA is significant at the 0.05 level (2-tailed).

Table 2: Correlation matrix of selected anthropometric, physical strength, body composition and performance test variables in inter-district level male cricketers of Punjab

Variables	*HT*	*WT*	*BMI*	*FLEX*	*SA*	*HGR*	*HGL*	*RT*	*CU*	*PU*	*B*	*T*	*SS*	*PEC*	*AB*	*SI*	*TH*	*BD*	*PBF*	*PLBM*
HT	1	.536**	.037	.041	-.037	.334**	.339**	-.009	.028	-.069	.031	.026	.108	.072	.054	.042	.027	-.069	.069	.681**
WT		1	.857**	-.005	.054	.401**	.453**	-.053	.066	.008	.463**	.465**	.524**	.515**	.574**	.420**	.494**	-.602**	.602**	.981**
BMI			1	-.023	.079	.283**	.337**	-.054	.060	.068	.529**	.537**	.551**	.567**	.644**	.470**	.564**	-.669**	.669**	.748**
FLEX				1	-.226**	.124*	.140*	.010	.161**	.117	-.201**	-.167**	-.152*	-.151*	-.248**	-.200**	-.294**	.243**	-.244**	.005
SA					1	-.246**	-.218**	.013	-.212**	-.154*	.244**	.238**	.258**	.264**	.300**	.280**	.316**	-.290**	.292**	.033
HGR						1	.767**	-.136*	.212**	.159**	.057	.051	.116	.093	.050	.128*	.041	-.118	.116	.419**
HGL							1	-.082	.203**	.142*	.101	.058	.118	.108	.114	.167**	.083	-.164**	.162**	.464**
RT								1	-.095	-.014	-.023	.025	-.034	-.032	-.010	-.061	.043	.005	-.006	-.043
CU									1	.413**	-.042	-.010	-.036	-.074	-.035	-.041	-.079	.056	-.056	.067
PU										1	-.155*	-.120*	-.146*	-.139*	-.116	-.133*	-.120*	.139*	-.140*	-.005
B											1	.734**	.655**	.654**	.710**	.675**	.682**	-.800**	.802**	.396**
T												1	.650**	.671**	.740**	.648**	.738**	-.835**	.835**	.408**
SS													1	.763**	.750**	.657**	.639**	-.831**	.832**	.474**
PEC														1	.777**	.700**	.672**	-.875**	.875**	.456**
AB															1	.694**	.739**	-.922**	.922**	.507**
SI																1	.670**	-.823**	.824**	.359**
TH																	1	-.860**	.861**	.430**
BD																		1	-1.000**	-.531**
PBF																			1	.531**
PLBM																				1

**. Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed).

HT – Height (cm), WT – Body Weight (kg), BMI – Body Mass Index (Kg/m2), FLEX – Flexibility, SA –Speed and agility, HGR – Right hand grip strength, HGL – Left hand grip strength, RT – Reaction time, CU – Curl-ups, PU – push-ups, B – Biceps skinfold (mm), T – Triceps skinfold (mm), SS – Subscapular skinfold (mm), PEC – Pectoral skinfold (mm), AB – Abdomen skinfold (mm), SI – Suprailiac skinfold (mm), TH – Mid-thigh skinfold (mm), BD – Body density, PBF – Percent body fat, PLBM – Percent lean body mass.

nents and performance tests were closely associated with each other in the inter-district level male cricketers of Punjab.The findings of the present study would be helpful to search the talents in cricket, to organize the training program, to excel the performance of the cricketers and also to avoid sports-specific injuries.

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