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# Optimizing Position-wise Anthropometric Models for Prediction of Playing Ability among Elite Indian Basketball Players

J. Viswanathan[1] & Dr. K. Chandrasekaran[2]

[1]Research Scholar, Department of Physical Education, Bharathidasan University, Tiruchirappalli, Tamil Nadu State, INDIA

[2]Associate Professor, Department of Physical Education, Bharathidasan University, Tiruchirappalli, Tamil Nadu State, INDIA

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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

## 1. 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

[1] Corresponding Author: Research Scholar, Department of Physical Education, Bharathidasan University, Tiruchirappalli – 620 024, Tamil Nadu State, INDIA. *E-mail address*: viswa3434@gmail.com

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.

# 2. Methods

## 2.1. Experimental Approach to the Problem

The experimental protocol of this study was elaborated to investigate the anthropometric characteristics of youth Basketball players with special reference to their playing positions. By this an attempt was made to obtain a description of physical dimensions of players those who are playing high level competitions (national level) through anthropometric profiling and then assess the relative importance of these body dimensions by comparing the players with special reference to their field positions in which they play in the game of Basketball. Therefore, a wide range of tests has been administered to produce a detailed analysis of the players' anthropometric profile; they were selected for their relevance to the efforts experienced in Basketball and their use in scientific studies on Basketball players.

## 2.2. Subjects

Two hundred and seventy six (age, 15.1 ± 1.3 years) youth elite male Basketball players from 23 states of India participated in the 26$^{th}$ Lakadawala Youth National Basketball Championship at Mastan YMCA, Mumbai, Maharashtra state, India, from 9$^{th}$ to 16$^{th}$ 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)**.

## 2.3. Procedures

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. The standardized testing protocol was used to collect the relevant data. **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.

## 2.4. Performance Evaluation

The criterion variable, playing ability of the selected Basketball players were assessed by three qualified Basketball coaches which was taken as the performance factor. The guidelines for assessment were provided by the investigators. 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.

## 2.5. Statistical Analysis

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 and regional classifications. P > 00.05 was considered to be statistically significant. The data were analyzed using statistical package SPSS 15th version.

Table 1. Selection of Variables and Test Descriptions

| Anthropometric Variables | Unit of Measure | Test Description | Instrument used |
|---|---|---|---|
| Height | centimeter | Maximum distance from the floor to the highest point on the head (apex), when the subject is facing directly ahead and stands erect. | Seca Stadiometer |
| Weight | kilogram | Stand erect on the weighing machine with bare foot. | Bathroom Weighing Machine |
| Skinfold - Biceps | millimeter | The anterior mid surface of the upper arm | Harpenden Skinfold Caliper |
| - Subscapula | millimeter | Undermost tip of the inferior angle of the scapula | |
| - Triceps | millimeter | The posterior surface of the upper arm | |
| - Supraspinale | millimeter | Lateral section of the abdominal region | |
| - Abdominal | millimeter | The 5 cm horizontally to the right hand side of the mid point of the navel | |
| - Illiac Crest | millimeter | The most inferior part of the tip to the anterior superior iliac spine | |
| - Front Thigh | millimeter | The mid – point of the linear distance between the Inguinal point and the patellare. | |
| - Medial Calf | millimeter | The medial aspect of the calf at the level of the maximal girth | |
| Arm girth relaxed | centimeter | Circumference of the arm at the level of the mid – acromiale – radiale site | Lufkin anthropometric tape |
| Arm girth flexed | centimeter | Circumference of the arm perpendicular to the long axis of the arm at the level of the peak contracted biceps brachii. | |
| Calf girth | centimeter | Circumference of the leg at the level of the medial calf site. | |
| Arm Span | centimeter | The measurement of the length from one end of an individual's arms (measured at the fingertips) to the other when raised parallel to the ground at shoulder height at a one-hundred eighty degree angle. | |
| Arm Length | centimeter | Linear distance between the acromiale and wrist | |
| Leg Length | centimeter | The vertical distance between the Trochanterion to the base of the foot | |
| Humerus Breadth | centimeter | Linear distance between lateral aspect of the epicondyle and the medial aspect of the humeral epicondyle | Campbell small bone caliper |
| Femur Breadth | centimeter | Linear distance between the lateral aspect of the lateral femoral epicondyle and the medial aspect of the femoral epicondyle. | |

## 3. 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 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 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 | $X_5$ | - Triceps skinfold | $X_{10}$ | - Medial Calf | $X_{15}$ | - Femur breadth |
| $X_1$ | - Height | $X_6$ | - Supraspinale | $X_{11}$ | - Arm length | $X_{16}$ | - 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 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: $\Delta R^2$ = .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: $\Delta R^2$ = 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 ($\Delta\mathbf{R^2}$) 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: $\Delta R^2$ = .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.

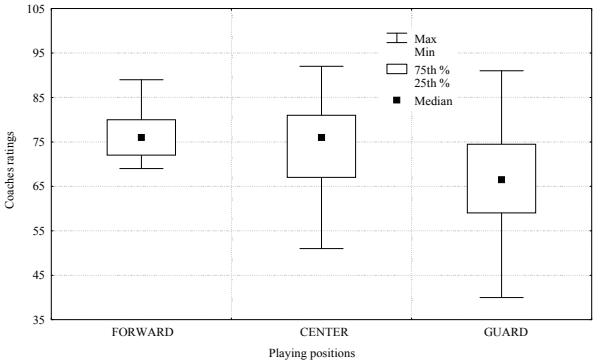


Fig. 1:Box Plot Showing the Coaches Rating of Elite Indian Basketball Players

# 4. 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.

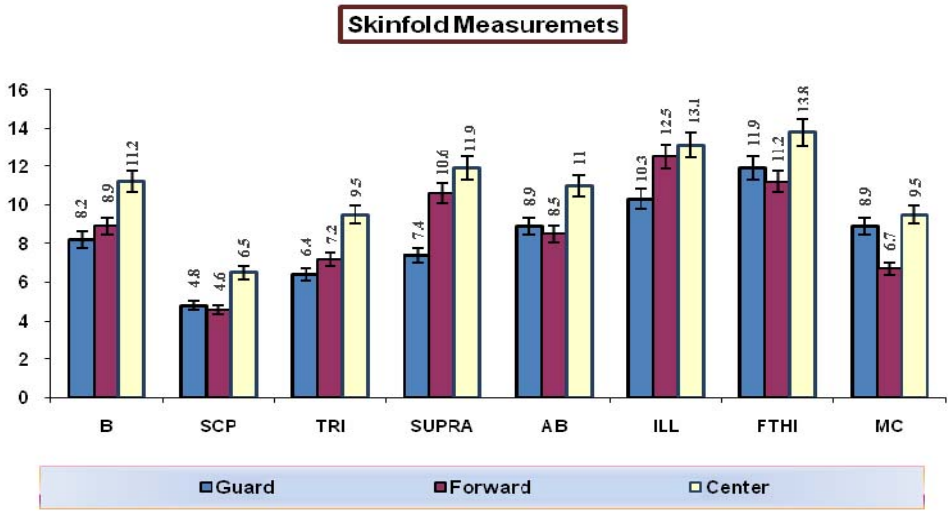


Fig.2:Error Bar diagram showing the skin fold measurements of Elite Indian Basketball Players

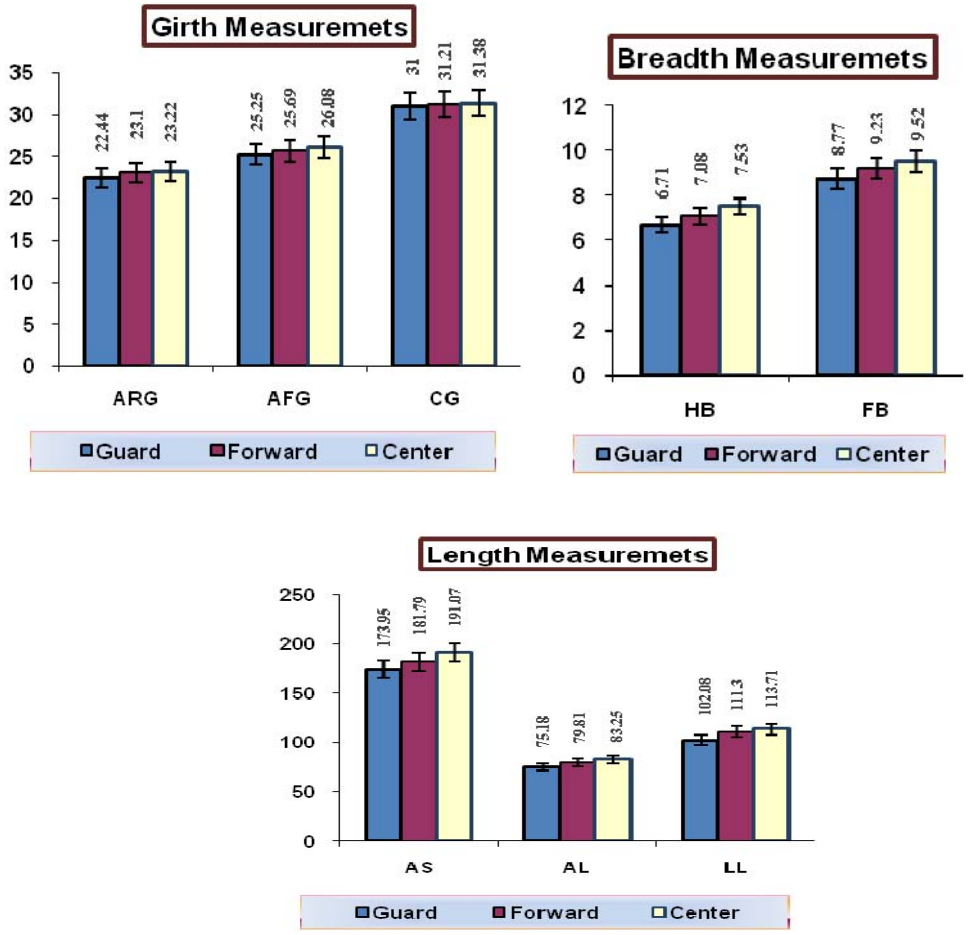


Fig. 3:Position-wise Anthropometric Measurements as Girth, Breadth and Length Mean values of Elite Indian Basketball Players

## 5. 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.

## 6. Practical Applications

The results of this study show there are differences in anthropometric characteristics of different positional roles of elite Basketball players. Consequently the players in various positional roles are inherently different, train differently, or both. The demands of the different positional roles appear to be unique, and thus training, as well as recruiting, should reflect the differences. Coaches can use this information to determine what type of profile is needed for specific positions and to design training programmes to maximize fitness development in their athletes and to achieve success in Basketball.

## 7. References


[1] Angyan, L., Teczely, T., Zalay, Z., & Karsai, I. Relationship of anthropometrical, physiological and motor attributes to sport-specific skills. *Acta Physiol. Hung*. 2003, **90**(3): 225-231.

[2] Apostolidis, N., Nassis, G.P., Bolatoglou, T., Geladas, N.D. Physiological and technical characteristics of elite young Basketball players. *The Journal of Strength and Conditioning Research*. 2004, **22**(8): 951-968.

[3] Bayios, I.A., Bergeles, N.K., Apostolidis, N.G., Noutsos, K.S., and Koskolou, M.D. Anthropometric, body composition and somatotype differences of Greek elite female Basketball, volleyball and handball players. *J Sports Med Phys Fitness*. 2006, **46**(2):271-80.

[4] Ben Abdelkrim, N., Chaouachi, A., Chamari, K., Chtara, M., Castagna, C. Positional role and competitive-level differences in elite-level men's Basketball players. *J Strength Cond Res*. 2010, **24**(5):1346-55.

[5] Delextrat, A., Cohen, D. Strength, power, speed, and agility of women Basketball players according to playing position. *J Strength Cond Res*. 2009, **23**(7):1974-81.

[6] Drinkwater, E.J., Pyne, D.B., and McKenna, M.J. Design and interpretation of anthropometric and fitness testing of Basketball players. *Journal of Sports Medicine*. 2008, **38**(7):565-78.

[7] Duncan, M.J., Lyons, M., Nevill, A.M.. Evaluation of peak power prediction equations in male basketball players. *J Strength Cond Res*. 2008, **22**(4):1379-81.

[8] Fitness Testing (2008) in oxford university press. Retrieved November 28, 2009, from http://www.topendsports.com/testing/

[9] Green, J. J., Mc Guine, T.A, Leverson, G., and Best, T.M. Anthropometric and performance measures of high school Basketball players. *Journal of Athletic Training.* 1998, **33** (3): 229 - 232.

[10] Hakkinen, K. Changes in physical fitness profile in female volleyball players during the competitive season. *J. Sports Med. Phys. Fitness*. 1993, **33**: 223 – 232.

[11] James, J. Laskin., Dustin Slivka., and Michael Frogley. A Cadence Based Sub-Maximal Field Test for the Prediction of Peak Oxygen Consumption in Elite Wheelchair Basketball Athletes. *[Electronic version] Journal of Exercise Physiology.* Retrieved December 25, 2009, from http://www.asep.org/files/LaskinV2/

[12] Jelicic, M., Sekulic, D., & Marinovic, M. Anthropometric characteristics of high level European junior Basketball players. *[Electronic version]. Br J Sports Med*. 2002, **41**:69–75. doi: 10.1136/bjsm.2006.032318.

[13] Jerry V. Krause. *Basketball Skills & Drills (Nivia).* Champaign: Human Kinetics Publishers Inc. 2000, pp. 19 - 5 1.

[14] Metaxas, T.I., Koutlianos, N., Sendelides, T., Mandroukas, A. Preseason physiological profile of soccer and Basketball players in different divisions. *J Strength Cond Res*. 2009: **23**(6):1704-13.

[15] Ostojic, S.M., Mazic, S., and Dikic, N. Anthropo-morpholigical characteristics of elite Serbian Basketball players. *Sportska Med*. 2003, **3**: 83.

[16] Sallet, P., Perrier, D., Ferret, J.M., Vitelli, V., and Baverel, G. Physiological differences in professional Basketball players as a function of playing position and level of play. *J Sports Med Phys Fitness.* 2005, **45**(3): 291-4.

[17] Smith, D.J., Roberts, D., Watson B. Physical, Physiological and performance differences between Canadian national team and universiade volleyball players. *J. of Sports Sciences*. 1992, **10**: 131 – 138.

[18] Spurgeon, J. H., Spurgeon, N.L., and Giese, W. K. Measures of body size and form of elite Basketball players. *[Electronic version] The Sports Journal.* Retrieved December 1,2009, from http://www.thesportjournal.org/article/motives-sport-participation/

[19] Thissen-Milder, M., Mayhew, I.L.. Selection and Classification of high school volleyball players from performance tests. *J. Sports Med. Phys. Fitness*. 1991, **31**(3): 380 – 384.

[20] Tsunawake, N., Tahara, Y., Moji, K., Muraki, S., Minowa, K., & Yukawa, K. Body Composition and Physical Fitness of Female Volleyball and Basketball Players of the Japan inter-high school championship teams. J Physiol Anthropol Appl Human Sci. 2003, **22**(4):195-201.

[21] Ziv, G., and Lidor, R. Physical attributes, physiological characteristics, on-court performances and nutritional strategies of female and male basketball players. *Sports Med*. 2009, **39**(7):547-68. doi: 10.2165/00007256-200939070-00003.