THE DETERMINANTS OF BALL RELEASE SPEED IN CRICKET FAST BOWLERS

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The purpose of this study was to identify parameters that contribute to high ball release speeds in cricket fast bowlers. 28 senior fast bowlers (mean ball release speed 34.0 ± 1.3 m/s) had their morphological dimensions, concentric and eccentric isokinetic strength and bowling technique analyzed. Six 50 Hz cameras and Ariel Performance Analysis System software analyzed their single fastest bowling action. Using Pearson's correlation the parameters that significantly predicted ball release speed were: front leg knee angle at ball release, shoulder transverse orientation angle at front foot strike and strength of the shoulder extensor muscle group. Predictor variables failed to allow their incorporation into a multivariate model which is known to exist in less accomplished bowlers, suggesting that data from other groups may not be applicable to competive fast bowlers.

KEY WORDS: cricket bowling, morphological dimensions, isokinetic strength, motion analysis.

INTRODUCTION:

Modern cricket is an international sport and teams at all levels strive to develop fast bowlers that can generate high ball release speeds. The ability of bowlers to bowl with high ball release speeds contributes to the successful performance of all cricket teams (Portus et al., 2004). The objective of high ball release speeds is to either dismiss or reduce the scoring ability of the opposing batsmen. Fast bowlers use speed of delivery as their primary strategy to dismiss the batsmen. Fast bowlers who bowl with higher ball release speeds make the task of the batsman more challenging as there is less time for the batsman to select and then execute his chosen shot (Abernethy, 1981). Mistakes by the batsmen increase the chances of the bowling team to win the match.

The aims of our study were therefore to identify the morphological, strength and biomechanical factors that contribute to higher ball release speeds. The selected parameters have been mentioned by previous researchers (Elliott et al., 1986, Bartlett et al., 1996, Portus et al., 2000, Glazier et al., 2000, Hurrion and Harmer, 2003, Elliott et al., 2002, Portus et al., 2004, Loram et al., 2005 and Salter et al., 2007) as contributing to ball release speed. Across these studies the correlation between these parameters and ball release speed remains inconsistent and, as such, it is difficult to accurately determine their importance or contribution to high ball release speeds.

METHOD:

Data Collection: Twenty-eight fast-medium bowlers (age 22.0 ± 3.0 years, body mass 82.0 ± 10.4 kg, height 183.0 ± 8.8 cm) representing clubs playing premier league outdoor cricket across Gauteng, South Africa, participated in the study. All subjects participated in a single data collection design in which morphological dimensions, strength and a bowling action analysis were assessed.

Included in the morphological dimensions were body dimensions (height and weight), body composition (seven skinfolds and somatotype) and selected skeletal limb lengths used in fast bowling. The skeletal limb lengths included arm-span, acromiale-radiale and radiale-stylion, trochanterion and tibiale laterale. Absolute and relative (to standing height) values were recorded. The international anthropometric standards adopted for this study were those used by the International Society for the Advancement of Kinanthropometry (ISAK).

The strength assessments consisted of isokinetic measurements of selected joint actions. Assessments were conducted on a Cybex NORM (Lumex, Inc., Ronkonkoma, New York, USA) isokinetic dynanometer. Peak torque recordings of both concentric and eccentric muscle actions at multiple velocities were obtained. Isokinetic torque values were displayed

in Newton-meters (Nm) and relative to the subject's body mass (Nm/kg). The selected joint actions included knee flexion-extension, shoulder flexion-extension and shoulder internal-external rotation. Knee flexion-extension (seated) included concentric and eccentric assessments at 60 and 240º/s. Shoulder flexion-extension (supine) included concentric assessments at 30, 60, 120 and 240º/s. Shoulder internal-external rotation (supine with 90º shoulder abduction) was assessed concentrically and eccentrically at a velocity of 30º/s.
The biomechanical analysis of the bowling action was conducted by capturing the in-door bowling action trials of each subject on video. The bowling action trial of each subject that produced the highest ball release speed, while maintaining accuracy, was analyzed using APAS (Ariel Performance Analysis System - Ariel Dynamics Inc., San Diego, California, USA) three-dimensional motion analysis software. Six 50 Hz digital video cameras captured the images and directly relayed the images to the APAS workstation. A radar gun (Stalker ATS, Texas, USA) was positioned 180º behind ball release to instantaneously display the peak release velocity of each delivery bowled. A calibration structure of sufficient volume for reliable digitizing, was constructed having the dimensions of 4.8 m x 2.5 m x 2.4 m. Twenty-four control points of known X (length), Y (height) and Z (depth) co-ordinates were used to calibrate the image space, 28.8 m^3 large. The volume allowed for the analysis of the complete bowling action; from the commencement of the pre-delivery stride to the end of the first follow-through stride. Wickets and lines (creases), of official size and length were included into the calibrated image-space. Two (25 cm tall) target cones were placed at 'good length' (Salter et al., 2007), 15.0 m from the bowling crease and subjects were instructed to hit the cones. Only six legitimate (excluding 'no-balls') and accurate deliveries were recorded with the fastest, as determined by the radar reading, being selected for subsequent kinematic analysis. For analysis, the six image sequences were synchronized to a single visual cue and the frames displaying the bowling action were saved. Manual digitizing (of 18 identified joint centres) was used and all relative two-dimensional co-ordinates were transformed, via the APAS software, to three-dimensional image space co-ordinates from which the calculation of biomechanical variables were derived.

Data Analysis: Pearson's product-moment correlation coefficients (two-tailed) were used to determine correlations with ball release speed. Statistical significance was set at $P< 0.05$. A stepwise multiple regression was used to combine variables in an attempt to generate a multivariate predictive model of ball release speed.

RESULTS AND DISCUSSION:

The mean ball release speed for our subjects was 34.0 ± 1.3 m/s which classifies them as fast-medium bowlers (Abernethy, 1981) and is comparable to the speeds obtained by previous authors for senior fast bowlers (Davis and Blanksby, 1976, Portus et al., 2004, Salter et al., 2007). The variables that were identified in our study as significantly correlating to ball release speed are presented in table 1.
None of the morphological variables reported in our study showed any significant correlation to ball release speed in either absolute or relative terms. These finding do not support the suggestions by Stockill and Bartlett (1994) and Glazier et al. (2000) that longer limb lengths contribute to higher ball release speeds, but the findings are in agreement with the anthropometric correlations to ball release speed reported by Loram et al. (2005).
In our study we identified a significant positive correlation between the relative concentric shoulder extension strength at 60º/s (95.5 ± 13.7 Nm/kg) and ball release speed. (No previous authors have reported on shoulder flexion-extension strength.) In our study there was also a positive correlation between the relative concentric shoulder internal-rotation strength at a mid-range position of 20º external rotation (45.6 ± 10.7 Nm/kg) and ball release speed. The correlations suggest that bowlers who are stronger in the shoulder region, bowl with higher ball release speeds (agreement with Portus et al., 2000). However, no significant correlations can be reported for any of the knee isokinetic strength capacities and ball release speed.

Table 1 Variables correlating significantly to ball release speed.

	r value	P value
Concentric shoulder extension strength at 60º/s (relative to body mass)	r = + 0.392	P = 0.039
Concentric shoulder internal-rotation strength at +20º (relative to body mass)	r = + 0.428	P = 0.023
Front leg knee angle at ball release	r = + 0.517	P = 0.005
Front leg knee flexion from front foot strike to ball release	r = - 0.465	P = 0.013
Shoulder transverse orientation at front foot strike	r = - 0.466	P = 0.013

The biomechanical variables that correlated to ball release speed were the front leg knee angle at ball release (150.7 ± 17.1º) and the shoulder transverse orientation at front foot strike. A more extended front leg at ball release has been reported by various authors (Portus et al., 2000, Hurrion and Harmer, 2003, Loram et al., 2005 and Salter et al., 2007) as contributing to higher ball release speeds. Although no significant correlation was found with the front leg knee angle at front foot strike, a significant negative correlation was observed between the degree of front leg knee flexion from front foot strike to ball release (15.0 ± 17.5º) and ball release speed, indicating that the less the front leg knee flexes between front foot strike and ball release the greater the ball release speed.

The data for the current subjects' transverse orientations for the shoulder and hip at back foot placement, front foot strike and ball release are within the range of data presented by previous authors (Elliott et al., 1986, Portus et al., 2000, Elliott et al., 2002). No significant correlations were found for the current study for either shoulder-hip separation angles or for the degree of shoulder counter-rotation. However, a significant negative correlation for the transverse shoulder orientation at front foot strike (210.4 ± 10.7º) with ball release speed was found indicating that the less the angle of the shoulders are at front foot strike the greater the ball release speed. This finding regarding shoulder orientation is in agreement with the Portus et al. (2004) finding. Literally, the more the shoulders are rotated away from batsman at front foot strike the greater the arc for transverse shoulder rotation towards the batsman at ball release. The desire for an increased arc of rotation may be the reason why so many fast bowlers, particularly front-on bowlers, counter-rotate their shoulders after back foot placement.

A stepwise multiple regression analysis was investigated to assess whether selected variables from table 1 could be combined to generate a multivariate predictive model of ball release speed. However, the predictor variables failed to allow their incorporation into a multivariate predictive model. The failure in the attempts to generate such a model show that previously reported predictive models (Loram et al., 2005, Salter et al., 2007) can not be inferred across all fast bowling populations.

Our findings have implications for all fast bowlers (both current and emerging), fast bowling coaches and conditioning experts. Mixed and front-on fast bowlers who wish to increase the arc of shoulder transverse rotation between front foot strike and ball release, without increasing the undesired and injurious shoulder counter-rotation (Burnett et al., 1998, Wallis et al., 2002, Elliott et al., 2002, Portus et al., 2004), need to consider making adaptations to their bowling technique. The possible options include adopting a semi-open or a front-on mixed bowling action. Fast bowlers should strive to adopt the flexed-extender front leg knee action technique, as advocated by Bartlett et al. (1996) and Portus et al. (2004), in order to optimize both impact force attenuation and the performance benefits of releasing the ball with a straighter leg. Lastly, strength conditioning programs must focus on the upper body strength development of particularly the bowling arm's shoulder extension and internal-rotation muscles.

CONCLUSION:

Our study shows that bowlers who are taller, have longer limb lengths and greater muscularity do not bowl with higher ball release speeds. These findings are encouraging to aspiring fast bowlers as it can be concluded that genetic characteristics will not limit their future and that they can still achieve, and exceed, the bowling speeds of taller or more mesomorphic fast bowlers. Our study identified that bowlers who generate higher isokinetic peak torque values for shoulder extension bowl with higher ball release speeds. In addition, we identified that the straightness of the front leg knee angle at ball release (including the magnitude of front leg knee flexion between front foot strike and ball release) as well as the shoulder transverse orientation angle at front foot strike also contributes to higher ball release speeds.

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