Angling for Better Pitching: Associations between stride direction angle, pitch velocity, and braking impulse

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Summary

Kinetic and kinematic parameters are often analyzed in baseball pitching to improve performance and mitigate injury risk. Stride direction angle (SDA), defined as the deviation of the stride path of the pitcher from a neutral line towards home plate, has yet to be investigated for its contribution to pitching biomechanical parameters. The influence of SDA on pitch velocity and breaking impulse (BI) in high school, college and minor league pitchers was evaluated retrospectively using the OpenBiomechanics dataset. SDA was negatively correlated with BI, with no correlation to pitch velocity. A larger deviation from a neutral SDA may impact energy transfer from the lower body to the upper body without influencing pitch performance. Performance professionals should consider the influence of SDA in their training programs to enhance energy efficiency and potentially mitigate injury risk.

Introduction

In baseball pitching, SDA quantifies the angle of the pitcher's stride path in relation to a straight line towards home plate. Prior research supports the influence of stride parameters on pitch velocity (PV): longer stride lengths [1], proper joint alignment [2], and stride patterns optimizing the SDA improve energy transfer and pitching performance [3]. Furthermore, studies evaluating the impact of kinetic parameters at foot contact such as braking impulse (BI), found positive associations with energy transfer through the pitch [4]. However, few studies have investigated the contribution of SDA to pitching mechanics. The aim of this study is to determine if SDA is related to PV or BI in baseball pitchers.

Methods

100 pitchers during regular training sessions at Driveline Baseball were retrospectively analyzed via the OpenBiomechanics dataset [5]. High school, college, and minor league pitchers threw fastballs on a Bertec instrumented pitching mound coupled with 3D motion capture. SDA was the angle between the line created by the push-off leg ankle joint center (AJC) and the stride leg AJC respective to a line pointing directly towards home plate (Figure 1). "Open" strides were denoted as positive and "closed" strides as negative angles; open and closed angles were averaged separately for each pitcher for analysis. To determine the relationship of SDA to PV and BI, Pearson's correlation analyses were performed. Normality was assessed via Shapiro-Wilk's test with the alpha level for all statistical tests set at .05.

Figure 1: Stride Direction Angle (SDA) and open and closed stance directions for a right-handed pitcher.

Results and Discussion

All data were normally distributed (p>.05). SDA and PV were not significantly correlated for the subgroups of open (p>.05) or closed stance pitches (p>.05). SDA and BI were significantly correlated for the open stance pitches (r=-0.41, p=0.008) but not for closed stance (p>.05).

The results of this study indicate SDA could play an important role in the mitigation of injury risk. The negative relationship with BI coupled with the lack of a relationship to PV suggests the compensation of the upper body to maintain velocity. As higher BI has been associated with improved energy transfer, excessively open SDAs could lead to a reduction in energy transference from the lower to upper body. This may have injury implications, as reduced energy transfer efficiency could place greater stress on upper body musculature. A more open stride may cause the pitcher to become off-balance and generate lateral, rather than anteroposterior, forces. To counteract this phenomenon, trunk, shoulder, and elbow musculature may be activated to a greater degree resulting in increased utilization and stress.

Conclusions

This study begins the investigation of the influence of SDA in pitching mechanics, supporting its inclusion as a metric in player development evaluations. A more neutral SDA is associated with higher BI without changes in PV, potentially indicating more effective energy transference and reduced injury risk. Baseball professionals should consider including SDA as a predictive performance metric in pitching analyses. Future studies should expand on these findings by examining SDA in pitchers across specific skill levels and age groups.

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Joeseph Marsh at Driveline Baseball

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