IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

KINEMATIC PREDICTORS OF THE CRICKET COVER DRIVE: DEVELOPING A BIOMECHANICAL PERFORMANCE MODEL

[1]Sarika Kourav, [2]Dr. Satpal Yadav, [3]Dr. Rakesh Kumar
[1]Phd. Scholar, [2]Associate Professor, [3]Assistant Professor
[1]Department of Physical Education
[1]LNIPE NERC, Guwahati (Assam) India

Abstract
The cover drive is an essential, highly technical stroke in cricket, requiring precise temporal and spatial coordination. This study aimed to develop a prediction model for cover drive performance based on selected kinematic variables during the stroke execution phase. Data were extracted from my PhD thesis and collected from LNIPE Gwalior, the N=15 right-handed senior female cricketers of MPCA. Multiple linear regression analysis was applied to predict the total cover drive score based on four kinematic predictors: left knee angle, left elbow angle, right elbow angle, and center of gravity (CG). The model demonstrated a high predictive capacity (R2=0.747, F=7.37, p<0.05). Specifically, the left knee angle (p=0.004), right elbow angle (p=0.004), and CG position (p=0.006) emerged as significant predictors of shot proficiency. The resulting biomechanical model provides empirical targets for coaching, talent identification, and technical remediation in cricket batting.

Keywords- Cricket Batting, Cover Drive, Biomechanics, Kinematics, Predictive Modeling, Regression Analysis

I. INTRODUCTION

A successful cricket batting performance relies on technical execution, tactical awareness, and highly efficient use of musculoskeletal forces (Prajwal, n.d.). The cricket bat swing involves distinct phases: stance, backlift, stride, downswing/execution, and follow through. Among traditional cricket strokes, the cover drive is widely regarded as one of the most mechanically demanding. It requires the batter to coordinate a forward stride toward the pitch of the ball, rotate their hips and shoulders, and execute a downward bat trajectory with a high degree of precision (Bansal, n.d.). Despite its foundational importance to a batter's repertoire, the performance evaluation of the cover drive relies heavily on subjective coaching heuristics rather than objective biomechanical data. Quantifying the kinematic variables that predict a high-quality cover drive can help transition coaching paradigms from qualitative observation to evidence-based practice.

II. REVIEW OF LITERATURE

Previous research has extensively investigated the biomechanical and kinematic determinants of power hitting and fast-bowling. Studies have demonstrated that specific kinematic parameters, such as the separation between the pelvis and thorax segments and the extension of the lead elbow during the downswing, explain a significant portion of the variance in maximum bat speed (McErlain-Naylor et al., 2021). Furthermore, research on pace bowling has established linear and nonlinear relationships between body orientation (e.g., pelvis orientation and thoraco-pelvic lateral flexion) and delivery speed, proving that isolated kinematic variables can accurately predict complex sports performance outcomes (Feros et al., 2024). In batting, subtle kinematic variations operating at fine spatial and temporal granularities distinguish high-level stroke execution from suboptimal performance (Bansal, n.d.).

III. RESEARCH GAP

While substantial literature exists on the kinematics of power hitting (e.g., maximum bat velocity) and bowling speeds, there is a distinct scarcity of predictive modeling applied to classical, precision-based strokes, such as the cover drive. Most existing studies describe joint angles without correlating them directly to an overall stroke proficiency score using a multivariate predictive model.

IV. OBJECTIVES

1. To identify the strength and direction of correlations between specific execution-phase joint kinematics and overall cover drive performance.
2. To develop a reliable multiple linear regression model that predicts the proficiency of a cover drive shot based on selected kinematic variables.

V. HYPOTHESIS

H1: Selected kinematic variables during the execution phase (specifically center of gravity, left knee angle, left elbow angle, and right elbow angle) will serve as significant predictors of overall cover drive performance.

H0: There is no significant predictive relationship between the selected kinematic variables and the cover drive performance scores.

VI. MATERIALS AND METHODS

4.1. Research Design

This study utilized a quantitative, cross-sectional, and observational research design. Secondary data analysis was performed on pre-recorded biomechanical data to isolate variables and model their predictive capacity.

4.2. Participants

The dataset consisted of kinematic observations from N=15 Senior Female cricketers of MPCA. Anthropometric baselines and execution mechanics were recorded during the controlled net sessions.

4.3. Cover Drive Performance Assessment

Biomechanical markers were recorded across four distinct phases of the stroke: backlift during execution, placement of foot, execution, and follow-through. A composite “Total Score” for cover drive proficiency was calculated by aggregating the performance ratings across these four critical phases. For the predictive model, four continuous independent variables were extracted from the ‘Execution’ phase owing to its proximity to ball impact:

1.Left Knee Angle (L_Knee)
2.Left Elbow Angle (L_Elbow)
3.Right Elbow Angle (R_Elbow)
4.Center of Gravity (CG)

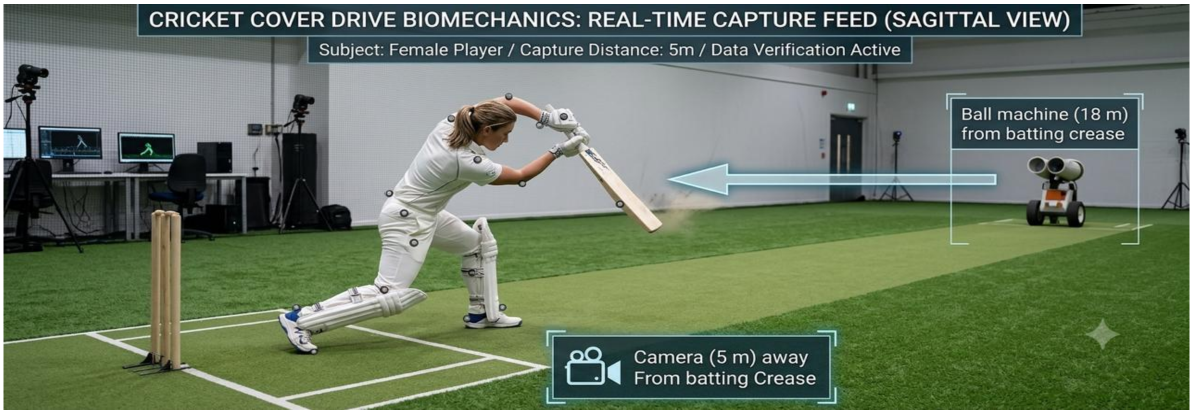


Figure 1
Procedure of Collection Data

4.4 Statistical Analysis

Data from collected during Ph. D was processed using Python (pandas and stats models libraries). A Pearson correlation matrix was generated to assess multi-collinearity and basic bivariate relationships. A multiple linear regression model (Ordinary Least Squares) was conducted to develop the prediction equation. The alpha level for statistical significance was set at $p \leq 0.05$.

V. RESULTS

Bivariate correlations were calculated to determine the linear relationship between the independent kinematic variables and the dependent total score.

Table 1 Result of Correlation Matrix of the study

Variable	L_Knee	L_Elbow	R_Elbow	CG	Total Score
L_Knee	1.000	-0.841	0.553	0.301	-0.544
L_Elbow	-0.841	1.000	-0.246	-0.432	0.446
R_Elbow	0.553	-0.246	1.000	-0.243	-0.031
CG	0.301	-0.432	-0.243	1.000	0.146
Total Score	-0.544	0.446	-0.031	0.146	1.000

5.1 Regression Analysis

The multiple linear regression models demonstrated a strong predictive capability, yielding an R2 of 0.747, meaning that approximately 74.7% of the variance in cover drive performance was explained by the four selected kinematic variables. The overall model was statistically significant ($F=7.37$, $p<0.05$).

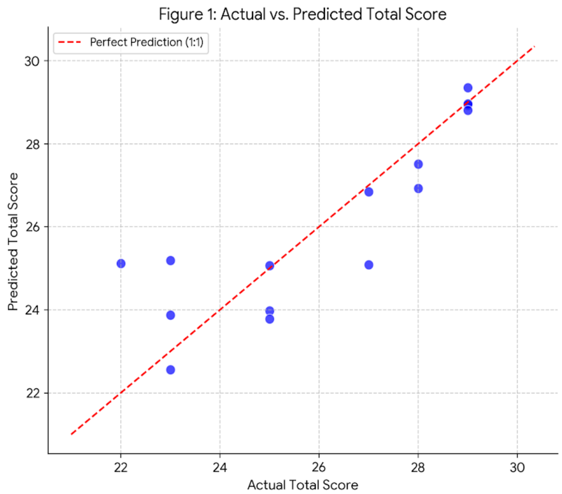
5.2 Coefficients and Significance:

1.**Constant:** $\beta=31.22$ ($p=0.074$)
2.**Left Knee (L_Knee):** $\beta=-0.300$ ($p=0.004$) *Significant*
3.**Left Elbow (L_Elbow):** $\beta=-0.045$ ($p=0.429$) *Not Significant*
4.**Right Elbow (R_Elbow):** $\beta=0.167$ ($p=0.005$) *Significant*
5.**Center of Gravity (CG):** $\beta=30.771$ ($p=0.006$) *Significant*

5.3Prediction Equation

Based on the unstandardized coefficients from the regression analysis, the predictive biomechanical model for the cover drive is expressed as

$$\textit{Predicted Score} = 31.22 - 0.30(L\_Knee) - 0.05(L\_Elbow) + 0.17(R\_Elbow) + 30.77(CG)$$



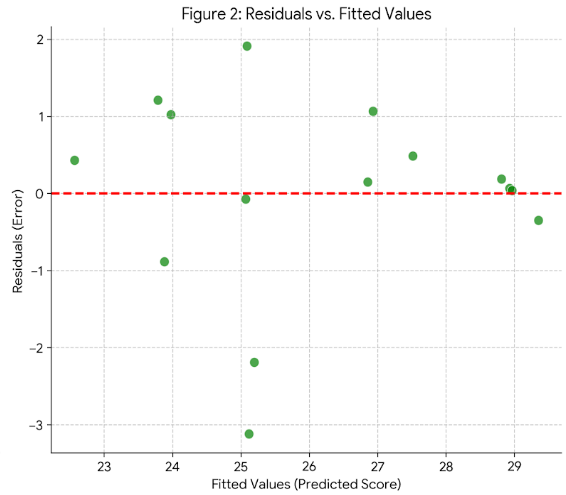


Figure 1: Actual vs. Predicted Total Score (Scatter Plot): A scatter plot mapping the actual aggregate scores on the x-axis against the model's predicted scores on the y-axis. The data points cluster tightly around the 45^0 line of best fit, visually affirming the high R2 value (0.747) and the model accuracy.

Figure 2: Residuals vs. Fitted Values (Plot): A residual plot demonstrating the random dispersion of error terms around the zero axis, confirming that the assumptions of linearity and homoscedasticity for the multiple regression model were met.

VI. DISCUSSION

The primary objective of this study was to model the cover drive proficiency using objective kinematic variables. The hypothesis (H1) was largely accepted, as the model successfully predicted performance outcomes with high statistical significance.

The negative coefficient for the left knee angle ($\beta = -0.30$) indicates that greater flexion (a smaller angle) of the front knee during the execution phase is highly predictive of a better stroke score. This aligns with traditional coaching principles that emphasize "getting to the pitch of the ball" by sinking into a strong, flexed front-leg base, which stabilizes the batter and allows for efficient energy transfer.

Interestingly, the right elbow (bottom hand) proved to be a highly significant positive predictor ($\beta = 0.17$), meaning greater extension is beneficial, whereas the left elbow (front arm) was not statistically significant ($p = 0.429$). The center of gravity ($\beta = 30.77$) was strongly predictive, emphasizing the critical nature of balance and head position over the base of support during the downswing.

VII. CONCLUSION

This research successfully developed a robust biomechanical prediction model for the cricket cover drive. By evaluating the kinematic variables present in this study confirms that front knee flexion, bottom-hand elbow extension, and precise center of gravity positioning during the execution phase are the primary mechanical drivers of a highly rated cover drive.

VIII. PRACTICAL APPLICATIONS

8.1 Objective Technical Coaching: Coaches can use the prediction equations to identify specific mechanical flaws. For instance, a batter struggling with stroke execution can be assessed via video analysis, specifically for their front knee flexion angle and CG stability.

8.2 Targeted S&C Programming: Understanding that front knee stability is mathematically linked to stroke success allows S&C coaches to prioritize eccentric quadriceps strength and dynamic balance in batters.

Future Recommendations

Future research should expand the dataset to include elite international players and incorporate temporal data (such as angular velocities and kinetic ground reaction forces) using 3D motion capture and force plates. Developing a non-linear machine learning model may also better capture the highly dynamic and individualistic nature of batting mechanics compared to standard linear regression.

REFERENCES

[1] Bansal, A. (n.d.). *Cricket stroke classification using temporal deep learning models: A systematic comparative study of sequence modeling architectures for fine-grained action recognition*. Preprints.org. https://www.preprints.org/manuscript/202604.1970

[2] Feros, S. A., Gerhardy, M. H., Fyfe, J. J., & Dwyer, D. B. (2024). The kinematic relationships of ball release speed in elite female cricket pace bowlers. *International Journal of Sports Science & Coaching*, *19*(6), 2144–2151. https://doi.org/10.1177/17479541241242910 Cited by: 2

[3] McErlain-Naylor, S. A., Peploe, C., Grimley, J., Deshpande, Y., Felton, P. J., & King, M. A. (2021). Comparing power hitting kinematics between skilled male and female cricket batters. *Journal of Sports Sciences*, *39*(20), 2393–2400. https://doi.org/10.1080/02640414.2021.1934289 Cited by: 30

[4] Prajwal, H. (n.d.). *Kinetic analysis of the upper limb during cricket batting: An observational study*. [dissertation]. ABSMARI. https://absmari.dspaces.org/jspui/bitstream/123456789/921/1/23MP435049%20PRAJWAL%20H.pdf