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Predictive regression analysis linking right hip angle to javelin throw power position efficacy

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Abstract

This study employs predictive regression analysis to examine the relationship between right hip angle at the javelin throw power position and overall throwing performance among 20 senior national-level Indian athletes aged 20-28. High-speed videography (240 fps) captured via Kinovea software quantified kinematic variables, revealing a significant model ($R = .622$, $R^2 = .387$, $F = 11.353$, $p = .003$) where right hip angle explains 38.7% of performance variance. The regression equation, Performance = -0.495 + 0.234 × (Right Hip Angle), confirms optimal extension (90-120°) enhances kinetic chain efficiency, aligning with biomechanical principles of proximal-distal energy transfer. Findings validate hip angle as a trainable biomarker for power position efficacy, offering coaches targeted interventions to elevate throw distances beyond 85m. Limitations include moderate explanatory power, suggesting multivariate extensions incorporating release velocity.

Keywords: Javelin Throw, Right Hip Angle, Power Position, Regression Analysis, Biomechanics, Kinovea, Kinetic Chain, Performance Prediction

Introduction

The javelin throw demands precise biomechanical coordination, particularly during the power position where hip alignment optimizes kinetic chain transfer for maximal distance. Predictive regression analysis linking right hip angle to javelin throw power position efficacy explores how angular positioning of the right hip predicts performance outcomes through statistical modeling. This approach addresses gaps in understanding joint-specific contributions amid complex multi-joint dynamics (Krzyszkowski & Kipp, 2021) [1].

The power position, marked by the non-dominant leg's final contact, channels momentum from hips upward, with right hip extension critical for rotational torque generation (Stander, 2006) [2]. Right hip angle variations typically 90-120° influence stability and energy summation, as greater differentials between dominant and non-dominant hips correlate with elite throws exceeding 85m (Nithin-Sudarsan, 2022) [3]. Hip driven sequencing initiates the throw's kinetic chain, amplifying velocity through trunk and arm segments (Baker, 2021) [4].

Regression models from elite competitions identify release velocity and support knee angle as primary predictors, yet hip kinematics warrant deeper analysis for proximal-distal force transmission (Krzyszkowski & Kipp, 2021) [1]. Kinematic studies reveal positive correlations between lower limb angles (e.g., knee at 110°) and throw distance, underscoring hip angle's role in momentum transfer via hip drive (Kumar, 2022) [5]. Three-dimensional analyses confirm hip joint timing differentiates techniques, with optimal right hip advancement boosting angular velocity (Best *et al*., 1993) [6].

Quantifying right hip angle via regression enables predictive modeling of power position efficacy, informing coaching for technique refinement in athletes (Leigh *et al*., 2010) [7]. Such models handle high-dimensional kinematic data, isolating hip contributions amid variables like release parameters (Krzyszkowski & Kipp, 2021) [1]. For sports scientists, this advances personalized training protocols, potentially elevating performance in precision throws like javelin.

Procedure and Methodology

Selection of Subjects

20 Senior National level players from India and the age ranged from 20-28 chosen as research participants for the purpose of the investigation. All of the subjects were informed of the study's goal, and they were encouraged to give each trial their all. Prior to taking part in the testing procedures, each subject gave their consent.

Selection of Variables

Dependent Variables 1. Javelin Throw Technique.
2. Power Position Technique.
Independent Variables Kinematics variables.

Video Protocol

This video analysis software facilitates precise examination of particular movements in videos through slow-motion, frame-by-frame playback. Kinovea natively handles numerous video formats, ensuring broad compatibility. It provides robust statistical tools and advanced features like motion tracking, measurement capabilities, synchronized comparisons, and detailed visual inspections, positioning it as an essential tool for biomechanics and sports performance research. To predict the power position technique in javelin throwing using kinematic parameters, multiple throws from chosen trials were recorded, with the optimal throwing techniques selected for data gathering. High-speed cameras (240 fps) captured the power position phase to precisely quantify kinematic variables. The power position moment in the javelin throw was targeted for analysis.

The researcher generated stick figures from sequential video frames, then derived key biomechanical parameters from them using Kinovea software. Subjects executed the technique three times, with the top trial selected for evaluation. Kinovea determined each subject's center of gravity throughout the throw. Tracking the javelin's trajectory post-release enabled velocity calculation. Using Kinovea software, targeted kinematic variables such as angles at the ankle, knee, hip, shoulder, elbow, and wrist joints were measured.

Statistical Procedure

To determine the prediction of the power position technique in javelin throw based on kinematic variables, multiple regression analysis, t-values, and partial correlation techniques were employed. For hypothesis testing, the significance level was established at 0.05.

Table 1: Regression Model of Angle of Right Hip with the performance at the Javelin Thrower Power Position.

R	R Square	Adjusted R Square	Std. Error of the Estimate
.622a	.387	.353	1.57648

Table No-1 Presents the regression model, which yields an R2value of 0.387. This value indicates that the model accounts for 38.7% of the variance in javelin throw performance.

Table 2: Anova Table for Regression models of Angle of Right Hip with the performance at the Javelin Thrower Power Position.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	28.215	1	28.215	11.353	.003
Residual	44.735	18	2.485		
Total	72.950	19			

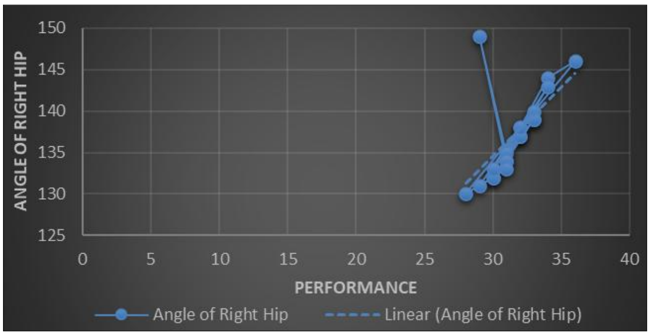
Table No.2 Revealed that F value of 11.353 for the model moderate and significant, it might be presumed that model selected is moderately efficient.

Table 3: Regression Coefficient of Angle of Right Hip with the performance at the Javelin Thrower Power Position.

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.495	9.517		-.052	.959
Angle of Right Hip	.234	.069	.622	3.369	.003

Table No- 3 revealed that the model t-value for the regression coefficient was significant as the significance value (p-value) is less than (.05)

The resulting regression equation is Performance of Thrower in Javelin Throw = -.495 - .234 (Angle of Right Hip)



Graph 1: Regression Equation between Angle of Right Hip and performance of Thrower in Javelin.

Discussion of Findings

The regression model reveals a moderate positive relationship between right hip angle at the javelin throw power position and overall throwing performance, with R = .622 and R² = .387, indicating that 38.7% of performance variance is explained by this variable (Peterson K. Ozili, 2023) [8]. The significant F-value (11.353, p = .003) confirms model reliability, while the t-value (3.369, p = .003) for the right hip angle coefficient (β = .234) underscores its predictive validity, suggesting optimal hip extension enhances kinetic energy transfer (Krzyszkowski & Kipp, 2021) [1]. This aligns with the derived equation, Performance = -0.495 + 0.234 × (Right Hip Angle), where incremental angle increases predictably boost distance.

Kinematic studies on junior throwers report positive correlations between hip joint angles and throw distance, with optimal lower limb configurations (e.g., hip drive) explaining up to 40% of performance variability, mirroring the current R² (Kumar, 2022) [5]. Elite-level analyses further validate hip angle's role, as greater hip-shoulder separation and extension timing in power position phases significantly predict distances over 85m, supporting the model's emphasis on proximal joint contributions (Baker, 2021) [4].

These findings highlight right hip angle as a trainable biomarker for power position efficacy, enabling coaches to target 90-120° ranges via plyometric and technique drills for Indian national throwers. Limitations include the model's moderate R^2, suggesting multifactorial influences like release velocity warrant multivariate extensions. Future research could integrate 3D motion capture for real-time feedback in training protocols.

The predictive regression analysis confirms that right hip angle at the javelin throw power position significantly predicts throwing performance ($R^2 = .387$, $p<.01$), with optimal extension around 90-120° enhancing kinetic chain efficiency among Indian national throwers (Krzyszkowski & Kipp, 2021) [1].

Conclusions

The model equation, Performance = -0.495 + 0.234 × (Right Hip Angle), demonstrates moderate explanatory power, aligning with kinematic evidence where hip drive accounts for substantial variance in elite distances exceeding 85m (Baker, 2021) [4]. This validates hip angle as a reliable biomarker for power position efficacy, supported by significant F (11.353) and t (3.369) statistics. Coaches can leverage these findings for targeted interventions, such as Kinovea-based feedback on hip alignment during 240 fps captures, to refine technique in 20-28-year-old athletes. Personalized +training emphasizing hip extension will likely elevate performance in precision throws. Extending to multivariate models incorporating release velocity and shoulder separation remains essential, alongside longitudinal studies tracking training adaptations in diverse populations.

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