Relationship Between Mechanical Stiffness and Ball Release Speed in Cricket Fast Bowling

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Summary

Mechanical stiffness, including vertical (Kvert) and leg (Kleg) stiffness, has been identified as one of the key biomechanical factors influencing athletic performance [1]. However, its relationship with ball release (BR) speed in cricket fast bowling has not been investigated. This study examined the relationship between mechanical stiffness and BR speed in elite male fast bowlers.

Introduction

Critical to a fast bowler's success is the ability to generate high BR speeds, which reduces the time the batter has to react to the oncoming delivery. Understanding factors influencing BR speed is important to gaining performance advantages. Studies have shown that bowlers who exhibit an extended front knee at the front foot contact (FFC) record higher BR speeds [2,3]. Given these factors and the importance of an extended front knee at BR, it is hypothesised that having stiffer lower extremities that collapse less could be beneficial to bear the load of landing and reduce energy loss, as well as transfer the momentum from larger segments (legs and trunk) to smaller segments (arms and hands) efficiently.

High mechanical stiffness of the lower extremities contributes substantially to numerous measures of human performance, including the rate of force production, spring kinematics, elastic energy storage and utilisation [1]. Studies have reported a positive influence of increased mechanical stiffness on human movements such as running and jumping-based activities. However, no research has investigated the association between mechanical stiffness during the final delivery stride to BR speed in cricket fast bowling. This study aimed to examine the correlation between Kvert, Kleg, and BR Speed in fast bowlers.

Methods

This cross-sectional study analysed existing 3D biomechanical data from 20 elite fast bowlers (state level or above) from Cricket Australia. Six bowling trials from each participant were considered for the study.

3D marker trajectories were reconstructed and labelled using Vicon Nexus software (Oxford Metrics Ltd, Oxford, UK) based on the UWA full-body marker set. During the delivery stride phase, the temporal events of FFC and BR were defined when the first ground reaction force (GRF) z vector appeared, and the distance between the ball marker and metacarpophalangeal joint marker of the bowling hand increased by 20mm, respectively.

Mechanical stiffness of the front leg calculated between FFC - BR based on the following equations: (i) $k_{vert} = F_{max} / \Delta y$, (ii) $k_{leg} = F_{max} / \Delta L$. (Fmax - maximum ground reaction force; Δy – vertical displacement of COM; ΔL change of leg length) [4]. The magnitude of the ball's resultant velocity vector collected from the 20 frames posts BR was used to measure BR speed. Mean values of Kvert, Kleg and BR speed were calculated for each fast bowler. A hypothesis test for the population correlation coefficient was conducted to determine any significant correlation between the given stiffness measure and BR speed. Simple linear regression was conducted to examine the relationship between the given stiffness measure and BR speed.

Results and Discussion

Kvert and BR speed were normally distributed ($p > 0.05$), while Kleg was not ($p < 0.05$). Spearman's correlation analysis was due to the non-normal distribution in Kleg. Correlation analysis showed a weak and non-significant relationship between kvert and BR ($r = 0.059$, $p = 0.81$) and a slightly moderate but non-significant relationship between kleg and BR ($r = 0.34$, $p = 0.41$). The regression analysis shows that neither Kvert ($p = 0.93$) nor Kleg ($p = 0.87$) significantly predicted BR speed. These findings suggested that mechanical stiffness alone does not determine BR speed, potentially due to the asymmetric nature and variations of bowling techniques and segmental coordination.

Conclusions

This study found no significant relationship between mechanical stiffness measures and BR speed in cricket fast bowlers. While mechanical stiffness is crucial in various athletic movements, its role in fast bowling remains unclear.

Acknowledgments

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References

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