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RELATIONSHIP OF SELECTED KINEMATIC VARIABLES WITH THE PERFORMANCE OF FOLLOW THROUGH OUT-SWING IN FAST BOWLING

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Abstract
Aim*: To assess the relationship between selected kinematic variables with the performance of follow through in out-swing bowling.* ***Material and Methods****: Twelve randomly selected male students aged 19-28 years from Ranji Trophy from U.P Team, Players of Combine University Camp and the players of Under 22 national Cricket volunteered to participate in the study. The data was collected by the help of Siliconcoach pro-07 motion analysis solution software. The Pearson's product moment correlation coefficient method was used to measure the relationship between selected biomechanical variables with the performance of out-swing bowling in cricket. The level of significance was set at 0.05****. Results****: The results have shown the values of coefficients of correlation of selected angular kinematics variables at follow through and Out-Swing bowling performance.* Knee Joint (Right) *Shoulder joint (Right), Elbow joint (Right) Knee joint (Left) Shoulder Joint (Left), Elbow joint (Left) & Wrist joint (Left).* ***Conclusion:*** *The General alignment of the bowling sequence following a* ***linear path****, there is a less likely chance of injury due to the reduction on the rotation of the upper and lower body in different directions. Through using* ***Newton's Third Law*** *which states* "For every action, there is an equal and opposite reaction" *we are effectively able to sum up that the follow through should be as long as needed to slow down the body without exerting any sudden forces which can cause injury and minimise the effectiveness of the action*

Key words: biomechanics, Siliconcoach Motion Analysis, Out-swing, Follow Through.

Introduction

In modern times, the spirit of extreme competition has changed the entire scenario in sports. The craze for winning medals in the Olympics and in other international competitions has catalyzed the sport scientists to take interest in exploring all the aspects and possibilities which can contribute to enhance sports performance to undreamt heights.

The role of biomechanics in attaining high performance cannot be overlooked, since it is the only science which helps in identifying the faults of performing technique very precisely. There are basically two methods by which skill can be analyzed. They are qualitative and quantitative. High speed module film for exactness has been used extensively to examine in great details of the movements which occur too fast for the human eye to detect. In many of elite sport training and research institution around the world, force applied during high caliber sporting event, while the analysis test have done much to improve understanding of movement and the performance of elite athletes, the analysis task faced by the coach are predominantly qualitative in nature.

Cricket has become one of the most popular in the world of all major games in India. It is the only one that has been zealously preserved by all those who play or support it. There are various departments in cricket i.e. Batting, Bowling, fielding and no other takes preference over the other, and they are all, of course, of equal importance.

The objective in any cricket match is to score as many run as possible, but equally important is to take wickets and to keep your opponent scoring rate down. As result so much depend on team bowlers. Fast bowlers are used as front line of attack who help the team by keeping the opponent run rate checked and by taking the opponents wickets at regular interval.

Objectives

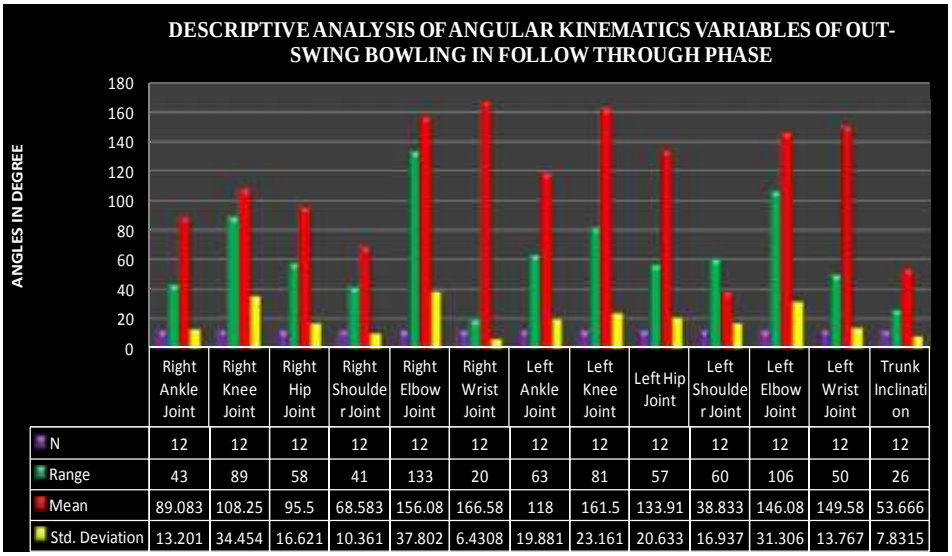
The purpose of this study was finding out the performance between selected kinematic variables at follow through and Out-swing bowling.

Methods

Twelve male cricket players aged between 19 to 28 years were selected for the purpose of this study. These subjects participated in the Ranji Trophy from U.P Team, Players of Combine University Camp and the players of Under 22 national Cricket Championship were selected as subjects for this study.

The performance of out-swing bowling of each selected subject was taken as the criterion measure for the purpose of the present study. The skills performance of subjects was evaluated by subjective judgment by a panel of three judges,

For the Kinematic analysis Out-swing in Fast Bowling in cricket High speed videography technique was employed. The two Casio Exilim EX-F1 high speed cameras used for this purpose. Performance of subjects was recorded in control and favorable conditions. The data were recorded from both planes i.e. Sagittal plane and frontal plane. Further Out-Swing Bowling divided into five phases such as gather phase, back foot impact, delivery stride, releasing phase and follow through. The center of gravity was calculated at selected moments, by using segmentation method. The Pearson's product moment correlations was calculated between selected kinematic variables and performance of the subjects in Out-Swing Bowling performance. The biomechanical variables were consisted of selected angular kinematic variables i.e. the measurements of angles at various joints of ankle joints (Right & Left), knee joints(Right & Left), hip joints (Right & Left), Shoulder joints (Right & Left), elbow joints (Right & Left), wrist joints (Right & Left), and Trunk inclination.



	Right Ankle Joint	Right Knee Joint	Right Hip Joint	Right Shoulder Joint	Right Elbow Joint	Right Wrist Joint	Left Ankle Joint	Left Knee Joint	Left Hip Joint	Left Shoulder Joint	Left Elbow Joint	Left Wrist Joint	Trunk Inclination
N	12	12	12	12	12	12	12	12	12	12	12	12	12
Range	43	89	58	41	133	20	63	81	57	60	106	50	26
Mean	89.083	108.25	95.5	68.583	156.08	166.58	118	161.5	133.91	38.833	146.08	149.58	53.666
Std. Deviation	13.201	34.454	16.621	10.361	37.802	6.4308	19.881	23.161	20.633	16.937	31.306	13.767	7.8315

Fig-1: Descriptive Analysis of Angular Kinematics Variables of Out- Swing Bowling In Follow Through Phase

The mean, standard deviation and range of angular kinematics variation of out- swing bowling in follow through phase are presented in Fig. 1.

The mean, standard deviation and range of angles for angular kinematics for different variables in degree are as follows: Right Ankle Joint (89.08± 13.20), range of angle is 43, Right Knee Joint (108.25± 43.45), range of angle is 89, Right Hip Joint (95.50 ± 16.62), range of angle is 58, Right Shoulder Joint (68.58 ± 10.36), range of angle is 41, Right Elbow Joint (156.08 ± 37.80), range of angle is 133, Right Wrist Joint (166.58 ± 6.43), range of angle is 20, Left Ankle Joint (118.00 ± 19.88), range of angle is 63, Left Knee Joint (161.5 ± 23.16), range of angle is 81, Left Hip Joint (133.92 ± 20.63), range of

angle is 57, Left Shoulder Joint (38.83 ± 16.93), range of angle is 60, Left Elbow Joint (146.08 ± 31.30), range of angle is 106, Left Wrist Joint (149.58 ± 13.76), range of angle is 50, Trunk inclination (53.66 ± 7.83) range of angle is 26.

Table-1.Correlation Between *Out-Swing Bowling Performance* and Angular Kinematics Variables at Follow Through Phase

Independent Variables	Correlation coefficient
Ankle Joint (Right)	.121
Knee joint (Right)	-.183
Hip joint (Right)	-.689*
Shoulder joint (Right)	-560
Elbow joint (Right)	.291
Wrist joint (Right)	.200
Ankle joint (Left)	-.334
Knee joint (Left)	.396
Hip joint (Left)	-.530
Shoulder joint (Left)	-.498
Elbow joint (Left)	-.613*
Wrist joint (Left)	.220
Body Inclination	.391

*** Significant at .05 level**

r.05 (10) = .576

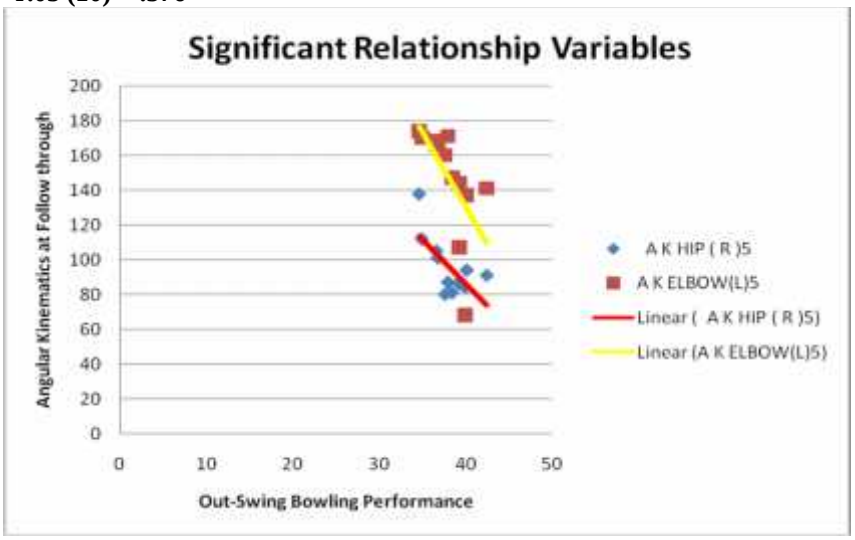


Fig-2: Significant Relationship Variables at Follow through in Out-Swing Bowling

Table-1 clearly indicates that there exists a significant relationship between *Out-Swing Bowling Performance and* Hip joint (Right) & Elbow joint (Left) as the correlation coefficient values were found higher than the tabulated value. at .05 level of significance.

On the other hand, there exists an insignificant relationship between *Out-Swing Bowling Performance and* Ankle joint (Right), Knee joint (Right), Shoulder joint (Right), Elbow joint (Right) Wrist Joint (Right) Ankle Joint (Left), Knee joint (Left), Hip joint (Left), Shoulder joint (Left), Wrist joint (Left) & Body Inclination as the correlation coefficient values were found less than the tabulated value. at .05 level of significance.

Discussion of Findings

The statistical analysis data clearly indicates that there exists a significant relationship between *Out-Swing bowling performance and Hip joint (Right) 95.50*^{o} $\pm$16.62^{o} *and Elbow joint (Left)* 146.08^{o} $\pm$31.30^{o}. This could be due to the fact that non bowling guiding the path of ball and hip joint (Right) provide help for regaining stability and minimize the momentum of body. The body is statically held in position until the ball is well down the lane.

The arm swing follows its natural directional path upward and outward, lifting with the fingers as they slide out of the holes. This is the only motion of the follow through phase except for the bowler continuing to slide. The body is statically held in position until the ball is well down the lane.

1. Left Knee Joint - flexed.
2. Left Hip Joint - flexed.
3. Right Hip Joint - extension.
4. Right Knee Joint - extension.
5. Right Ankle Joint - plantar flexed, dragging on tops of toes.

On the other hand, there exists an insignificant relationship between *Out-swing bowling performance and* Angular kinematic variables. This could be due to the fact that most of these variables might have contributed in Out-swing bowling performance; however the individual contribution were insignificant.

Limited data is available on the follow-through, as most analyses stop shortly after ball release. It was suggested by barlett et al., (1996) that the bowler should ensure that the bowling arm follows through down the outside of the left thigh allowing a gradual reduction in the bowlers speed and that the first stride of the follow-through should be behind the line of the ball, before running off the wicket for a further 2-3 strides. Foster (1989) suggested that the bowler should ensure that the bowling arm follows through down the outside of the left thigh (for a right-handed bowler) with the bowling arm almost brushing the ground. Tyson (1976) suggests that the first stride of the follow-through should be behind the line of the ball before running off the pitch with the second and third stride. Hurrion (2004) states that the bowler during follow through should be aligned with the intended direction of ball travel which is generally off stump, this is made easier if the run-up, pre-delivery stride and delivery stride follow a straight line. The sequence of images in figure 10 (below) demonstrate the effective alignment of the run-up, pre-delivery stride and delivery stride which in turn allows for the first stride of the follow through to be aiming in a straight line at the intended target (Hurrion, P, 2005) Through the General alignment of the bowling sequence following a **linear path**, there is a less likely chance of injury due to the reduction on the rotation of the upper and lower body in different directions (Ferdinands, R, 2008). Through using **Newton's Third Law** which states "*For every action, there is an equal and opposite reaction"* we are effectively able to sum up that the follow through should be as long as needed to slow down the body without exerting any sudden forces which can cause injury and minimise the effectiveness of the action (Blazevich, A, 2012,).

Present Study supported the findings of the study conducted by Berglund Dave and Dr Paul Hurrion.

Conclusion

1. The Hip joint (Right) & Elbow joint (Left) has positive effect on the performance of Out -Swing bowling at follow through phase. On the other hand the other selected angular kinematics variables did not have significant relationship with Out-Swing bowling at follow through phase.

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