

# VISUALIZING RISK FACTORS AND CAREER IMPACTS OF INJURIES AMONG MLB PITCHERS

Team 73

Sumair Shah, Sejal Dua, Tim Ehlenbeck, Jake Hlavaty, Leon Hu, Matthew Schulz

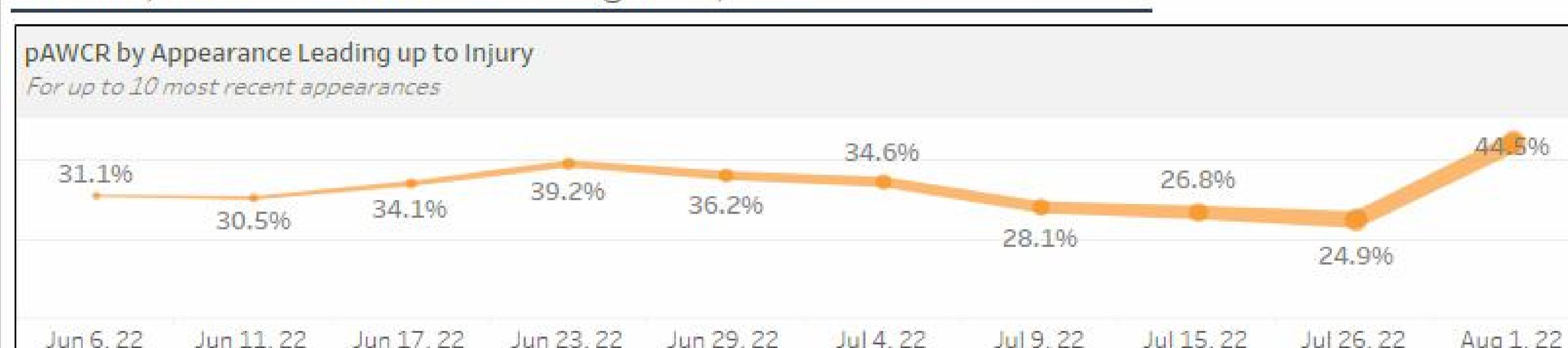
## PROJECT INTRODUCTION

Our project leverages advanced analytics and pitch tracking to quantify relationships between pitching mechanics, workload, and injuries, and to offer actionable recommendations for injury mitigation and player longevity. This analysis will benefit players, teams and fans by deepening understanding of pitcher injuries.

Prior attempts to study pitching injuries used measures such as preseason range-of-motion tests and pitch count limits, yet pitcher injury incidence has only increased. We utilized publicly accessible pitch tracking data to develop a novel, pitching-specific workload metric, **pitcher acute to chronic workload ratio (pACWR)**, to quantify and focus on changes in pitcher workload before and after injury. The figure below visualizes Hunter Greene's workload increase prior to his 2022 shoulder injury.

### Diving Deeper into Performance Before & After Injury

Greene, Hunter - Shoulder on August 2, 2022

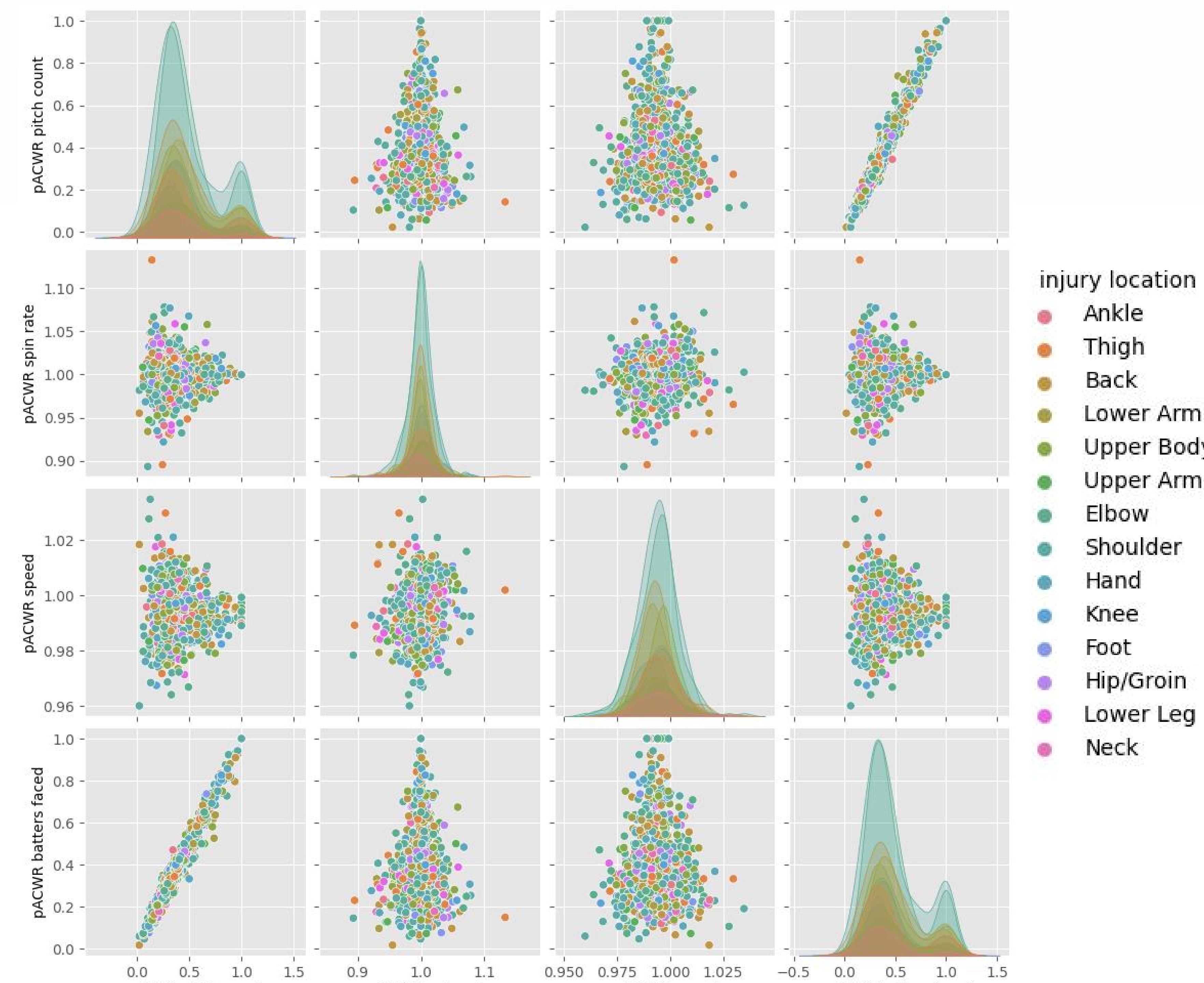


## DEVELOPING A NEW METRIC: pACWR

The Acute to Chronic Workload Ratio (ACWR) is an established method used to identify players who may be at risk of injury. ACWR uses game counts to measure the ratio of acute (1 week) to chronic (4-6 week) workloads.

Because game counts may not accurately measure a pitcher's workload, **our approach was to leverage pitch tracking data in creating a novel version of ACWR specific to pitchers, called pACWR**.

After rigorous statistical testing of candidate metrics for inclusion in pACWR, including *spin rate*, *release speed*, *batters faced*, and others, we found that using **pitch count** as the load indicator was the best proxy for training workload. Correlations between candidate pACWR metrics are shown in the pair plot below.



## WHY FOCUS ON PITCHING INJURIES?

Pitching performance is crucial to team success in Major League Baseball, with pitchers making up half (approx. 390 players) of all roster spots. Star pitchers can command salaries of over \$40m per season.

Historically, teams and players have had limited data that could be used to analyze, quantify, predict, or prevent injury. The occurrence of major injuries has increased in recent years.

**During the 2023 season, 43 pitchers had season-ending 'Tommy John' elbow surgery.**

The average recovery time from this reconstructive procedure is **16.1 months**.

**By 2016, 27.4% of active MLB pitchers had previously undergone reconstructive 'Tommy John' elbow surgery.**

**As of 2023, this percentage had risen to 35.6%**

## DATASETS

Total size on disk: 2.41GB

### Pitch Tracking

dataset gathered from *MLB Statcast*, *Baseball-Reference.com*, and *Fangraphs.com* using R package **baseballr**

93 attributes for **2.82 million** pitches thrown 2019 through 2023

### Player Injuries

dataset scraped using Python from *Fangraphs.com*

2,148 injuries for 884 pitchers from 2019-23

## EVALUATION AND RESULTS

The primary advantage of pACWR is that it flags **both over-use and under-use injury risk**. For example, if a pitcher is starting a new season and has not thrown any pitches in games yet, their pACWR after their first game would be 1, since their load in the previous 1 week is identical to their load in the previous 4 weeks. Injuries that occur during this period of time would likely be due to the player not having enough conditioning or "ramp up" prior to putting their body through intense load. On the other hand, a 200% increase in usage over a given week would cause pACWR to spike to around 0.5, which is also an indicator of injury risk. **Generally, periods of load fluctuation are hypothesized to be correlated with increased injury incidence.**

The definition of pACWR which uses pitch count as the load metric was highly correlated with the one that uses batters faced. Pitch count pACWR is advantageous to batters faced pACWR because pitch count is more granular and is less dependent on the pitcher's efficiency on the mound. Release speed and spin rate did not yield promising findings with respect to this metric because of the variance caused by different pitch types.

A t-test validated our hypothesis that periods of load fluctuation are correlated with increased injury incidence.

**Our analysis provides actionable insight for baseball teams. A pACWR value of 0.44 is the threshold at which pitchers are at high risk of injury.**