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POSITION-WISE ANTHROPOMETRIC MODELS FOR PREDICTION OF PLAYING ABILITY AMONG ELITE INDIAN BASKETBALL PLAYERS

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Abstract: The purpose of this study was to predict the role of a number of anthropometric characteristics in performance of Indian youth elite Basketball players with special reference to their playing positions. Two hundred and seventy six (age, 15.1 ± 1.3 years) youth elite male Basketball players from 23 states of India participated in the 26th Lakadawala Youth National Basketball Championship at Mastan YMCA, Mumbai from 9th to 16th May 2009, were selected as the subjects. The selected subjects were divided into three groups according to their playing positions namely Guard **(GD = 72)**, Forward **(FD = 126)** and Centre **(CR = 78)**. The selected anthropometric variables namely *Body weight*, **Skinfold measurements (mm)** - *Biceps, Subscapular, Triceps, Supraspinale, Abdominal, Illiac Crest, Front Thigh and Medial Calf;***Girth measurements (cm)** - *Arm girth relaxed, Arm girth flexed and Calf girth*; **Length measurements (cm)** - *Standing height, Arm span, Arm length, Leg length* and **Breadth measurements (cm)** - *Humerus breadth and Femur breadth* as the independent variables were taken for this study. The data were collected by following standard testing protocal of International Society for the Advancement of Kinanthropometry (*ISAK*) during the competition by scientifically approved equipments. The criterion variable, playing ability of the selected Basketball players are assessed by three qualified Basketball coaches. To determine the relationship between the selected anthropometric variables and the coaches rating on playing ability, the coefficient of correlation was used. Anthropometric variables that statistically correlated with performance were used to form respective linear predictive models (stepwise argument selection) with special reference to their playing positions for predictive equation development. The results revealed that there was a strong correlations (r = 0.9) exists between the playing ability versus height, weight, arm length, arm span, leg length and flexed arm girth among all the playing positions.

Keywords: Kinanthropometry, Guard, Forward, Centre and Basketball

Introduction

Anthropometric characteristics of athletes determine the success in particular sports events in various ways. The knowledge of these characteristics is necessary to establish their importance for the success in competitive sport. The research on the influence of these characteristics in sports and games are of particular complexity, because the success in the game depends, among other things, on how the individual characteristics of some players fit into the whole, thus creating a coherent team. Basketball is one of the complex technical team games and differences in performance between players of different region and varying ability levels are quit nature. The game of Basketball requires the application of variety of different abilities (Angyan, et al., 2003; Jelicic, et al., 2002).Basketball is a sport that consists of activities of short duration but high intensity during the course of the game. It is the game where all the possible loco motions are involved. Great physiological demands necessarily influence the anthropological characteristics (Duncan, et al., 2008). Specifically speaking the role played by the player in relation to the position in which he played is different from others. Further on, Basketball is the game where size, shape and body composition play an important part in providing distinct advantage for specific playing positions. A significant role also belongs to the individual features of the players' body build. Until now, only a relatively small number of variables such as height, weight (Tsunawake, 2003), proximal, mean and distal thigh circumferences (Hakkinen, 1993), and skinfolds to determine the total mass of adipose tissue (Thissen & Mayhew, 1991; Smith, et al., 1992; Hakkinen, 1993) have been studied. There is no clarity about the significance of other anthropometric characteristics and anthropometric structure of the body, as a whole, for successful game performance. Therefore, there is a need for more detailed research involving the anthropometry of youth Basketball players. The purpose of this study was to predict the role of a number of anthropometric characteristics in performance of Indian youth elite Basketball players with special reference to their playing positions.

Methods

The experimental protocol of this study was elaborated to investigate the anthropometric characteristics of youth Basketball players with special reference to their playing positions. Two hundred and seventy six (age, 15.1 ± 1.3 years) youth elite male Basketball players from 23 states of India participated in the 26th Lakadawala Youth National Basketball Championship at Mastan YMCA, Mumbai, Maharashtra state, India, from 9th to 16th May 2009, were volunteered for this study. All players were competing at various state level tournaments for approximately one year and had been specific Basketball training for 3.3 ± 0.8 years. All players had official medical clearance according to Basketball Federation of India (BFI) and were divided into three groups according to their playing positions in which they play in this competition namely Guard **(GD = 72)**, Forward **(FD = 126)** and Centre **(CR = 78)**.The selected anthropometric variables, which included *body weight, height,* three skeletal lengths, two skeletal breadths, three limb circumferences and eight skinfolds (SKF), was taken on each player. All measurements were taken by trained and qualified level one anthropometrist of International Society for the Advancement of Kinanthropometry (ISAK). Anthropometric Instruments used in this study included a stadiometer, Lufkins Anthropometric Tape, Harpendens Skinfold Caliper and electronic weighing machine. **Skinfold measurements (mm)** - *Biceps, Subscapular, Triceps, Supraspinale, Abdominal, Illiac Crest, Front Thigh and Medial Calf*; **Girth measurements (cm)** - *Arm girth relaxed, Arm girth flexed and Calf girth;***Length measurements (cm) -***Standing height, Arm span, Arm length, Leg length* and **Breadth measurements (cm)** - *Humerus breadth and Femur breadth (biepicondylar)* as the independent variables were taken for this study.

The criterion variable, playing ability of the selected Basketball players were assessed by three qualified Basketball coaches which was taken as the performance factor. Each coach will rate the playing ability of the selected players in 100 points scale for each subject. The ratings given by the coaches on each subject will be added and will be divided by three to make the individual score of the subject. The correlation between the coaches on performance ratings was highly correlated (r = 0.87). Model has been calculated, as well as correlation of all variables in the system, finally, the interpretation of the results has been done. Mean and Standard Deviation were calculated for each variables. The relationship between the selected anthropometric variables and the coaches rating on playing ability, were tested using Pearson' product-moment correlation coefficients. Anthropometric variables that statistically correlated with performance were used to form respective linear predictive models (step-wise argument selection) with special reference to their playing positions. P > 00.05 was considered to be statistically significant. The data were analyzed using statistical package SPSS 15th version.

Results

Descriptive statistics for the anthropometric characteristics of the position-wise sample are shown in the Table – 2. To predict the playing ability of the basketball players, a multiple regression analysis was performed using the predictor variables of anthropometric variables. From the table – 2, it was found that mean values of guard, forward and centre were compared, the centre players have maximum values in all most all the parameters followed by forward players and then the guard players. Table – 2 displays descriptions of the acronyms used in these analyses.

Table 2. Mean and Standard Deviation (± SD) Values of Elite Indian Basketball Players on Selected Anthropometric Variables and Playing Ability

Anthropometric Variables	Acronyms	Guard (N = 72)		Forward (N = 126)		Centre (N = 78)	
		Mean	± SD	Mean	± SD	Mean	± SD
Height	HIT	168.50	7.47	176.92	6.75	184.60	8.65
Weight	WET	54.93	6.67	60.57	7.90	66.53	6.02
Biceps	BIC	8.20	3.22	8.52	3.41	8.53	3.10
Subscapular	SUB	4.93	2.32	4.83	1.98	5.20	20.05
Triceps	TCP	8.39	1.85	8.18	1.74	8.22	2.43
Supraspinale	SUP	10.08	3.82	9.82	3.41	9.28	3.34
Abdominal	ABD	8.30	3.56	8.33	3.03	8.07	3.55
Illiac Crest	ICT	11.04	4.22	10.66	3.86	10.24	4.14
Front Thigh	FTH	10.51	3.47	10.26	3.79	10.50	3.46
Medial Calf	MCF	7.50	2.76	7.03	1.93	7.19	1.90
Arm girth relaxed	AGR	22.44	1.95	23.10	1.89	23.22	1.77
Arm girth flexed	AGF	25.25	2.51	25.69	2.38	26.08	2.24
Calf girth	CFG	31.00	4.11	31.21	3.84	31.38	4.14
Arm span	ASP	173.95	7.96	181.79	7.17	191.07	8.80
Arm length	ALH	75.18	8.88	79.81	3.34	83.25	3.81
Leg length	LLH	102.08	5.36	111.30	16.66	113.71	10.53

Humerus breadth	HUB	6.71	0.65	7.08	0.67	7.53	0.78
Femur breadth	FEB	8.77	0.57	9.23	0.70	9.52	0.64
Coaches Rating	CRT	66.48	11.49	69.76	11.26	74.53	9.97

The present study attempted to link the coaches rating as measure of playing ability with the anthropometric characteristics of Basketball players of elite youth group, correlation analysis was made. Table – 3 displays a correlation matrix among each of the variables used in the study and shows the correlation coefficient associated with each other.

Table 3. Inter-Correlation of Selected Anthropometric Variables with the Playing Ability of Youth Elite Basketball Players

V	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}
C	**.90**	**.92**	**.30**	**.43**	**.61**	**.23**	**.86**	**.59**	**.62**	**.12**	**.89**	**.90**	**.90**	**.81**	**.84**	**.60**	**.96**	**.88**
X_1		**.96**	**.25**	**.45**	**.69**	**.12**	**.75**	**.49**	**.53**	**.06**	**.91**	**.98**	**.86**	**.70**	**.77**	**.46**	**.94**	**.76**
X_2			**.31**	**.50**	**.72**	**.17**	**.73**	**.51**	**.57**	**.30**	**.89**	**.97**	**.90**	**.68**	**.75**	**.45**	**.96**	**.76**
X_3				**.96**	**.73**	**.95**	**.35**	**.72**	**.73**	**.62**	**.35**	**.23**	**.61**	**.37**	**.29**	**.32**	**.31**	**.40**
X_4					**.83**	**.88**	**.42**	**.73**	**.77**	**.54**	**.15**	**.44**	**.72**	**.45**	**.39**	**.35**	**.47**	**.49**
X_5						**.59**	**.39**	**.59**	**.65**	**.12**	**.38**	**.62**	**.77**	**.34**	**.35**	**.10**	**.70**	**.45**
X_6							**.36**	**.72**	**.72**	**.72**	**.21**	**.17**	**.52**	**.39**	**.28**	**.38**	**.21**	**.41**
X_7								**.68**	**.69**	**.44**	**.79**	**.78**	**.84**	**.97**	**.96**	**.88**	**.79**	**.98**
X_8									**.73**	**.52**	**.35**	**.49**	**.75**	**.68**	**.62**	**.61**	**.56**	**.71**
X_9										**.53**	**.38**	**.55**	**.78**	**.68**	**.62**	**.58**	**.59**	**.71**
X_{10}											**.58**	**.78**	**.33**	**.52**	**.41**	**.63**	**.28**	**.45**
X_{11}												**.93**	**.74**	**.74**	**.83**	**.56**	**.92**	**.80**
X_{12}													**.86**	**.75**	**.82**	**.55**	**.92**	**.88**
X_{13}														**.81**	**.83**	**.63**	**.91**	**.88**
X_{14}															**.96**	**.93**	**.72**	**.96**
X_{15}																**.89**	**.79**	**.96**
X_{16}																	**.47**	**.87**
X_{17}																		**.82**

C - Playing Ability
X_1 - Height
X_5 - Triceps skinfold
X_6 - Supraspinale
X_{10} - Medial Calf
X_{11} - Arm length
X_{15} - Femur breadth
X_{16} - Arm girth relaxed

X_2	- Weight	X_7	- Abdominal	X_{12}	- Arm span	X_{17}	- Arm girth flexed
X_3	- Biceps Skinfold	X_8	- Illiac Crest	X_{13}	- Leg length	X_{18}	- Calf girth
X_4	- Subscapular skinfold	X_9	- Front Thigh	X_{14}	- Humerus breadth		

Table – 3 shows that there was a strong correlations ($r \geq 0.9$) exists between the playing ability versus height, weight, arm length, arm span, leg length and flexed arm girth. These variables turned to be influential characteristics with reference to the playing ability – determinants of youth Basketball players as the whole. Each variable represented not only a concrete measurement of the anthropometric characteristics of Basketball players, but also particularly represented body type as the whole. Thus, the peculiarities of the whole body can be represented by height, weight, arm length, arm span, leg length and flexed arm girth, as well as by different combinations of other variables or in combinations with other measurements. Thirteen of eighteen anthropometric variables significantly correlated to playing ability of youth basketball players. Next, by means of stepwise selection, the best models of linear regression for predicting the playing ability of the game Basketball were found with special reference to the playing positions as well as in general classifications. In each model, only the variable that achieved significance with the cut-off criteria set at probability of F < equal to or less than 0.001, 0.01 and 0.05 level was listed. The predictor variables and their importance in predicting the playing ability of youth basketball players sample by playing positions are presented in the tables 4, 5, 6 and 7 respectively.

Table 4. Stepwise Regression Analysis of Playing Ability for Guard Elite Indian Basketball Players

Variables		R^2	Unstandardized Coefficients Std Error		Standardized Coefficients Beta
			b	SE b	β
Step 1	**Constant**		- 38.137	2.267	
	WET	**.744**	1.838	0.078	0.784***
Step 2	**Constant**		- 0.542	6.470	
	WET		1.330	0.089	0.714***
	ABD	**.741**	- 0.795	0.172	0.290**
Step 3	**Constant**		- 9.303	6.731	
	WET		1.187	0.097	0.636***
	ABD		- 0.662	0.131	- 0.241**
	AGF	**.724**	0.0618	0.200	0.134*
Step 4	**Constant**		-15.532	7.263	
	WET		1.115	0.950	0.651**
	ABD		- 0.585	0.134	0.213*
	AGF		0.633	0.195	0.138*
	ALH	**.712**	0.045	0.022	0.034*

(n=72):(R^2 = .744 for step 1: ΔR^2 = .032 for final step)Significant at *** p <0.001, ** p <0.01, * p < 0.5.

Playing Ability = -15.532+ 1.115 (WET) - 0.585(ABD) + 0.633 (AGF) 0.045 (ALH)

Table –4 shows the regression analyses for guard basketball players in the sample. Among the anthropometric variables, weight scores accounted for 74 % in the first model of the performance ability. The abdominal skinfold, arm girth flexed and arm length subsequently added significantly (0.01, and 0.05 level) to the prediction of the guard basketball players up to the final model. The R^2 value for the combination of weight, abdominal skinfold, arm girth flexed and arm length on playing ability was .712 (71%) with the R^2 change ($\Delta \mathbf{R^2}$) .032 for the final model.

Table 5. Stepwise Regression Analysis of Playing Ability for Forward Elite Indian Basketball Players

Variables		R^2	Unstandardized Coefficients Std Error		Standardized Coefficients Beta
			b	SE b	β
Step 1	Constant		-2170.012	7.559	
	HIT	.658	1.627	.043	.671**
Step 2	Constant		-207.633	8.452	
	HIT		1.621	.042	.656**
	ABD	.652	-.361	.155	-0.058*
Step 3	Constant		-192.782	10.904	
	HIT		1.620	.042	.642*
	ABD		-.375	.153	-.060*
	AGF	.647	-.178	.084	-0.052*

(n=126):(R^2 = .658 for step 1: ΔR^2 = 0.011 for final step)Significant at *** p <0.001, ** p <0.01, * p < 0.5.

Playing Ability = -192.782 + 1.620 (HIT) -.375 (ABD) -.178 (AGF)

Table – 5 shows the regression analyses for forward basketball players in the sample. Among the anthropometric variables, height scores accounted for 65 % in the first model of the performance ability. The abdominal skinfold and arm girth flexed subsequently added significantly (0.001, 0.01, and 0.05 level) to the prediction of the forward basketball players up to the final model. The R^2 value for the combination of height, abdominal skinfold and arm girth flexed on playing ability was .647 (65%) with the R^2 change (ΔR^2) 0.011 for the final model.

Table 6. Stepwise Regression Analysis of Playing Ability for Center Elite Indian Basketball Players

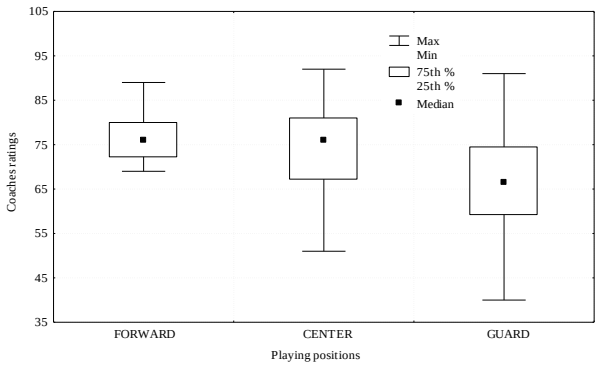
Variables		R^2	Unstandardized Coefficients Std Error		Standardized Coefficients Beta
			b	SE b	β
Step 1	**Constant**		-86.333	21.483	
	ASP	**.803**	.859	.118	.822***
Step 2	**Constant**		-114.336	23.030	
	ASP		.536	.160	.341**
	HIT	**.794**	.490	.170	.294**
Step 3	**Constant**		-108.868	22.902	
	ASP		.720	.183	.458**
	HIT		.413	.172	.248**
	FEB	**.787**	-2.743	1.350	-.173**
Step 4	**Constant**		-91.689	23.864	
	ASP		.631	.184	.402*
	HIT		.379	.170	.228*
	FEB		-4.149	1.475	-.261*
	WET	**.781**	.296	.135	.208*

(n=78):(R^2 = .803 for step 1: ΔR^2 = .022 for final step)Significant at *** p <0.001, ** p <0.01, * p < 0.5.

Playing Ability = -91.689 + .631 (ASP) + .379 (HIT) -4.149 (FEB) + .296 (WET)

Table – 6 shows the regression analyses for center basketball players in the sample. Among the anthropometric variables, arm span scores accounted for 80 % in the first model of the performance ability. The height, femur breadth and weight subsequently added significantly (0.001, 0.01, and 0.05 level) to the prediction of the forward basketball players up to the final model. The R^2 value for the combination of arm span, height, femur breadth and weight on playing ability was .803 (80%) with the R^2 change ($\Delta \mathbf{R^2}$) .022 for the final model. The range of the playing ability (coaches rating) for the guard players were 91 to 48 with the mean value of 66.48 where as for the forward and center players, 89 to 49 : 92 to 51 with the mean values of 74.2 and 74.54 respectively. From the figure – 1, it was observed that the range of the playing ability in terms of coaches rating among the playing positions were GD > CR > FD, where as among the median values of coaches rating on playing ability were CR > FD > GD respectively. It can be concluded that the forward and center basketball players can be utilized their playing positions interchangeably if their morphological characteristics required for this positions were met.

Fig. 1:Box Plot Showing the Coaches Rating of Elite Indian Basketball Players



Discussion

This study has provided the most comprehensive predictions of anthropometric characteristics in relation to different positional roles of elite Indian youth male Basketball players. The present study indicated that a strong relationship exists between playing ability versus height, weight, arm length, arm span and flexed arm girth. The positional roles of Basketball players can be characterised by the heterogeneity expressed with the teams, between the players regional classification, age, competitive level, training methods etcetera. However, in modern sport, particularly Basketball, professional experience and mature tactical judgment have become important factors of performance excellence (Ostojic, et. al, 2003). The average age of Indian Youth Basketball players was 15.1 ± 1.3 years. Today, professional players do seem prepared to stay in the game for longer than was traditional. This is probable due to fact that professional level of game-play requires competent and well-versed players and commercial attractions of maintaining players' career as long as possible. Unique types of body size and proportion may constitute important prerequisites for successful participation in Basketball. We found that centres are significantly taller and heavier than the guards followed by the forwards. On the one hand, because the game involves physical contact with the intention of getting the ball in a basket elevated 30.05 meters above the ground level, physical attributes of centre players could help them to dominate in a low-post position, which involves box-out, picks, and rebounding. The shorter the Centre, the higher he has to jump in order to play successfully in this restricted area zone near the basket. On the other hand, the playmakers (guards)

with the lower mass, height and body fat percentage are the most skillful players and are used to set up attacks that are sometimes completed by the taller players (Ziv and Lidor, 2009).

The results of this investigation indicate the need for more comprehensive anthropometric studies of young Basketball players. The available literature did not contain any analogous data that could have been used for comparison. Future, the analysis of young Basketball players' anthropometric characteristics by various other complex testing programs will facilitate the better selection of promising players and also will be useful in evaluating the performance enhancement of the whole team. More research must be done before definitive inference can be made; however, the results of the present study demonstrated the relationship between the playing ability with the anthropometric characteristics according to the nature of the game and positional role in Basketball. Certain qualities are prerequisite and an advantage for playing Basketball at elite level, according to positional role. Profiling may be useful in player selection and development of sport-specific training programmes, because some variables cannot be affected by conditioning (e.g., body size and proportion) and others are quite trainable (e.g., endurance capacity, anaerobic power). Being a top level Basketball players is a complex function of genetics endowment, training, and health status (e.g., injury, diet, drugs), as well as physical, physiological, psychological, sociological, skill acquisition and other capabilities.

Conclusions

The results obtained in the present study illustrated the formation of anthropometric optimum predictive equation models in male Basketball players across the position-wise classifications. From the analysis of data, it was concluded that height and arm girth flexed becomes the common anthropometrical characteristics to be required for the basketball players to Indian context irrespective of the playing positions. Anthropometric characteristics were related to hereditary and trait efficiency, describing three types of Indian youth elite male Basketball players, i.e. those have greater arm span, femur breadth, height and weight (Centre players); those have greater body compositions height, weight and abdominal skinfold (Forward players) and those have lesser length measurements and body compositions weight, abdominal skinfold, arm girth flexed and arm length (more efficient in passing and dribbling; guard players). Based on the results collected in the present study and those reported by Delextrat et al., *(2009)*, Ben, et.al, (2010) and Metaxas, et.al, (2009) on the anthropometric characteristics of Basketball players with position-wise analysis, a model of selection in male Basketball players could be established.

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