

# Changes in Elbow Stress and Ball Velocity During Reduced Effort Pitching: A Marker-Based Motion Capture Analysis

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## INTRODUCTION:

Baseball pitchers often participate in throwing programs that involve throwing at reduced effort levels to gradually increase the amount of stress experienced across the elbow. It is currently unknown how reduced effort pitching compares to maximum effort with respect to elbow stress and ball velocity. The purposes of this study were to determine whether elbow stress and ball velocity correlate with reduced effort pitching, whether elbow stress and ball velocity decrease proportionally while throwing at a reduced effort, and to assess intrathrower reliability.

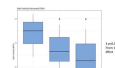
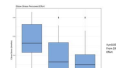
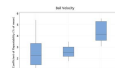
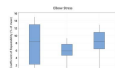
**METHODS:** Ten healthy male high school baseball pitchers threw 5 pitches from a regulation pitching mound at 3 effort levels: maximum effort, 75% effort, and 50% effort. Elbow stress, specifically elbow varus torque, was calculated for all pitches using a marker-based 3D motion capture system. Ball velocity was measured using a Doppler radar gun. Intrathrower variability was calculated for each effort level.

## RESULTS:

Elbow stress and ball velocity decreased with reduced effort throws ( $p < 0.001$  and  $p = 0.003$ , respectively). However, the reductions in elbow stress and ball velocity were not proportional. At 75% effort throws, elbow stress decreased only 19% and ball velocity decreased only 10%. At 50% effort throws, elbow stress decreased only 25% and ball velocity decreased only 15%. Intrathrower reliability was excellent for elbow stress and ball velocity, with intraclass correlation coefficients all  $\geq 0.80$ .

## DISCUSSION AND CONCLUSION:

Pitching at a reduced effort level resulted in decreased elbow stress and ball velocity. However, for every 25% reduction in perceived effort, elbow stress decreased by a mean of 13% and ball velocity decreased 8%. When baseball pitchers attempt to throw at a reduced effort of maximum, throwing metrics do not decrease proportionately. Based on the results of the current study using gold standard motion capture, reduced effort pitching from a regulation baseball mound does not proportionately decrease elbow stress and ball velocity. It is important that players, coaches, and medical providers understand how much these kinetics change when constructing rehabilitation and throwing programs that utilize reduced effort pitching.



Parameter	Max Effort	75% Effort	50% Effort
Ball Velocity (m/s)	24.5	22.0	20.5
Elbow Stress (Nm)	15.0	12.5	11.0
Elbow Stress (CoV)	0.15	0.15	0.15
Ball Velocity (CoV)	0.15	0.15	0.15

Parameter	Max Effort	75% Effort	50% Effort
Intrathrower Reliability (ICC)	0.95	0.95	0.95
Interthrower Reliability (ICC)	0.85	0.85	0.85

Figure 1. Illustrating retroreflective markers on the elbow.