

## ELBOW ANGLE EXCURSION SLOPE AS A DETERMINANT OF BOWLING LEGALITY

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### INTRODUCTION

The legality of a bowler's action in cricket has been established in accordance with Law 24.3 of the International Cricket Council (ICC) rules, which state that "once the bowler's arm has reached the level of the shoulder in the delivery swing, the elbow joint is not straightened partially or completely from that point until the ball has left the hand" (MCC, 2002). However, fast bowlers seldom use a rigid straight arm, and the elbow angle generally increases after reaching shoulder height [1,3].

The ICC in keeping with these facts set a range of allowable elbow extension angles: 10° for fast bowlers, 7.5° for medium-pace bowlers, and 5° for spin bowlers. However, in a laboratory study of 42 subjects Ferdinands and Kersting [1] showed that there was no correlation between elbow extension angle and bowling type, and recommended a 15° flat tolerance level. The aim of this study was to further examine bowling action legality by measuring the elbow extension angle, and the elbow excursion angle slope through ball release of a sample of 67 bowlers using an 8-camera three-dimensional (3D) motion analysis system (240 Hz). The results suggest that elbow excursion angle is an important determinant of bowling action legality.

### METHODS

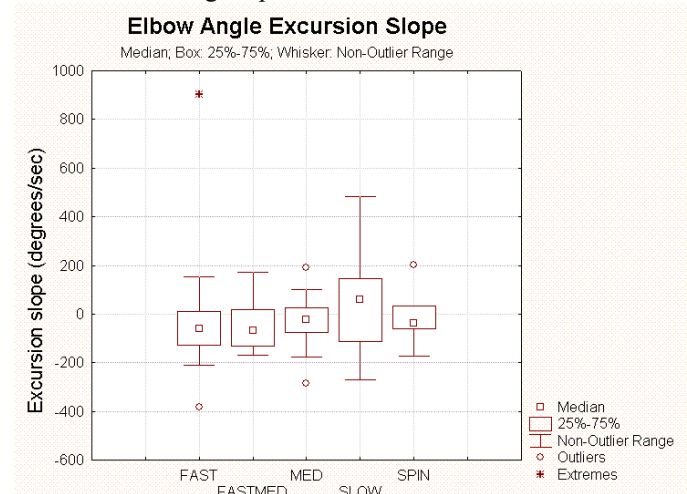
Sixty-seven bowlers were selected for the study, and grouped into fast, med-fast, medium, slow, and finger-spin categories. Also, 8 bowlers in this sample were observed as possibly having a throwing-type action. Each subject was filmed by an 8-camera marker-based 240 Hz motion analysis system. A 10-marker static calibration marker system was used. This was reduced to a 7-marker bowling set, which is the minimum required to carry out a 3D analysis of the arm based on an anatomically based joint coordinate system (JCS). The 3D elbow angles were calculated from the relative orientation of the forearm to the upper arm based on a joint coordinate system [2]. Six trials per subject were recorded. Elbow excursion angle slope was calculated as the rate of elbow angle change from two frames before to two frames after ball release.

### RESULTS AND DISCUSSION

The mean elbow extension angles for the groups were fast: 6.23±0.65°, med-fast: 4.79±0.63°, medium: 7.27±0.93°, and slow: 6.74±1.59°. There was no correlation found between elbow extension angle and ball release speed. Also, there was some variability in the mean elbow extension angles per subject. Eight bowlers had elbow extension angles in excess of 10°, and rare individual trials could have up to 15° extension. However, only one of these bowlers was suspected of throwing.

The elbow excursion angle slope was negative for 70.1% of the bowlers, which means that after an initial elbow extension,

the elbow flexed through release (Figure 1). For the remaining bowlers, the elbow excursion angle slope was positive, indicating that the elbow extended through release. This is partially consistent with the 4<sup>th</sup> edition of the MCC 1947 code (1970) which defined a legal bowl when the "process of straightening the bowling arm, whether it be partial or complete, takes place during that part of the delivery swing which directly precedes the ball leaving the hand." However, according to this law there would still be too many illegal bowlers. However, above an elbow excursion angle slope of a 100 °/sec, only 11.9% of the bowlers would be considered illegal, including all eight bowlers who had been previously observed as having suspect actions.



**Figure 1: Elbow excursion angle slope for all bowling groups. Positive means extension through release.**

### CONCLUSIONS

The findings suggest that a new bowling law should not only specify a flat tolerance level for elbow extension angle, but examine the new concept of elbow excursion angle slope through ball release. It is also possible that elbow excursion angle slope has a better correlation with a visual determination of bowling legality. From a biomechanical perspective, an extending arm through release is able to use both humerus internal rotation and elbow extension as a contribution to ball speed, as in a throw. More research is needed to determine the legal level of excursion angle slope. Also, the mean elbow extension data indicates that a 15° tolerance level may be excessive, particularly if there is no consideration of elbow excursion angle slope.

### REFERENCES

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