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REVIEW

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Shoulder Angle During Ball Release Are Predictors of Ball Velocity Among Medium Pace Bowlers

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ABSTRACT

The purpose of the study. The aim was to find the effect of kinematic variables on ball velocity of medium pace bowlers.

Materials and methods. A total of 10 male cricket players who were right arm medium pace bowlers were selected for this study. The kinematic variables selected in this study were wrist angle, elbow angle, shoulder angle, hip angle, knee angle, ankle angle, and centre of gravity.

Results. A regression equation with R2 value of 0.616 was obtained from the study, i.e., 52.266+0.371 × (right shoulder angle).

Conclusions. The study suggests shoulder angle to be important factor in determining ball velocity among medium pace bowlers.

Keywords: *biomechanics cricket; kinematics; physical education; radar gun.*

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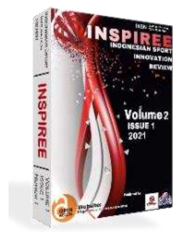

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INTRODUCTION

Bowling in cricket is influenced by many different factors (e.g., technique, physical fitness, psychological skills, social factors), especially when fast bowling is considered (Stockill and Barlett, 1992). The fast-bowling action can be classified as front-on, side-on, semi-front-on, or mixed based on the orientation of the shoulder-hip axes and back foot alignment during delivery of ball. Cricket in its modern form at all levels strive to develop fast bowlers who can deliver high speed during bowling. Additionally, this ability of bowlers to deliver high ball release also contributes to the successful performance of cricket teams (Portus et al., 2000). Fast bowling capability may either help the team by dismissing or reducing the scoring ability of the opposition team. Past research studies have suggested that fast bowling is crucial in determining the

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success of any bowling side (Bartlett et al., 1996; Elliott et al., 1986; Glazier et al., 2000; Hanley et al., 2005; Loram et al., 2005; Portus et al., 2004; Salter et al, 2007; Stockhill & Bartlett, 1994). The ability of bowler to attain a greater ball velocity has been related to specific bowling action (Bartlett et al, 1996; Elliot et al., 1986; Glazier et al., 2000; Hanley et al., 2005; Loram et al., 2005; Portus et al., 2004; Salter et al, 2007; Stockhill & Barlett, 1994).

Previous studies have investigated many biomechanical parameters that may contribute to higher ball speed (Elliot et al., 1986; Glazier et al., 2000; Loram et al., 2005; Portus et al., 2000, 2004; Salter et al, 2007). The studies have reported that there is a relationship between knee angle of the front leg during front foot contact correlates to the ball release speed. In addition, no correlation was observed between ball velocity and variables such as approach run-up velocity, delivery stride length, shoulder and hip alignment in transverse plan, ball release height or angular velocity of bowling humerus.Therefore, this study was conducted to identify the relationship of various kinematic variables with ball velocity among division level cricketers.

MATERIALS AND METHODS

Study participants

In this study a total of ten male cricket players of 18 to 25 years were purposively selected from Gwalior division cricket academy who were basically right arm medium pace bowlers and with high level of skill in medium pace bowling. It was considered that the subjects possessed reasonable level of technique of medium pace bowling in cricket considering the training experience. All subject signed an informed consent form stating their voluntary participation in the study. The study was conducted in accordance with the declaration of Helsinki.

Variables

Dependent variable: Ball velocity

The ball velocity was measured using a radar gun, placed in front of the bowling pitch (Figure 1). In this study to measure the speed of the bowler the researcher used a speed gun, as speed also plays a vital role in managing the accuracy of a bowler. With good speed and good accuracy, a fast bowler could be very lethal for the batsman to face. To measure the speed the scholar was standing on the opposite end of the crease, i.e., the batting end with the speed gun named Bushnell Speed Gun in hand, the speed gun was pointing towards the path and line of the ball, as the subjects bowled the deliveries the trigger was squeezed so that the speed could be marked on the gun. The speed was noted in Km/hr with 0.96 was the reliability.

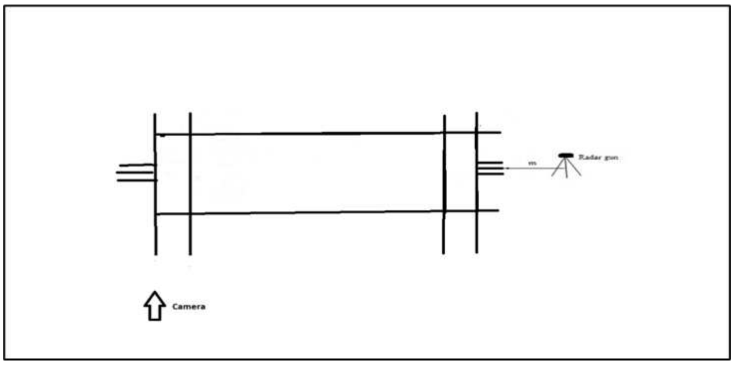

***Figure 1**. Set Up For Placement Of Radar Gun And Camera During Bowling*

Independent Variables:

- Angular kinematics: 1) Ankle angle of leg during release phase, 2) Knee angle during release phase, 3) Hip angle during release phase, 4) Elbow angle during release phase, 5) Wrist angle during release phase, 6) Angle of release.
- Linear Kinematics: 1) Centre of gravity during release phase.

Procedure for Collection of Data

A total of ten medium pace bowlers were chosen to fulfill the purpose of the study. Thereafter the selected ten subjects were asked to fill up the consent form and anthropometric measurements of the selected sites was measured using the anthropometric kit available in the sports biomechanics laboratory. Later, each bowler was asked to bowl six legal deliveries with maximum velocity and five deliveries with maximum velocity were taken into consideration for the analysis. The standard cricket leather ball was used for the purpose of the study.

Filming Protocol

The method of videography was employed for the biomechanical analysis of pace bowling in cricket with to obtain maximum velocity of the ball delivery. A Y1 Action camera was used with the frequency of 240 frames per seconds was used to capture the movement action. The camera was placed on the sagittal plane from the subjects on their right-hand side (as all the subjects taken were right-handed). The distance of the camera from the subject final delivery position was 3.63 meters away and the height of the lens was 1.26 meter from the ground level. Only release phase was required and captured for the purpose of the study. On the basis of photographs obtained from the video the researcher created required stick figures (using opensource free software Kinovea) and the rest of the biomechanical variables were also calculated by it. The required stick figure was developed with the help of latest version of Kinovea Software 0.9.3. The subjects performed the skill for a total of six trails and out of the six trails, five trails were taken into consideration and were analyzed.

Reliability

There were many sophisticated instruments used for the purpose of the study such as Y1 high speed action camera, speed gun (i.e., radar gun), and anthropometric kit. All the instruments were purchased and procured from standard firms and were considered to be reliable. In addition, the data showed no fluctuation when taken in different parameters using the same instruments.

Statistical Procedure

In this study, the multiple regression analysis was used in order to find out the prediction of ball velocity in fast bowling on the basis of kinematic variables. For testing the hypothesis, the level of significance was set at 0.05.

RESULTS

Kinematic variables on ball velocity

In this sub-section, the influence of kinematic variables on ball velocity has been presented.

Table 1. *Descriptive Statistics for Different Kinematic Variables of Medium Pace Bowlers on Ball Velocity During Release Phase*

Variables	Mean	SD	N
Ball Velocity (km/hour)	117.98	2.34	50
Right Wrist Angle (angle)	177.08	1.74	50
Right Elbow Angle (angle)	165.20	4.45	50
Right Shoulder Angle (angle)	166.22	4.96	50
Right Hip Angle (angle)	146.22	6.91	50
Right Knee Angle (angle)	106.62	4.35	50
Right Ankle Angle (angle)	132.64	10.73	50
Centre of Gravity (metre)	0.75	0.02	50

The values of mean, standard deviation and number of subjects for all the variables are shown in Table 6. Mean and standard deviation of outcome variable i.e., Ball velocity is 117.98±2.34. Mean and standard deviation of predictor variables are as follows; Right wrist angle 177.08±1.74, Right elbow angle 165.20±4.45, Right shoulder angle 166.22±4.96, Right hip angle 146.22±6.91, Right knee angle 106.62±4.35, Right ankle angle 132.64±10.73, and Centre of gravity 0.75±0.02. These values can be used for further analysis in the study.

Table 2. *Correlation Matrix For Kinematic Variables During Release Phase*

	Ball Velocity	Right Wrist Angle	Right Elbow Angle	Right Shoulder Angle	Right Hip Angle	Right Knee Angle	Right Ankle Angle	Centre of Gravity
Ball Velocity	1	.177	-.184	.785**	-.208	.378**	.358*	.023
Right Wrist Angle		1	-.144	.186	-.243	.127	.027	-.086
Right Elbow Angle			1	-.114	.091	-.177	-.045	.032
Right Shoulder Angle				1	-.104	.302*	.260	-.151
Right Hip Angle					1	-.142	-.488**	.193
Right Knee Angle						1	.560**	.181
Right Ankle Angle							1	.195
Centre of Gravity								1

In Table 2, correlation matrix including significance level (p-value) for each correlation coefficient at 0.05 level has been shown. Significance has been tested for two-tailed test. The correlation coefficient with asterisk mark (*) indicates that it is significant at 5% level. Whereas, the correlation coefficient with double asterisk mark (**) indicates that it is significant at 1% level.

For two-tail test, value of correlation coefficient required for its significance at 0.01 level and 48(N − 2) df is 0.354 and at 0.05 level is 0.273. Thus, all those correlation coefficients having values more than 0.354 are significant at 1% level and those correlation coefficients having values more than 0.273 are significant at 5% level.

Table 2 shows significant positive relationship between ball velocity and right shoulder angle, right knee angle and right ankle angle; and also relationship between right shoulder angle and right knee angle; and right hip angle shows negative correlation with right ankle angle; and it also shows significant positive relationship between right knee angle and right ankle angle.

Table 3. *Model summary along with the values of R and R2*

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	0.785[a]	0.616	0.608	1.471	0.616	76.981	1	48	0.000

a. Predictors: (Constant), Right Shoulder Angle

b. Dependent Variable: Ball Velocity

Regression model has been presented in Table 3. For this model, the value of R^2 is 0.616, which is maximum; hence, this model shall be used to develop the regression equation. It can be seen from Table 3 that in this model, one independent variable, **right shoulder angle** has been identified; and therefore, the regression equation shall be developed by using this variable only. Since R^2 for this model is 0.616, this independent variable explains 61.6% variability in ball velocity of medium pace bowlers. Thus, this model is quite appropriate to estimate ball velocity of medium pace bowlers.

Table 4. *Anova Table Showing F Values For The Model*

Model	Sum of Squares	df	Mean Square	F	p-value
Regression	166.600	1	166.600	76.981	0.000^b
Residual	103.880	48	2.164		
Total	270.480	49			

a. Dependent variable: Ball velocity
b. Predictors: (Constant), Right Shoulder Angle

In Table 4, F value for this model have been shown. Since F value for this model is quite high and significant, $p<0.05$, it may be concluded that the model selected is highly efficient.

Table 5. *Regression Coefficients Of Kinematic Variables During Release Phase In Model Along With Their T Values And Partial Correlations*

	Unstandardized Coefficients		Standardized Coefficients			Correlations		
Model	B	Std. Error	Beta	T	Sig.	Zero-order	Partial	part
1(constant)	56.266	7.037		7.996	0.000			
Right Shoulder Angle	0.371	0.042	0.785	8.774	0.000	0.785	0.785	0.785

a. Dependent Variable: Ball Velocity

Regression coefficient in the model have been shown in table 5. In this model, t value for regression coefficient right shoulder angle is significant as the significance value (p value) associated with them is less than 0.05. Thus, it may be concluded that the variable right shoulder angle significantly explain the variation in the ball velocity of medium pace bowlers. Larger the absolute value of Beta coefficient, more is the contribution of that variable in the model. Thus, right shoulder angle is the most contributory predictor in this model.

Regression equation: Using regression coefficient (B) of the model shown in the table 5, the regression equation can be developed which is as follows:

Ball velocity = 56.266+0.371 × (right shoulder angle)

To conclude, it may be interpreted that the above regression equation is quite reliable as the value of R^2 is 0.616. In other words, the variable selected in the regression equation explain 61.6% of the total variability in the ball velocity of medium pace bowlers which is quite good. Since F value for this regression model is highly significant, the model is reliable. At the same time, regression coefficient in this model is highly significant; and therefore, it may be interpreted that variable selected in the model, namely, right shoulder angle is quite appropriate in estimating the ball velocity of medium pace bowlers.

DISCUSSION

The study was conducted with the aim of finding the role of kinematic variables (i.e., wrist angle, elbow angle, shoulder angle, hip angle, knee angle, ankle angle, and centre of gravity) on ball velocity among medium pace bowlers. Although the study included seven kinematic variables during medium pace bowling, only one variable i.e., shoulder angle was found to be contributing to the velocity of bowling.

The possible explanation for this finding may be due to the fact that during pace bowing in cricket, the shoulder angle determines the angle of release of the ball. During pace bowling, the angle or the point of release of the ball is very crucial for a delivery to be legal in cricket. And since the selected bowlers for this study were sub-elite level bowlers, and possessed a significant training experience in bowling, therefore, the shoulder angle might have contributed sufficiently in determining the ball velocity. Similar findings were also observed in a previous study by Wormgoor et al. 2010. In the study the authors found significant correlation between the shoulder alignment in the transverse plane at the front foot strike to ball release velocity among medium pace bowlers.

Aligning shoulder in a proper way before release of ball has been reported to affect the ball velocity in an effective way (Portus et al. 2004; Wormgoor et al. 2010). In addition, the main reason for pace bowlers to rotate their shoulders transversely in the opposite direction, away from the batsman (i.e., shoulder counter-rotation) may also be related to gaining the momentum for pace bowling.

CONCLUSION

In conclusion, the study findings suggest shoulder angle during release to be an important factor during medium pace bowling. This may be due to the factor that the ball release point is dependent on the shoulder angle and hence dictates the outcome of bowling. Therefore, practitioners are suggested to keep this factor in mind while training medium pace bowlers. Young bowlers should be trained to improve the shoulder angle during release, thereby making them able to optimize the performance using sports biomechanics.

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CONFLICT OF INTEREST

The authors declare that there are no conflict of interest.

REFERENCES

Akbari, R., Pardilla, H., & Zulfah, Z. (2022). In Junior High School Boys, a Comparison Of Hollow Sprint and Acceleration Sprint Methods on the Sprinter 100 Meters. *INSPIREE: Indonesian Sport Innovation Review*, *3*(01), 47–55. https://doi.org/10.53905/inspiree.v3i01.72

Bartlett, R. M., Stockill, N. P., Elliott, B. C., & Burnett, A. F. (1996). The biomechanics of fast bowling in men's cricket: A review. *Journal of Sports Sciences*, 14, 403–424.

Elliott, B. C., Foster, D. H., & Grey, S. (1986). Biomechanical and physical factors influencing fast bowling. *Australian Journal of Sport and Medicine in Sport*, 18, 16–21.

Glazier, P. S., Paradisis, G. P., & Cooper, S. (2000). Anthropometric and kinematic influences on releases speed in men's fastmedium bowling. *Journal of Sports Sciences*, 18, 1013–1021.

Hanley, B., Lloyd, R., & Bissas, A. (2005). Relationship between ball release velocity and kinematic variables in fast bowling in cricket. *Journal of Sports Sciences*, 23, 112–113.

Loram, L. C., McKinon, W., Wormgoor, S., Rogers, G. G., Nowak, I., & Harden, L. M. (2005). The determinants of ball release speed in schoolboy fast-medium bowlers in cricket. *Journal of Sports Medicine and Physical Fitness*, 45, 483–490.

Pardilla, H. (2021). Physical Fitness and Learning Achievement Academic in Children Aged 10-12 years . *INSPIREE: Indonesian Sport Innovation Review*, *2*(2), 165 of 175. https://doi.org/10.53905/inspiree.v2i2.51

Portus, M. R., Sinclair, P. J., Burke, S. T., Moore, D. J. A., & Farhart, P. J. (2000). Cricket fast bowling performance and technique and the influence of selected physical factors during an 8-over spell. *Journal of Sports Sciences*, 18, 999–1011.

Portus, M. R., Sinclair, P. J., Burke, S. T., Moore, D. J. A., & Farhart, P. J. (2000). Cricket fast bowling performance and technique and the influence of selected physical factors during an 8-over spell. *Journal of Sports Sciences*, 18, 999–1011.

Portus, M., Mason, B., Elliott, B., Pfitzner, M., & Done, R. (2004). Technique factors related to trunk injuries and ball release speed in high performance cricket fast bowlers. *Sports Biomechanics*, 3, 263–283.

Rezki, R., Zulkifli, Z., Jatra, R., & Aprianti, L. (2022). An Analysis Of Freestyle Swimming Technique on Students the Physical Education, Health And Leisure Study Program. *INSPIREE: Indonesian Sport Innovation Review*, *3*(02), 93–105. https://doi.org/10.53905/inspiree.v3i02.78

Salter, C. W., Sinclair, P. J., & Portus, M. R. (2007). The associations between fast bowling technique and ball release speed: A pilot study of the within-bowler and between-bowler approaches. *Journal of Sports Sciences*, 25, 1279–1285.

silvia, E., Yani , A., & Alficandra, A. (2022). VO2max Level of Women's Futsal Players (UIR Student Activity Unit). *INSPIREE: Indonesian Sport Innovation Review*, *3*(02), 128–136. https://doi.org/10.53905/inspiree.v3i02.85

Stockill, N., & Bartlett, R. M. (1994). An investigation into the important determinants of ball release speed in junior and senior international cricket bowlers. *Journal of Sports Sciences*, 12, 177–178.

Stockill, N.P. and Bartlett, R.M. (1992). A three-dimensional cinematographical analysis of the techniques of Inter- national and English county cricket fast bowlers. *In Proceedings of the Xth Symposium of the International Society of Biomechanics in Sports* (edited by R. Rodano, G. Ferringo and G.C. Santambrogio), pp. 52±55. Milan: Edi Ermes.

Syamsulrizal, S., Riski Afrianda, T., Iqbal, M., Marlina, Y. ., & Zahara, Z. (2022). Evaluation of Reaction Time on Karate Athletes UKM Syiah Kuala University. *INSPIREE: Indonesian Sport Innovation Review*, *3*(01), 71–79. https://doi.org/10.53905/inspiree.v3i01.74

Wormgoor, S., Harden, L., & Mckinon, W. (2010). Anthropometric, biomechanical, and isokinetic strength predictors of ball release speed in high-performance cricket fast bowlers. *Journal of Sports Sciences*, *28*(9), 957-965.

APPENDIX

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