Per-Pitch Strength and ROM Trends in Live-Game Baseball Pitching

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Introduction

Throwing Stress and Injury Risk: The repetitive, high-velocity nature of pitching places significant mechanical stress on the throwing arm, leading to both acute and chronic adaptations that increase injury risk over a season.

Chronic Adaptations: Long-term throwing exposure is associated with glenohumeral internal rotation deficit (GIRD)—a ≥ 20° loss of internal rotation compared to the non-throwing arm—linked to osseous adaptations like humeral retroversion and an elevated risk of shoulder injury or surgery.

Protective and Deteriorating Strength Metrics: Decreased preseason external rotation (ER) strength predicts greater injury risk, while both ER and scaption strength tend to decline during the season, emphasizing the importance of maintaining shoulder muscle balance.

Acute Neuromuscular Changes: Studies show immediate reductions in internal rotation range of motion (ROM), ER strength, and increased fatigue following pitching sessions; however, live-game variability in pitch counts necessitates further research with greater ecological validity.

Study Purpose: This retrospective study examines how pitch count acutely affects ROM, shoulder rotational strength, scaption, and chuck pinch strength in collegiate pitchers, hypothesizing a negative correlation between pitch count and all measures except ER ROM to inform injury prevention and return-to-play strategies.

Methods

Participants and Timing: The study included 3,587 pitchers aged 8–30, encompassing 28,616 total outings, providing a large dataset across youth to collegiate levels. All ROM and strength tests were conducted immediately before and after live game outings to evaluate acute changes related to pitching workload.

Instrumentation: Data on shoulder ROM and strength (ER, IR, scaption, and chuck pinch) were collected using the ArmCare handheld dynamometer and inclinometer (Activebody Inc.), capable of precise force (±1.4 lb + 5%) and angle (±1°–3%) measurements.

ROM Testing Protocol: Internal and external rotation ROM were measured in a half-kneeling position with strict control of posture and elbow alignment, using a wall or stable surface to ensure consistent 90° arm positioning and accurate angle readings.

Strength Testing Protocol: ER, IR, and scaption strength were measured with participants lying supine against a fixed 90° surface, performing two maximal isometric efforts per test with 10 second rests, using the ArmCare sensor to record force output.

Chuck Pinch Strength Protocol: Chuck pinch grip strength was assessed in a half-kneeling 90-90° arm position simulating a baseball grip.

Figure 1. ER Strength Measurement

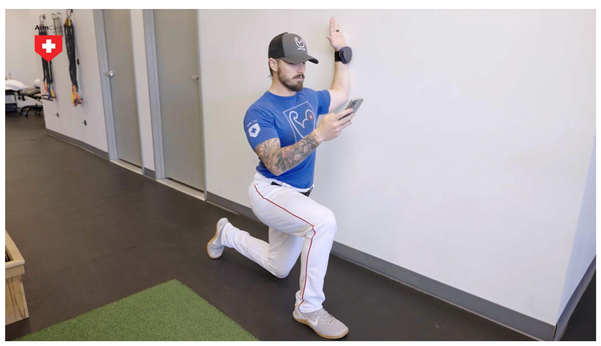

Figure 2. External ROM Measurement

Results

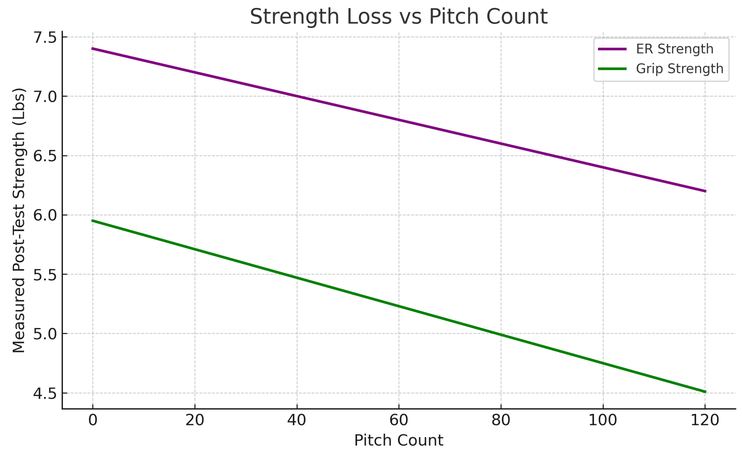

Figure 3. ER and Grip Strength loss per pitch

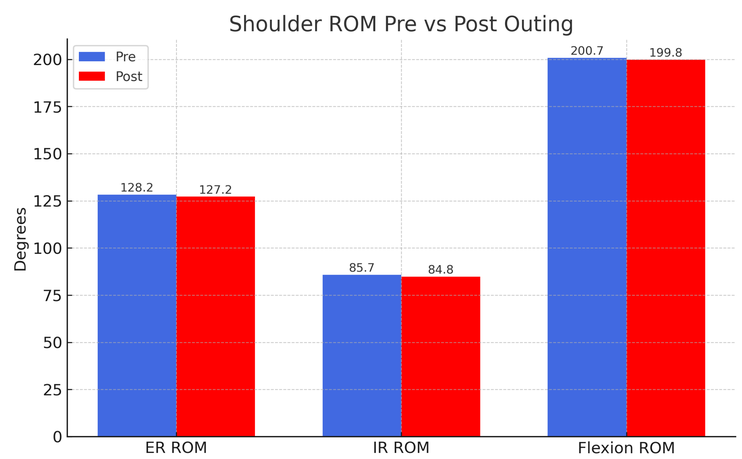

Figure 4. Shoulder ROM Pre vs Post Pitching

Strength Findings: Pitchers lost approximately 0.1 lb of ER, IR, scaption, and chuck pinch strength per every 10 pitches thrown, indicating uniform strength decline throughout the throwing arm as pitch count increased.

Range of Motion Findings: External and Internal ROM decreased slightly (−0.99° and −0.81°, respectively) and were statistically insignificant in relation to pitch count, but were significant yet minimal in relation to Pre vs Post outing.

Conclusions

The results indicate there is a generalizable rate of change of throwing arm strength that can be assessed at various times around pitching outings to predict return to baseline metrics.

The ROM findings indicate that these metrics change over the course of a season from chronic stress and not acutely.

Findings support developing a predictive algorithm that integrates strength and recovery data (including 24-hour post-outing metrics) to guide personalized workload management and role assignment within pitching staffs.

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