

**THE RELATIONSHIP OF THE NUMBER OF PITCHES TO THE KINETIC CHANGES OF BASEBALL PITCHING**

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**KEY WORDS:** baseball, pitching, kinetics, fatigue.

**INTRODUCTION:** At the latter half of the baseball game, ball velocity and control decrease due to fatigue by excess of pitching. Therefore, it is difficult for a baseball pitcher to pitch the whole game in many cases. Although many studies have been reported about the kinematics and kinetics of baseball pitching, only a few trials were analyzed for one subject. The purpose of this study was to investigate the relationship of the number of pitches to the kinetics changes of pitching during a simulated baseball game.

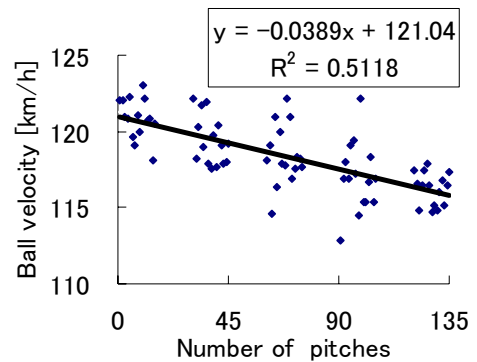
**METHOD:** Three male college baseball pitchers threw 15 pitches in an inning for 9 innings (135 pitches) in an indoor pitcher's mound with two force platforms. Rest time between innings was 6 minutes. Three-dimensional positions of 47 reflective markers attached to subject were tracked by an optical motion capture system (Vicon Motion System 612, Oxford Metrics) with eight cameras (250Hz). For each subject 75 fastball pitches (1st, 3rd, 5th, 7th, and 9th inings) were chosen for analysis. Kinetic parameters were analyzed by simple linear regression analysis ( $p < 0.05$ ).

**RESULTS:** The ball velocity was decreased with increasing the number of pitches (Figure 1). The extension positive and absolute work of the stride leg decreased with increasing the number of pitches (Table 1). The internal rotation positive work of the throwing arm decreased with increasing the number of pitches. The horizontal adduction positive and absolute work of the throwing arm increased with increasing the number of pitches (Table 2).

**DISCUSSION:** Decrease in the extension work of the stride leg is considered as the result of the muscle fatigue. Although the ball velocity was decreased, the horizontal adduction positive and absolute work of the throwing arm increased. It might be inferred from these results that the pitching motion relies more on the arm than the legs. In conclusion, it is shown that the decrease in extension work of the stride leg is the importance of lower extremity training and additional horizontal adduction work of shoulder might be to maintain the ball velocity.

**REFERENCES:**

Murray TA, Cook TD, Werner SL et al. (2001). The effects of extended play on professional base ball pitchers. *Am J Sports Med*, 29(2), 137-142.



**Table 1. The relationship of the number of pitches (Subject A).**

Hip extension		Figure 1. Ball velocity (Subject A)	
Positive work [J/kg]	A	$y = -0.0003x + 0.0846$	↘ *
Absolute work [J/kg]	A	$y = -0.0011x + 0.6359$	↘ *

Significant differences \* :  $p < 0.05$  \*\* :  $p < 0.01$  \*\*\* :  $p < 0.001$

**Table 1. The relationship of the number of pitches (Subject A).**

Shoulder horizontal adduction		Sub. Regression expression	
Positive work [J/kg]	B	$y = 0.0001x + 0.5007$	↗ *
	C	$y = 0.0001x + 0.2162$	↗ **
Absolute work [J/kg]	B	$y = 0.0001x + 0.5238$	↗ *
	C	$y = 0.0002x + 0.2495$	↗ ***

Significant differences \* :  $p < 0.05$  \*\* :  $p < 0.01$  \*\*\* :  $p < 0.001$