

Primary Injury Factors of  
Ulnar Collateral Ligament Reconstruction  
for Major League Baseball Pitchers  
by *Statcast Measures*

---

Taehoon Ha



Primary Injury Factors of  
**Ulnar Collateral Ligament Reconstruction**  
for Major League Baseball Pitchers  
by *Statcast Measures*

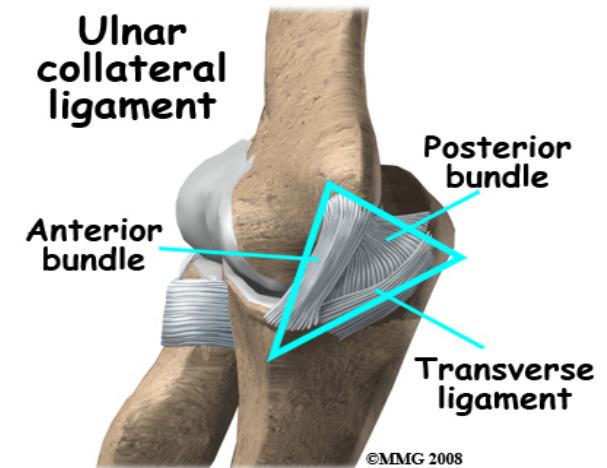
---

Taehoon Ha

# What is Ulnar Collateral Ligament (UCL) and Reconstruction?

---

- **Ulnar Collateral Ligament (UCL)** is a thick triangular band at the elbow.
- **Ulnar Collateral Ligament Reconstruction (UCLR)** is a surgical treatment where the UCL is replaced with either a tendon from other arm (or elsewhere) in the patient's body.
- Common injuries for baseball players, especially for pitchers who throw a ball in a baseball game.
- Also known as **Tommy John Surgery (TJS)**

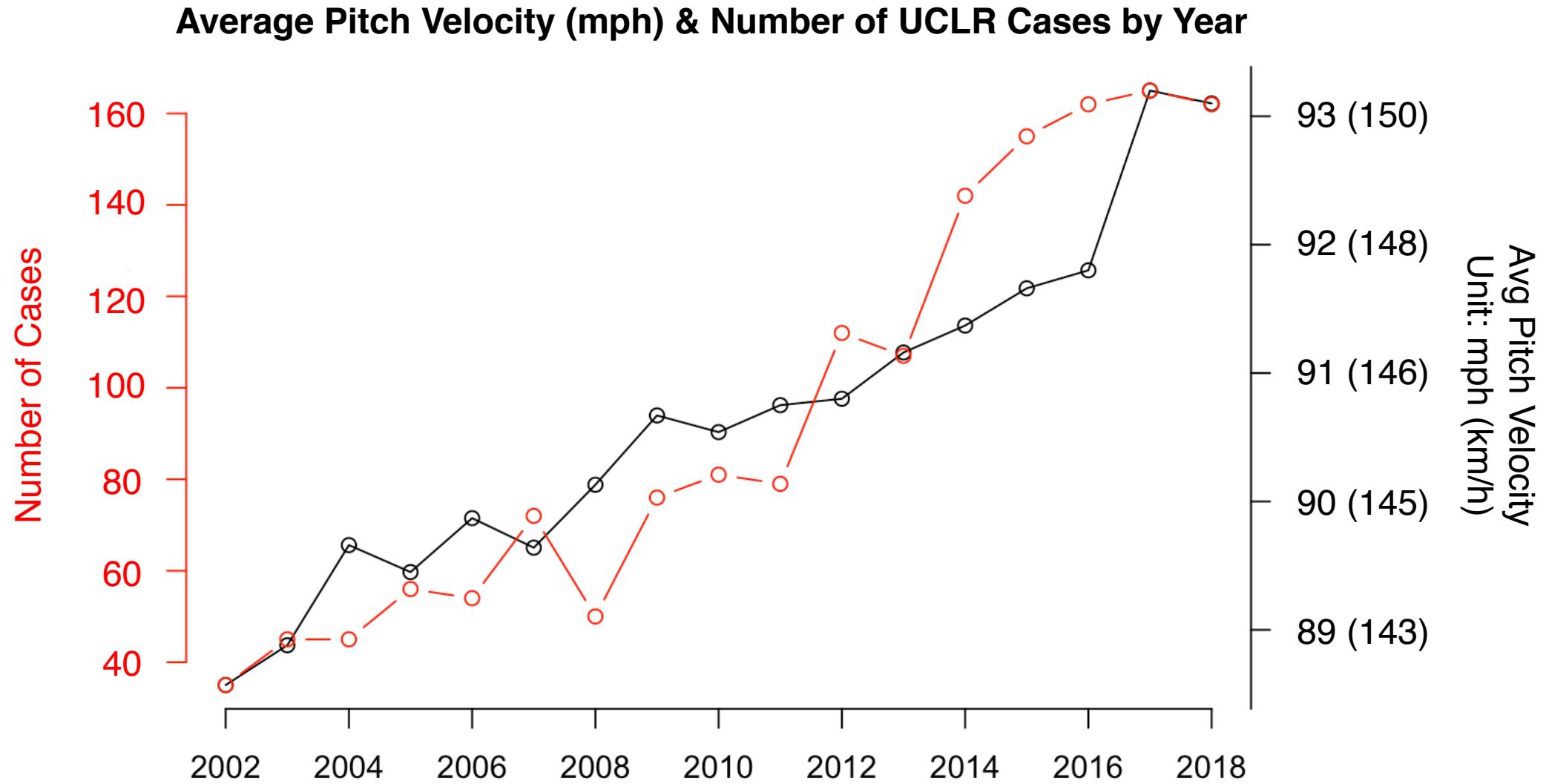


## Proposed Risk Factors In Previous Studies

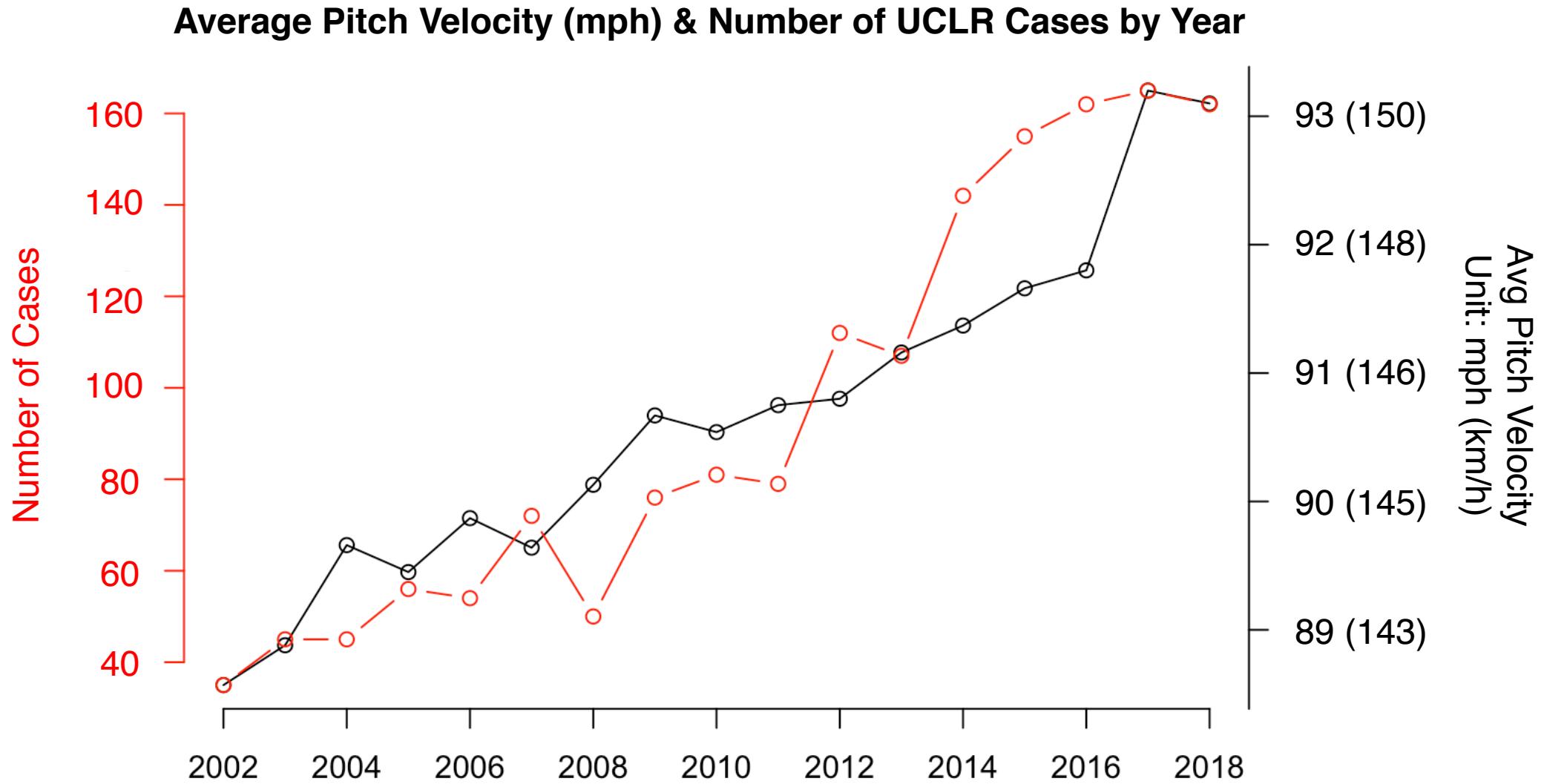
---

- The proposed risk factors so far are:
  - (1) more pitch counts
  - (2) greater peak fastball velocity
  - (3) higher fastball proportion among pitch types
  - (4) demographics (age, height, and weight)
  - (5) low release point (the degree of a pitcher's arm when releasing a ball)

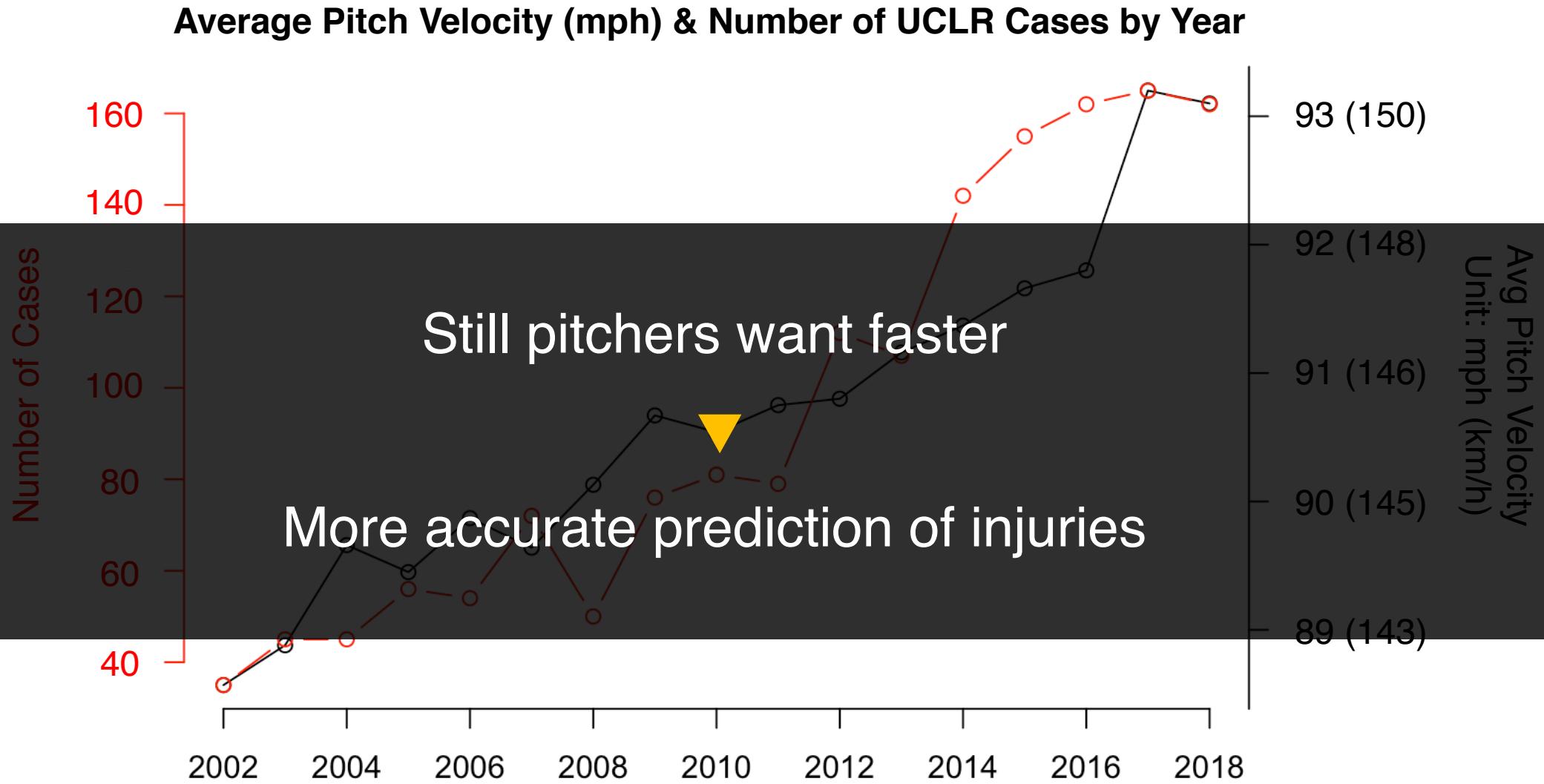
# The More Velocity, The More Injuries



# The More Velocity, The More Injuries



# The More Velocity, The More Injuries



# Technology Lets Us Know More

*Statcast*, a pitching tracking technology, enabled us to measure more pitching-related factors we couldn't measure before.



- A radar system originally developed for the military purpose
- Installed all stadiums in 2015
- *Statcast* can measure and save the data on a real-time basis about:
  - **Extension:** distance of the stride
  - **Spin Rate:** rate of spin after release  
(unit: revolutions per minute)
  - **Peak Velocity:** fastest pitch in a game
  - Etc.

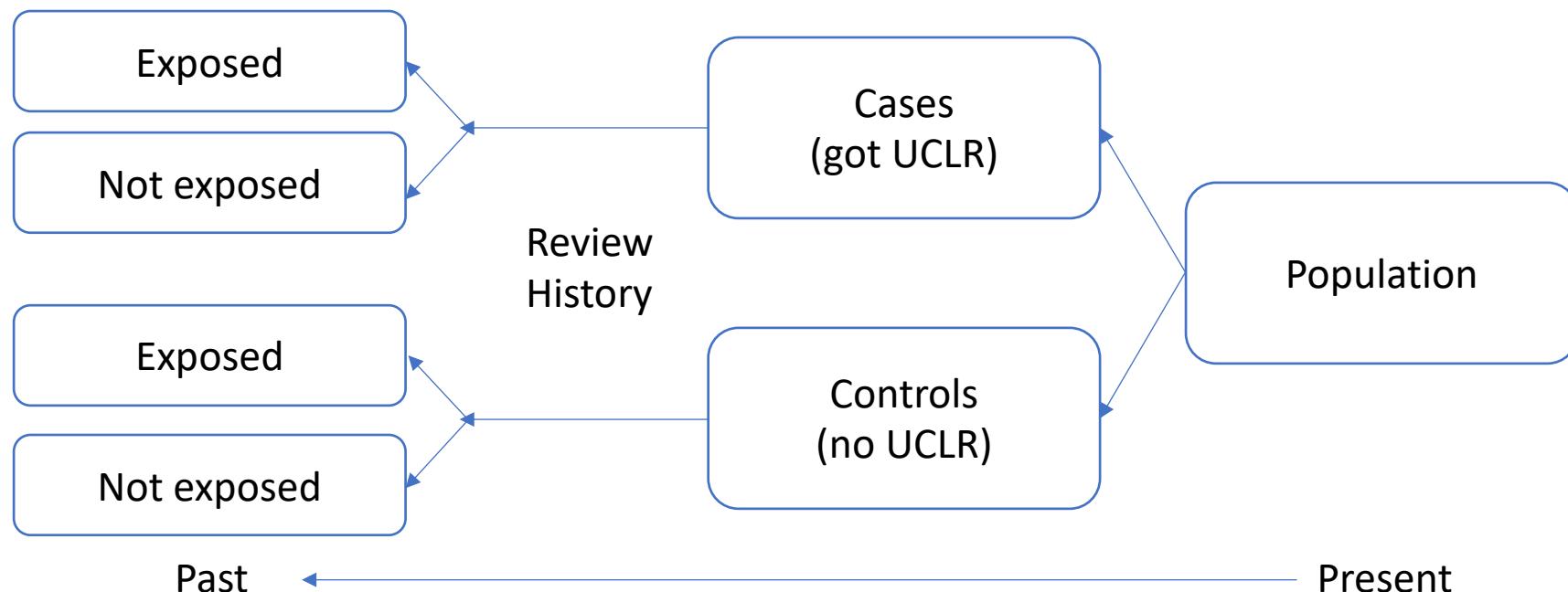
# Objective and Hypotheses

---

- **Goal:** To identify primary injury factors that significantly affect an MLB pitcher's UCL damage among *Statcast* measures.
- The **primary hypotheses** are:
  - Pitchers who got UCLR have a longer **extension** than pitchers who do not have UCL injury.
  - Pitchers who got UCLR have greater **spin rate** than pitchers who do not have UCL injury.
- The **secondary hypothesis** is:
  - Pitchers who got UCLR have higher **peak velocity** than pitchers who do not have UCL injury.

# Study Design

- **Retrospective Case-control study**
  - Data source: MLB Statcast pitching data from 2015 to 2018 (publicly available)
  - Case: '**All**' **MLB pitchers who got UCLR surgical treatments between 2015 and 2018**
  - Control: **MLB pitchers with no UCL injury**



# Participants Selection

---

- **Only Major League level pitchers**
  - Excluded Minor League (i.e. lower-leveled league) pitchers.
    - Reason: the time of getting UCLR between MLB pitchers and Minor pitchers are different.
  - Excluded Major League non-pitchers (i.e., field players such as catcher, short-stop etc.)
    - Reason: pitchers have a higher prevalence of UCLR than non-pitchers (16% vs. 3%)
  - Pitchers with other injuries on other spots except UCL will not be excluded from the sample.
    - Reason: Randomization

# Matching

---

- All 81 cases will be included between 2015 and 2018.
- Will be **individually matched** with the control pitchers.
- Matching variables: **age**, **height**, **weight**, and **innings pitched**
  - Because they are potential major confounders.
  - **Age**, **height**, and **weight** are proposed risk factors in the previous studies.
  - **Innings pitched** are related to pitch counts and a role in a team. (starting vs. relief pitcher)
  - Can obtain power.

# Blinding

---

- In the process of matching the case to the control individually.
- If a pitcher's name in the control group were not anonymized, they could bias the matching process and potential result.
- The blinding procedure will be:
  - 1) Fix the number of control pitchers.
  - 2) Create a data table that consists of anonymized MLB pitchers with no UCL injury.
  - 3) Individually match the case with the control based on **age**, **height**, **weight**, and **innings pitched**. These variables are potential **confounders**.

# Independent & Dependent Variables, Measurement, and Intervention

---

- Independent variables: pitching-related *Statcast* measures
  - **Extension:** the distance of a stride during pitching.
  - **Spin rate:** the rate of spin after the release of a ball (measured by revolutions per minute)
  - **Peak velocity:** the fastest pitch in a game
- Dependent variable: **the probability of getting UCL injury**
- Measurement
  - *Statcast* radar automatically measures and saves data on a real-time basis.
  - The data is updated after the game on a daily basis and is publicly available.
- No intervention involved in a case-control study.



# Statistical Methods and Procedure

---

- **Descriptive Statistics:** case and control will be summarized.
- **T-test or chi-square test:** differences and associations will be tested with t-test or chi-square test for the four matching variables (**age**, **height**, **weight**, and **innings pitched**).
- **Single-variable logistic regression:** test for each independent variable (i.e., **extension**, **spin rate**, and **peak velocity**) will be made through single-variable logistic regression. Hence three tests will be made separately.
- **Likelihood estimator:** odds ratios and confidence level of 95% will be calculated.
- **Hypothesis testing:** to report the results of each hypothesis testing and draw conclusion.

# Expected Significance and Limitations

---

- **Expected limitations:**
  - $R^2$  value will be low since the causes of injury is complex.
    - Previous study's model explains only 6% of the outcome variable.
  - Different measurement conditions between stadiums still exist.  
(e.g. altitudes, humidity, temperature, wind, etc.)
- **Expected significance:**
  - The more we can predict UCL tears precisely, the more athletes would avoid the surgery.
  - In a long-term perspective, this study could contribute to developing more scientific and systematic pitcher rotation management.