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Anthropometric and Body Composition Characteristics as Predictors of Ball Speed Performance in Cricket for Pace Bowlers: Multiple Regression Approach

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Abstract

Aim and Objective: The study aimed to investigate the relationship of selected anthropometric and body compositional variables to the releasing speed of the ball in medium pace bowlers. **Materials and Methods:** Thirty senior's women board players (BCCI) were selected for the study (mean age 23.4 ± 2.03, mean height 152.1 ± 3.44, and mean weight 52.4 ± 4.21). Sliding caliper and anthropometric rode were used for anthropometrical measurements, and for the body compositional measurement, bio-electrical impedance was used and the releasing speed of the ball was assessed using velocity speed radar gun. **Results:** Among all the selected variables, the model identified three variables which were muscle mass, total arm length, and fat and the regression model explains 97.6% of the total variability in the muscle mass, total arm length, and fat in relation to ball release speed of the pace bowlers and which is quite good. **Conclusion:** The regression equation which was developed by the model was as follow: Speed of the ball (performance of pace bowlers) = –94.767+5.15×(Muscle Mass)+1.488×(Total Arm Length)+0.220×(Fat).

Key words: Adjusted R square, Multiple regression model, Total arm length

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Introduction

The increasing professionalism with which players are prepared for the physical demands of both test matches and 1-day cricket is having an impact on player coaching at all levels of the game.[1] Running, jumping, and throwing are the foundations for all of the moves. Every player must have a well-balanced physique and various levels of physical fitness to perform these motions.[2]

The various anthropometric, physical, and physiological characteristics that can differentiate an athlete's position/role in each sport have received more attention in recent years.[3] Pace bowling's main goal is to bowl the cricket ball at a fast rate and cause it to bounce off the pitch or move sideways through the air, making it difficult for the batsman to hit the ball cleanly.[4]

Various anthropometric, morphological, and kinematic characteristics influence fast bowlers. Longer limb lengths, for example, have been linked to higher ball release speeds in senior bowlers.[5] These anthropometric dimensions and morphological traits are crucial in determining an athlete's success.[6-8]

Height, sitting height, arm length, and arm girth are anthropometric parameters that are beneficial for a fast bowler's high performance. The greater the leverage, the easier it is for the bowler to achieve maximum velocity. It is evidence of a successful international bowler who utilizes their height to their advantage.[9]

Aim of the Study

The prime aim of this study was to investigate the association ship between selected anthropometric and body composition characteristics to the performance of medium pace bowlers in terms of speed of the ball while delivering the ball in cricket, as well as to define which predictive variable is most contributing in the performance enhancement selected by the model.

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Materials and Methods

Study Design

This study includes predictive research design in which the selected statistical technique is used to develop a multiple regression model on the basis of pre dominant variables to predict the future characteristics.

Study Population

For fulfilling the purpose of the study, the total 30 (n = 30) female medium pace bowlers representing senior's women board tournament in cricket were selected with mean age 23.4 ± 2.03, mean height 152.1 ± 3.44, and mean weight 52.4 ± 4.21. The selected subjects had a minimum 3 years of playing experience in the board trophy in women's cricket. The subjects selected for the data collection were totally free from any recent injuries related to body parts (Lower and upper limb).

Inclusion Criteria

The following criteria were included in the study:

- Age limit from 20–30 years
- BCCI senior's board players of Madhya Pradesh, Himachal Pradesh, Delhi, Uttarakhand, Uttar Pradesh, and Haryana state were selected in the study
- Only anthropometric and body compositional measurements were included as independent variables
- The speed of the ball taken as a performance (dependent variable)
- Only pace bowlers were selected for the study
- Subjects having three and more years of match experience in senior's board tournaments.

Exclusion Criteria

The following criteria were excluded in the study:

- Players above 30 years and below 18 years were excluded from the study to avoid large deviation in anthropometric and body compositional measurements
- Players which were having any kind of chronic as well as acute injury were opting out from the study
- Spin bowlers were not the part of the study.

Procedure

All the subjects were assembled and informed in details about the research protocol and the prime aim of the study. Proper instructions and complete demonstration were given to the subjects regarding the correct standing position (Anatomical position) for taking anthropometrical measurements. Sliding caliper and anthropometric rode were used for anthropometrical measurements of total arm length (cm.), palm length (cm.), leg length (cm.), shoulder diameter (cm.), and hip diameter (cm.); and for the body compositional measurement, bio-electrical impedance was used to measure muscles mass (kg.) and fat mass (kg.). The normalized Bushnell velocity speed radar gun was used to measure speed of the ball (in kmph) of the subjects at the time of bowling. Total six attempts (an over) were given to each subject and the average of best three valid and good length delivery bowls were calculated as the final speed score of the subjects. The illustration of data collection can be seen in Figure 1.

Statistical Analysis

The data were analyzed using IBM SPSS software as a statistical tool. Mean was used as descriptive statistics and multiple regression equation was developed to identify speed performance variables using multiple regression analysis.

Observations and Results

For developing the multiple regression model and to achieve the objectives, all the assumptions for applying multiple regression analysis (multi co-linearity was not violated, independent and dependent variables in ratio and Shaprio–Wilk test for normality also not violated) were taken into consideration.

Table 1 shows the value of descriptive statistics [mean and standard deviation] for all the selected variables in the study with the graphical representation [Figure 2] for the clear pictorial view.

Table 1: Descriptive statistics of all the variables

Descriptive statistics	*Mean*	*Std. Deviation*	*n*
Speed of the ball (performance)	107.26	6.25	30
Total Arm Length	72.98	1.66	30
Palm Length	18.57	1.06	30
Leg Length	92.74	2.59	30
Shoulder Diameter	28.05	1.06	30
Hip Diameter	23.05	1.96	30
Muscle mass	17.39	0.757	30
Fat	16.70	1.82	30

Figure 1: Illustration of data collection

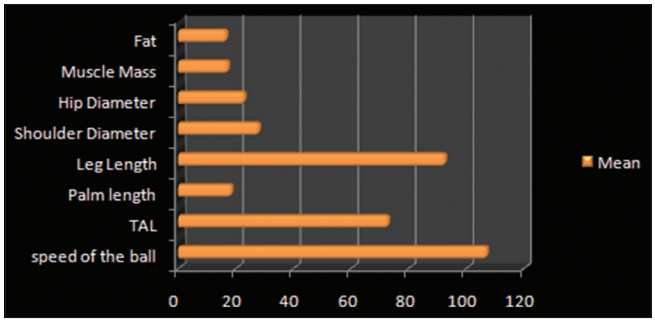

Figure 2: Graphical presentation shows the mean of selected variables

Table 2 indicated the value of R and R square generated by the model, from the above table, it is clearly shown that the three regression model was developed and we can see among all the three developed regression model the third model has highest value of R square which is 0.978, but we will see the value of adjusted R^2 instead of R^2 as by increasing the variables the value of R^2 also increases so to compensate the effect of other variables the researcher used adjusted R^2 as it shows the actual relationship as well as explain the overall effectiveness of the model and the value is 0.976 and which is the highest value the model identified three independent variables which were, muscle mass, total arm length, and fat therefore, the third model will be used to develop the regression equation. These three predictor variables explain total 97.6% of variation responsible for the speed of the ball while delivery and which is quite high due to which we can considered that the model is appropriate to develop regression equation.

The R-squared number indicates how near the data is to the fitted regression line. For multiple regressions, it is also known as the coefficient of determination or the coefficient of multiple regressions. The amount of the variation in the response variable that is explained by a linear model is known as R-squared. R-squared is always in the range of 0–100%, with 0% indicating that the model explains no variability in the response data around

Table 2: Model summary value of R and R square

Model	R	R Square	Adjusted R square	Std. Error of the estimate	Change statistics				
					R Square Change	F Change	df1	df2	Sig. F change
1	0.977[a]	0.955	0.953	1.35460	0.955	591.019	1	28	0.000*
2	0.987[a]	0.974	0.972	1.04117	0.019	20.395	1	27	0.000*
3	0.989[a]	0.978	0.976	0.97900	0.004	4.538	1	26	0.043*

a. Predictors: (Constant), Leg Explosive strength
b. Predictors: (Constant), Muscle Mass and Total Arm Length
c. Predictors: (Constant), Muscle Mass, Total Arm Length, and Fat
d. Dependent Variable: Speed of the ball (Performance)
* Significant at 0.05 level of significance

its mean and 100% indicating that the model explains all variability in the response data around its mean. The higher the R-squared, the better the model fits your data in general.

Table 3 shows that the F ratio values for the chosen model are significant because the p value is lower than 0.05. The regression model chosen was found to be extremely effective in predicting the performance of the pace bowlers in respect to their speed of the ball while delivering the ball.

Table 4 indicates that the value of unstandarized and standardized regression coefficients in the all developed regression model. For developing the multiple regression models, a regression equation is used in the model and which is explained by the value of "B" coefficients which is also termed as unstandardized coefficients and to see the associative importance of all the selected independent variables to the dependent variables, the value of "β" [standardized regression coefficients] was analyzed in the model. Regression equation: Using regression coefficient (B) of the model shown in Table 4, the regression equation can be developed which is as follow: Speed of the ball (performance of pace bowlers) = –94.767+5.15×(Muscle Mass)+1.488×(Total Arm Length)+0.220×(Fat) to conclude, it may be analyzed after seeing above regression equation is quite authentic as the value of R^2 is 0.976. It means that the three variables selected in this regression equation explain 97.6% of the variability in the muscle mass, total arm length, and fat which are quite good. Since F-value for this regression model is highly significant and reliable. In the model, the value of regression coefficient was significantly high and which indicated that the three selected variables were good enough in predicting the speed of the ball for the pace bowlers.

Table 3: ANOVA table for the selected model (F-Value)

Model	Sum of squares	df	Mean square	F	Sig.
1.					
Regression	1084.4	1	1084.48	591.01	0.000[b]
Residual	51.34	28	1.835		
Total	1135.8	29			
2.					
Regression	1106.59	2	553.29	510.40	0.000[c]
Residual	29.26	27	1.084		
Total	1135.86	29			
3.					
Regression	1110.94	3	370.31	386.37	0.000[d]
Residual	24.91	26	0.958		
Total	1135.86	29			

a. Dependent Variable: Speed of the ball (Performance)
b. Predictors: (Constant), Muscle Mass
c. Predictors: (Constant), Muscle Mass and Total Arm Length
d. Predictors: (Constant), Muscle Mass, Total Arm Length, and Fat
b, c and d Significant at 0.05 level of significance

Table 4: Regression coefficient of selected variable in model along with it's t-value

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1					
(Constant)	–33.19	5.783		–5.74	0.000*
Muscle Mass	8.074	0.332	0.977	24.31	0.000*
2					
(Constant)	–87.10	12.73		–6.838	0.000*
Muscle Mass	5.103	0.706	0.618	7.231	0.000*
Total Arm Length	1.447	0.320	0.386	4.516	0.000*
3					
(Constant)	–94.767	12.506		–7.578	0.000*
Muscle Mass	5.158	0.664	0.624	7.768	0.000*
Total Arm Length	1.488	0.302	0.397	4.930	0.000*
Fat	0.220	0.103	0.064	2.130	0.043*

a. Dependent Variable: Speed of the ball (performance)
*Significant at 0.05 level of significance

Discussion

The main objective of the study was to identify parameters that contribute to high ball release speeds in cricket fast bowlers on the basis of anthropometric and body compositional parameters. The concept of the present study was to find out the most prominent factors (Anthropometric and body compositional) responsible for predicting the performance of pace bowlers in terms of their ball release speed.

The three independent variables were identified by the multiple regression models among all the selected variables by the model were muscle mass, total arm length, and fat mass. There is no doubt that the excellent performance in any games and sports is highly influenced by body composition.[10] The body composition consists of fat mass and lean body mass (muscle mass, bone density, and fluids). When it comes to fat mass, Buuren *et al*. stated in their article that fat is not a contractile tissue and it also represents extra weight that the athlete must bear when performing a movement, so it appears that in activities that require a body to be pushed through space, calculated body fat percentage has been thought to negatively affect performance. In a cricket match, a cricket players require great linear momentum of the body to transfer his or her generated body momentum to the ball in the line of the wicket to get the wicket as well as to secure more run as a pacer also as a fielder they have to chase the ball quickly and react accordingly and to do these tasks efficiently every cricket player either batsmen, pacer, or spinners must keep his or her body fat very low or can say in an optimum require level. On the other hand, an increased muscle mass has been confirmed to improve overall performance in all games and sports. There is a positive relation of muscles and the forces generated by these muscles.[11,12] Hence, further to this, it may assume that the

body with increased muscles mass for pacers may give the more speed to the ball to get the more wicket as well all the batsmen or bowler as a fielder may give the long and accurate throw from the boundary line to save the score for their teams. Hence, the ideal muscles mass can be convinced easily to all of us as the best predictor of enhancing performance not only in cricket but also in all games and sports.

The other variable which was selected by the model was total arm length, it has a positive relationship with the speed of the ball; this study was also supported by Stockill *et al*. who explained that longer the limb lengths have been linked to faster ball release velocity in bowlers and another study in which ball-release speed was strongly linked with shoulder–wrist length and overall arm length, according to the nine collegiate fast-medium bowlers.[13] Similarly, to bowling, the bowler's limb length is an essential element in bowling faster. The bowler's arm is understood to operate as a lever, and according to the biomechanics, a higher resistance arm improves velocity.[14] Longer the arm length, greater the leverage, and allow the bowler to achieve maximum velocity.

Conclusion

The multiple regressions were developed by the present study, in which, the three independent variables were effectively identified by the multiple regression model among all the selected predicting variables which were muscle mass, total arm length, and fat mass. Total 97.6% of variability was explained by all the three selected predicting variables in the study. The regression equation generated by the model was speed of the ball (performance of pace bowlers) = –94.767+5.15×(Muscle Mass)+1.488×(Total Arm Length)+0.220×(Fat).

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