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### The Effects Of Hip And Torso Kinematics On Fastball Velocity In Baseball Pitchers

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Baseball pitching involves the transfer of energy through the kinetic chain, including the hips and torso. Understanding how fastball kinematics affect throwing velocity (TV) will help inform coaches and other sport personnel in devising optimal training programs.

**PURPOSE:** To evaluate the relationship between TV and hip and torso kinematics in male baseball pitchers.

**METHODS:** We assessed the hip and pelvis mechanics of 100 baseball pitchers (18 professional, 75 college, and 7 high school) with motion capture cameras (Optitrack Prime 17W). Variables assessed were maximum torso rotational velocity (TR<sub>max</sub>), maximum pelvis rotational velocity (PR<sub>max</sub>), maximum hip-shoulder separation (HSS<sub>max</sub>), and hip-shoulder separation at foot plant (HSS<sub>fp</sub>). TV was assessed using a Stalker Sport radar system. All pitchers underwent an identical warm-up followed by 5 evaluated pitches. Regression analyses measured the effect of each kinematic parameter on TV with confounders held constant.

**RESULTS:** Subjects were 21.4 ± 2.3 years old, 185.3 ± 7.2 cm tall, and weighed 90.7 ± 10.1 kg. TR<sub>max</sub> was 1050.0 ± 87.2°/s, PR<sub>max</sub> was 745.8 ± 96.3°/s, HSS<sub>max</sub> was 32.1 ± 6.7°, and HSS<sub>fp</sub> was 29.7 ± 6.8°. TV was 84.8 ± 4.7 mph, and differed across play levels (p=0.002). TV was also related to age (r=0.331; p<0.001), height (r=0.250; p=0.012), and weight (r=0.245; p=0.014). TV was correlated with TR<sub>max</sub> (r=0.328, p<0.001), HSS<sub>max</sub> (r=0.299, p=0.002), and HSS<sub>fp</sub> (r=0.304, p=0.002); TV was not related to PR<sub>max</sub> (r=0.011, p=0.910). HSS<sub>max</sub> and HSS<sub>fp</sub> were correlated (r=0.929; p<0.001); when both were included in the regression model, variance inflation factors were 8.1 and 7.7 respectively; HSS<sub>fp</sub> was retained owing to its stronger correlation both alone and in the full model. PR<sub>max</sub> was removed owing to insignificance in the full model (p=0.265). Holding age, height, and TR<sub>max</sub> constant, HSS<sub>fp</sub> did not reach significance (β=0.108; p=0.101); it was removed. In the final regression model, age (β=0.598; p=0.001; 95% CI: 0.239, 0.957), height (β=19.633; p<0.001; 95% CI: 8.325, 30.940), and TR<sub>max</sub> (β=0.018; p<0.001; 95% CI: 0.009, 0.028) were significant predictors of TV (R<sup>2</sup>=0.283; p<0.001).

**CONCLUSIONS:** Maximum trunk rotation velocity was the only significant predictor of TV when tested together. Exercises that increase torso velocity may benefit pitchers.

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### Effects Of Wrist Position At Stride Foot Contact On Joint Moments In Baseball Pitching

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Shoulder and elbow joints endure high stress during pitching, leading to injuries. While various kinematic variables have been linked to higher joint moments, the effects of the throwing arm position at stride foot contact (SFC) on joint moments are not well understood despite being a common coaching point for young pitchers.

**PURPOSE:** The objective of this study was to examine how the pitcher's arm position at SFC affects the joint moments in high school/collegiate pitchers by quantifying the arm position based on the height of the wrist (= endpoint of the throwing arm) relative to the shoulder.

**METHODS:** 75 high school (n=60) and collegiate (n=15) pitchers participated. The pitching motion was captured using a motion capture system (600Hz). Upper