UCL: Prevention and Non-operative Treatment in Throwers

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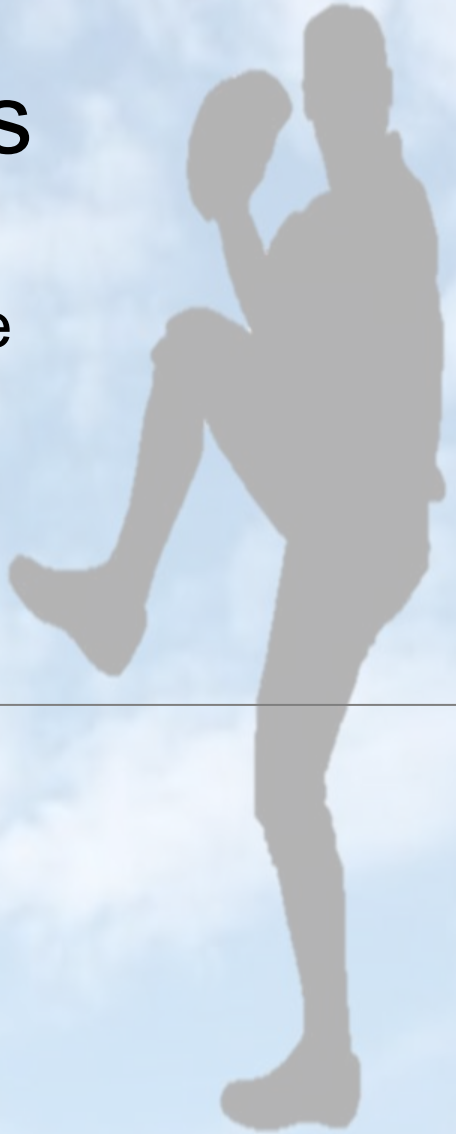
Disclosures

Nothing to disclose



Learning Objectives

1. Examine why injuries occur in the throwing athlete.
2. Present data on throwing UCL injuries and the rise in UCL surgeries in the past 50 years.
3. Evaluate the treatment algorithm for UCL treatment and next steps for prevention.

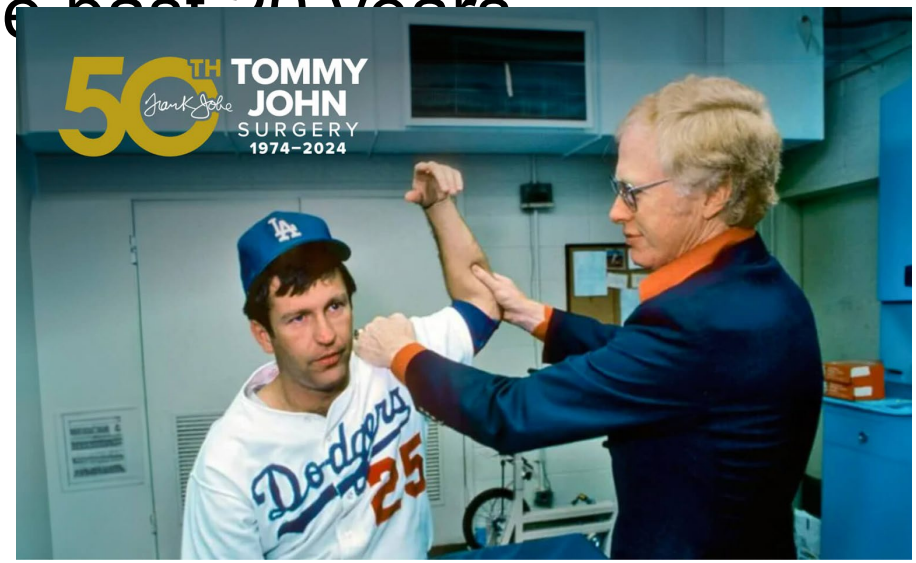
Sincere Thanks

ANDREW DUBIN & MARC GERBER

U.S. Olympic & Paralympic
MEDICAL NETWORK

Background

Ulnar collateral ligament-reconstructions (UCL-R) in baseball players were first performed in 1974 and have substantially increased in the past 20 years



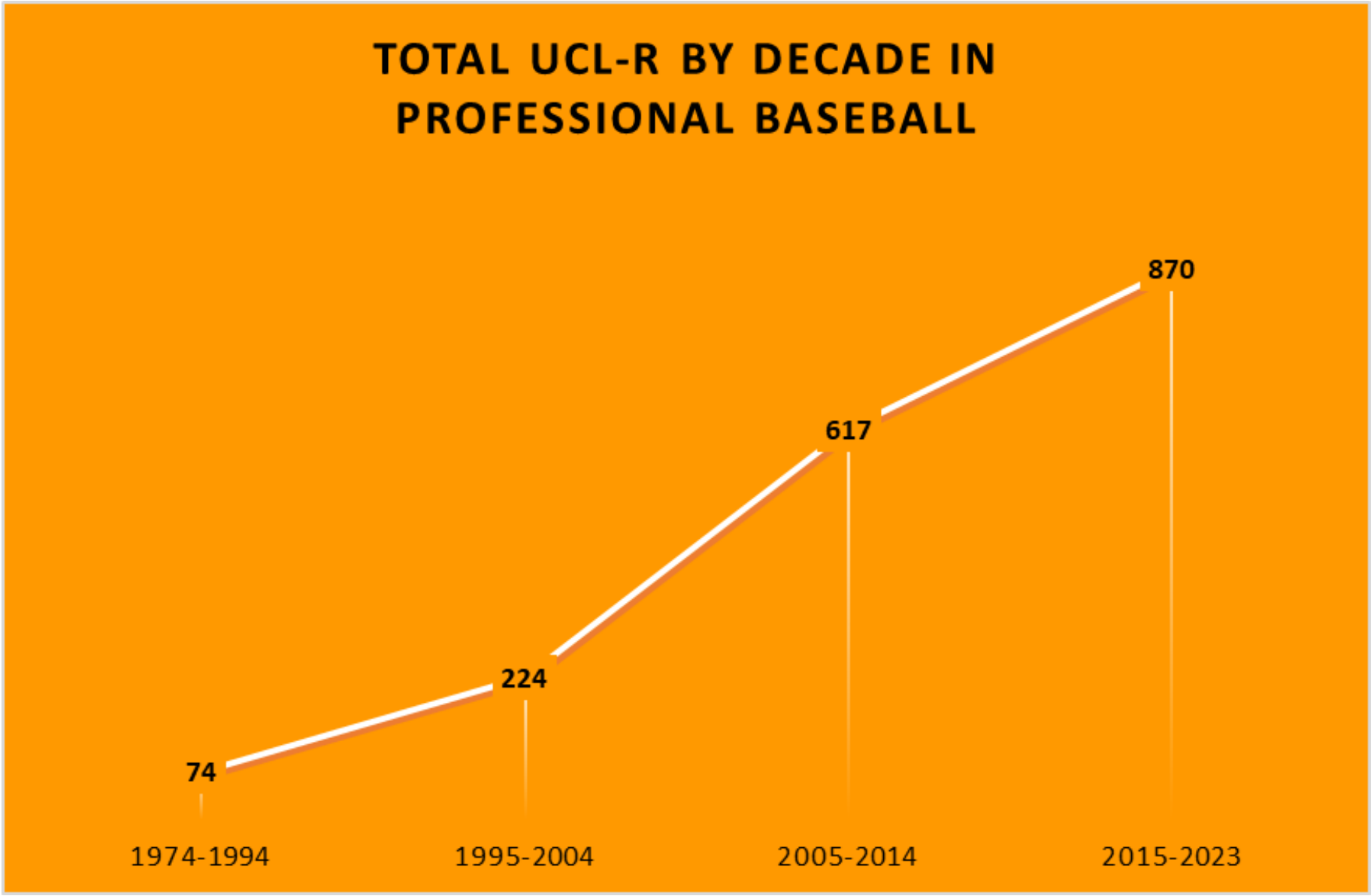
https://kerlanjobe.org/50-years-tommy-john-surgery/

Results

- **1782 UCL surgeries** have been performed in pro baseball players (89.6% pitchers, 3.7% catchers, and 6.7% infielders, outfielders, and designated hitters collectively) from 1974 until 10/10/2023.
- The United States (1328), Dominican Republic (183), and Venezuela (99) represent player country of origin most commonly.

*The **link for the dataset** (Accessed 10/10/23) is https://docs.google.com/spreadsheets/d/1gQujXQQGOVNaiuwSN680Hq-FDVsCwvN-3AazykOBON0/htmlview#gid=0.*

TOTAL UCL-R BY DECADE IN PROFESSIONAL BASEBALL

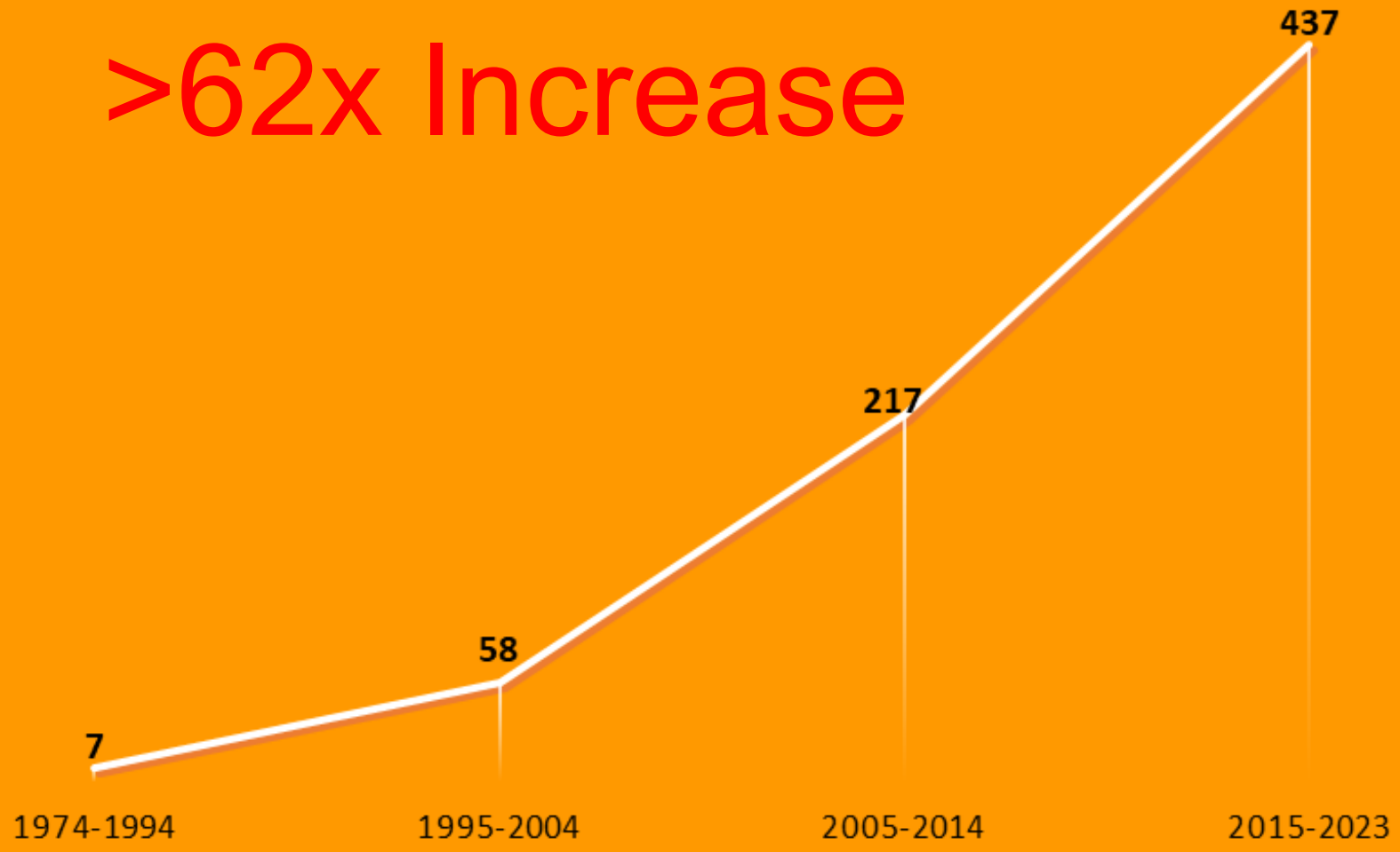


Results

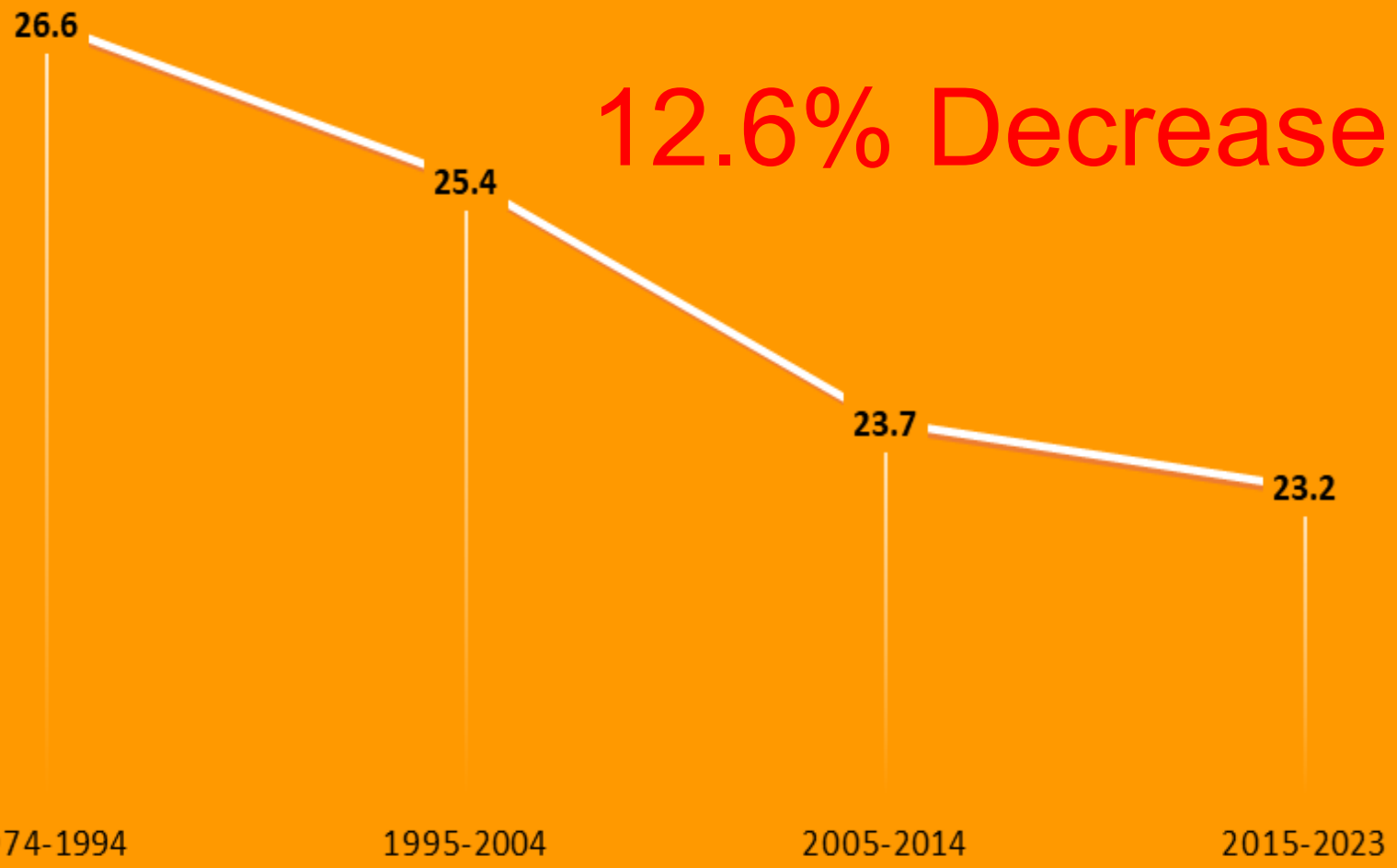
- At the Rookie and A-Ball levels of pro baseball, the number of UCL surgical interventions increased from 7 (1974-1994), to 58 (1995-2004), to 217 (2005-2014), to 437 (2015-present), **an increase of more than 62-fold.**
- There have been 148 revision surgeries since 1974 including 135 (91.2%) in pitchers. Mean time between initial and revision surgery was 56.1± 42.8 months.

TOTAL UCL-R AT ROOKIES AND A LEVELS OF PROFESSIONAL BASEBALL SINCE 1974

>62x Increase



AVERAGE AGE OF UCL- R BY DECADE IN PROFESSIONAL BASEBALL



Conclusions

These data confirm that the incidence of elbow UCL surgeries has significantly increased over the last several decades.

More troubling is that the average age of players undergoing these surgeries continues to decrease.

Why Do Throwing Injuries Occur?

1. Mechanics
2. Pitch Type
3. Pitch Volume
4. Rest Periods
5. Physical Make-up
   -ROM
6. Nutrition
7. Genetics

- Height, Weight, G-d given ability

Most Commonly Injured Body Part Level in Baseball

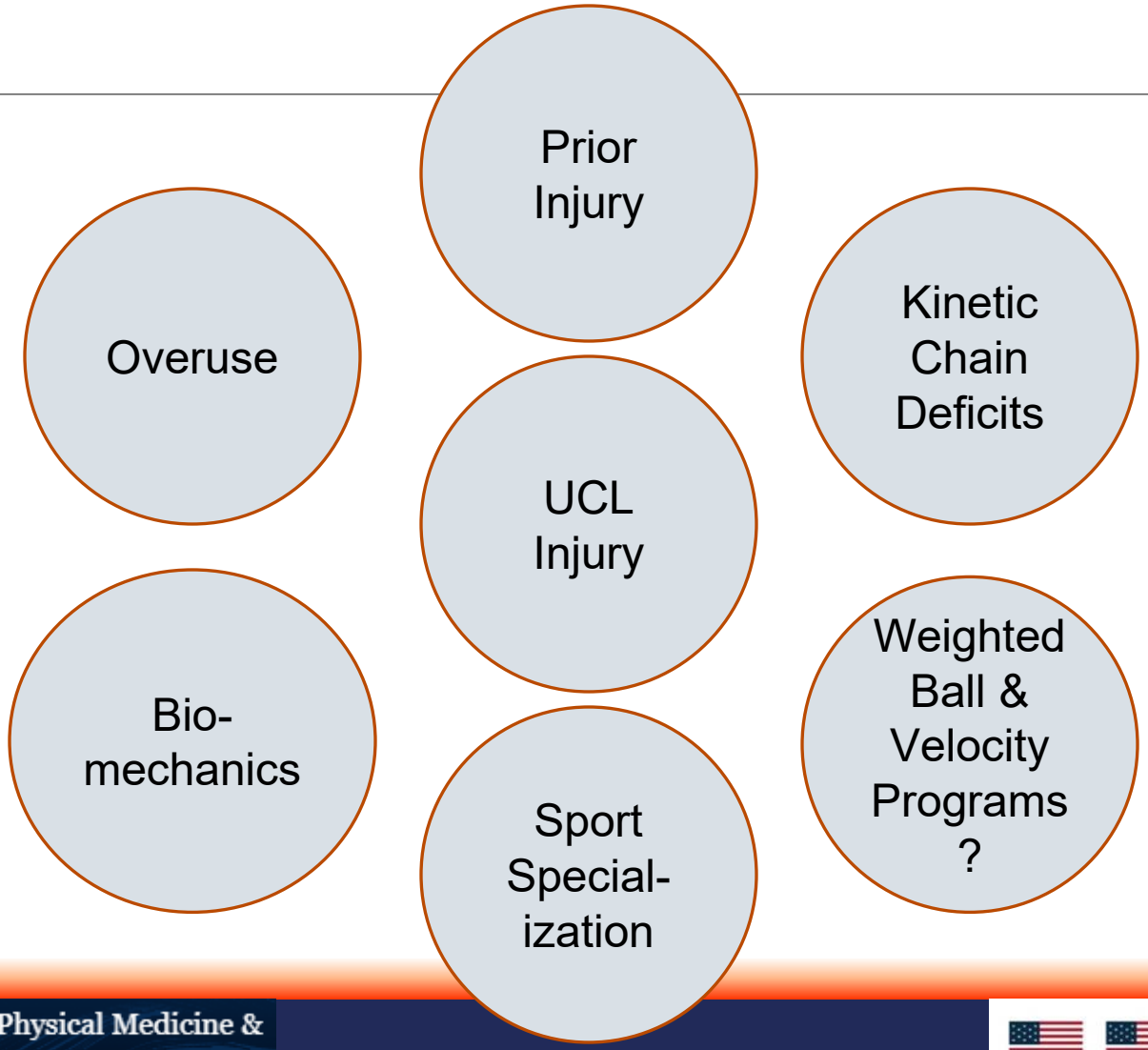
The shoulder (in pitchers)
- 31% of all injuries

#2 = the elbow (26%)
- UCL: 1.12/10,000 A-Exposures NCAA over 5 years

- ***But most common injury is hamstring strain!**

Collins CL, Comstock RD. Epidemiological features of high school baseball injuries in the United States, 2005-2007. Pediatrics 2008;121(6):1181–1187.
DeFroda, et al. AJSM May 2018.

So Why Are There So Many UCL Injuries?



Risk Factors for UCL Injury

- Pitch Velocity
- Pitch Count
- Innings Pitched (season)
- Days of Rest
- Fatigue
- Throwing Mechanics
- Showcase Participation

1. Chalmers PN et al, *Am J Sports Med.* 2016
2. Defroda SF et al, *Orthop J Sports Med.* 2016
3. Fleisig GS et al, *Am J Sports Med.* 2011
4. Whiteside D et al, *Am J Sports Med.* 2016
5. Kriz PK et al, *Am J Sports Med. 2022*

Clinical Journal of SPORT MEDICINE
Founded in 1990 by the Canadian Academy of Sport and Exercise Medicine

Weighted Ball Velocity Programs: An Infographic Summary

Benefits vs Risks

Data Summary

Increased Throwing Velocity 2-11 mph

Increased Shoulder External Rotation

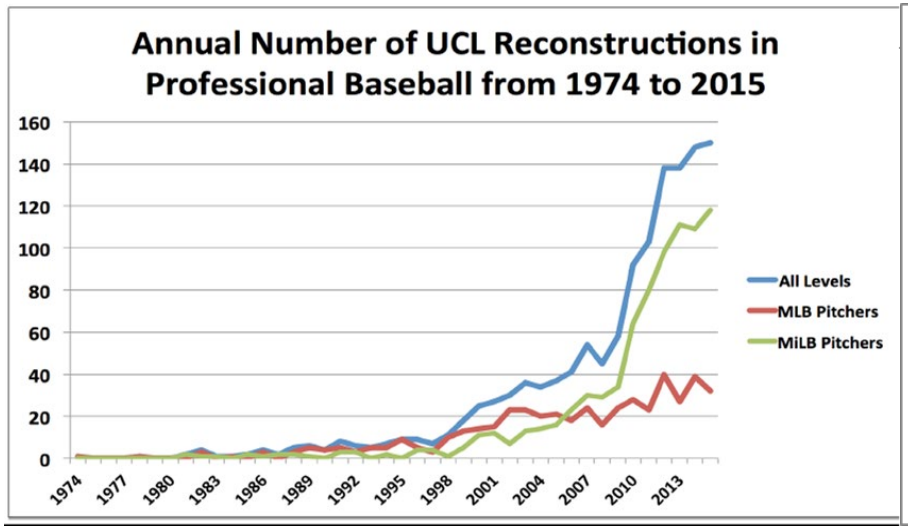
Types of Injuries

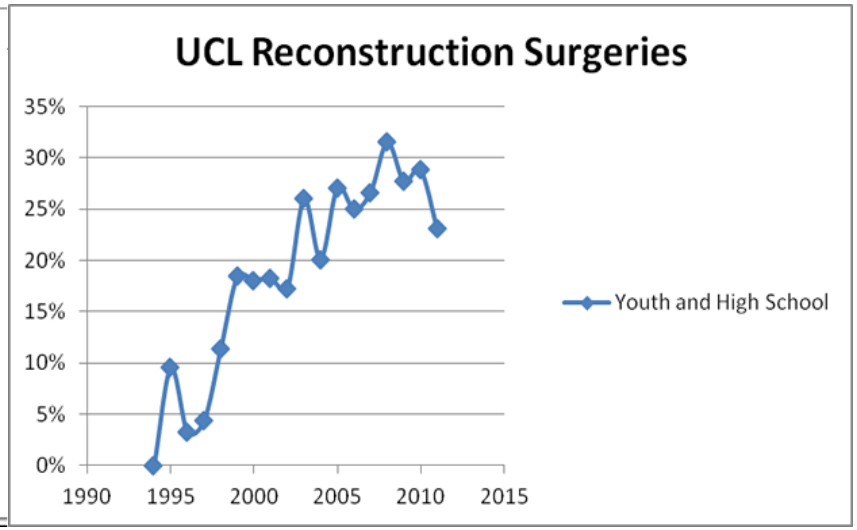
Olecranon Stress Fractures

UCL Injuries

Zaremski CJSM 2022

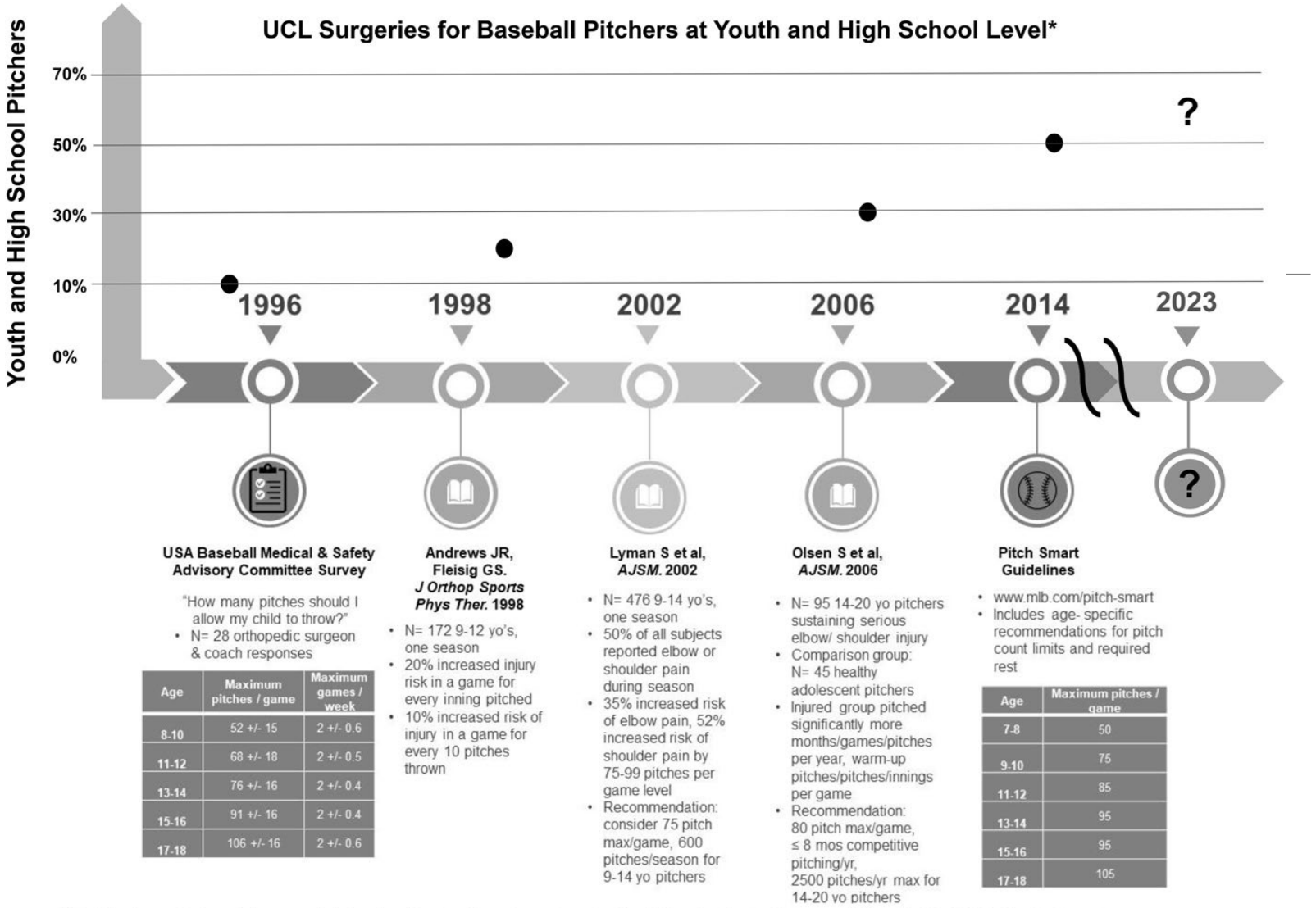
UCL Historical Numbers





Camp CS, et al study, taken from Conte S presentation at PBATS conference 2017. http://www.conteanalytics.com/uploads/2/6/9/4/26948048/epidemiology_of_tommy_john_surgery_-pbats_2017.pdf

http://www.asmi.org/images/UCLgraph.png



USA Baseball Medical & Safety Advisory Committee Survey

"How many pitches should I allow my child to throw?"

- N= 28 orthopedic surgeon & coach responses

Age	Maximum pitches / game	Maximum games / week
8-10	52 +/- 15	2 +/- 0.6
11-12	68 +/- 18	2 +/- 0.5
13-14	76 +/- 16	2 +/- 0.4
15-16	91 +/- 16	2 +/- 0.4
17-18	106 +/- 16	2 +/- 0.6

Andrews JR, Fleisig GS. *J Orthop Sports Phys Ther.* 1998

- N= 172 9-12 yo's, one season
- 20% increased injury risk in a game for every inning pitched
- 10% increased risk of injury in a game for every 10 pitches thrown

Lyman S et al, *AJSM.* 2002

- N= 476 9-14 yo's, one season
- 50% of all subjects reported elbow or shoulder pain during season
- 35% increased risk of elbow pain, 52% increased risk of shoulder pain by 75-99 pitches per game level
- Recommendation: consider 75 pitch max/game, 600 pitches/season for 9-14 yo pitchers

Olsen S et al, *AJSM.* 2006

- N= 95 14-20 yo pitchers sustaining serious elbow/ shoulder injury
- Comparison group: N= 45 healthy adolescent pitchers
- Injured group pitched significantly more months/games/pitches per year, warm-up pitches/pitches/innings per game
- Recommendation: 80 pitch max/game, ≤ 8 mos competitive pitching/yr, 2500 pitches/yr max for 14-20 yo pitchers

Pitch Smart Guidelines

- www.mlb.com/pitch-smart
- Includes age- specific recommendations for pitch count limits and required rest

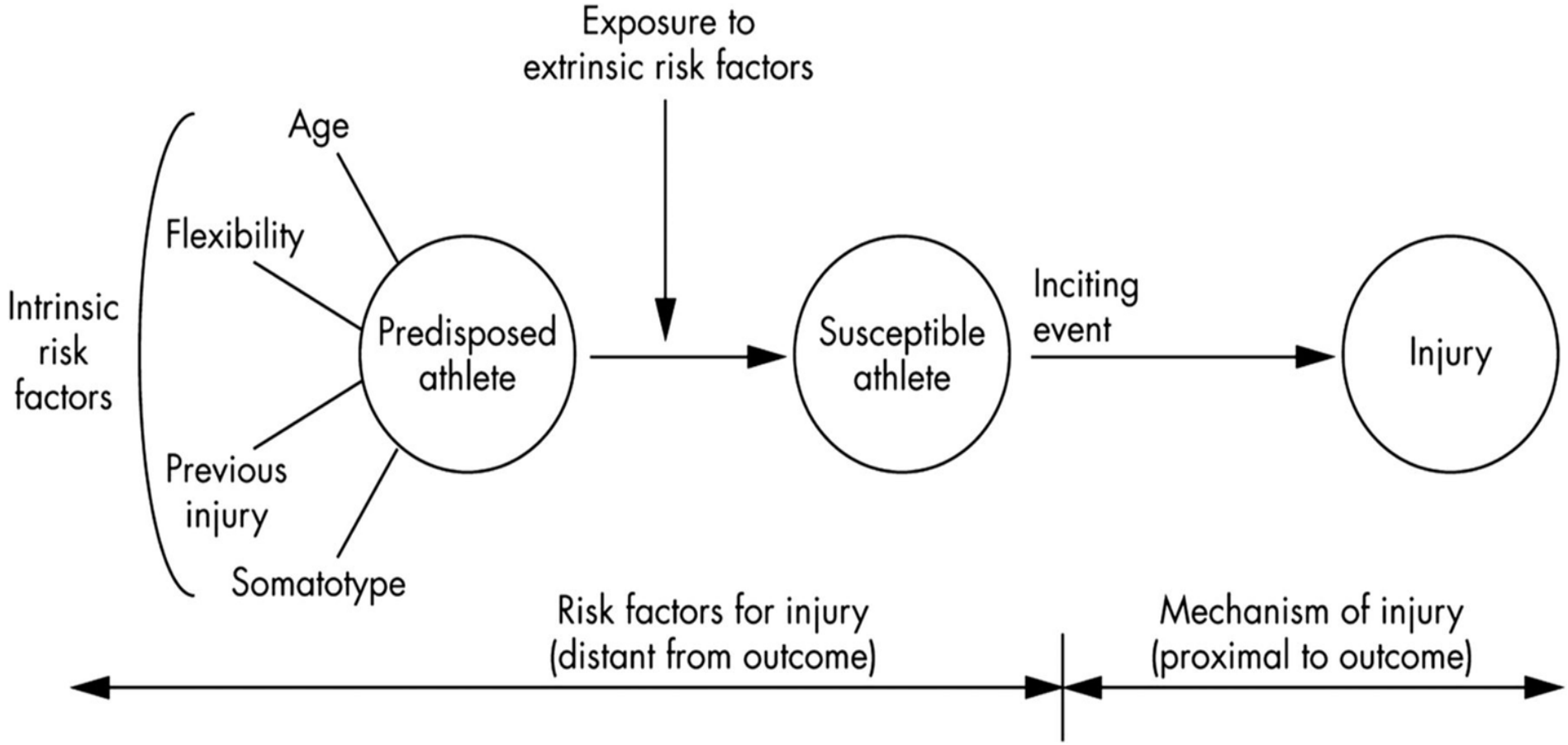
Age	Maximum pitches / game
7-8	50
9-10	75
11-12	85
13-14	95
15-16	95
17-18	105

*Modified graph from Figure published online by American Sports Medicine Institute. Accessed March 26, 2023. Available at: www.asmi.org/ucl-surgeries-on-adolescent-baseball-pitchers/

Data comes from References: [1,5,8,13]

Zaremski JL, Bowers RB, Kriz PK. Pitching Restriction Policies in Adolescent and High-School Baseball Pitchers: Is It Time for an Updated Paradigm? CJSM 2023

Why do we get injured?



Windt J, Gabbett TJ. How do training and competition workloads relate to injury? The workload-injury aetiology model. Br J Sports Med. 2017 Mar;51(5):428-435. doi: 10.1136/bjsports-2016-096040.

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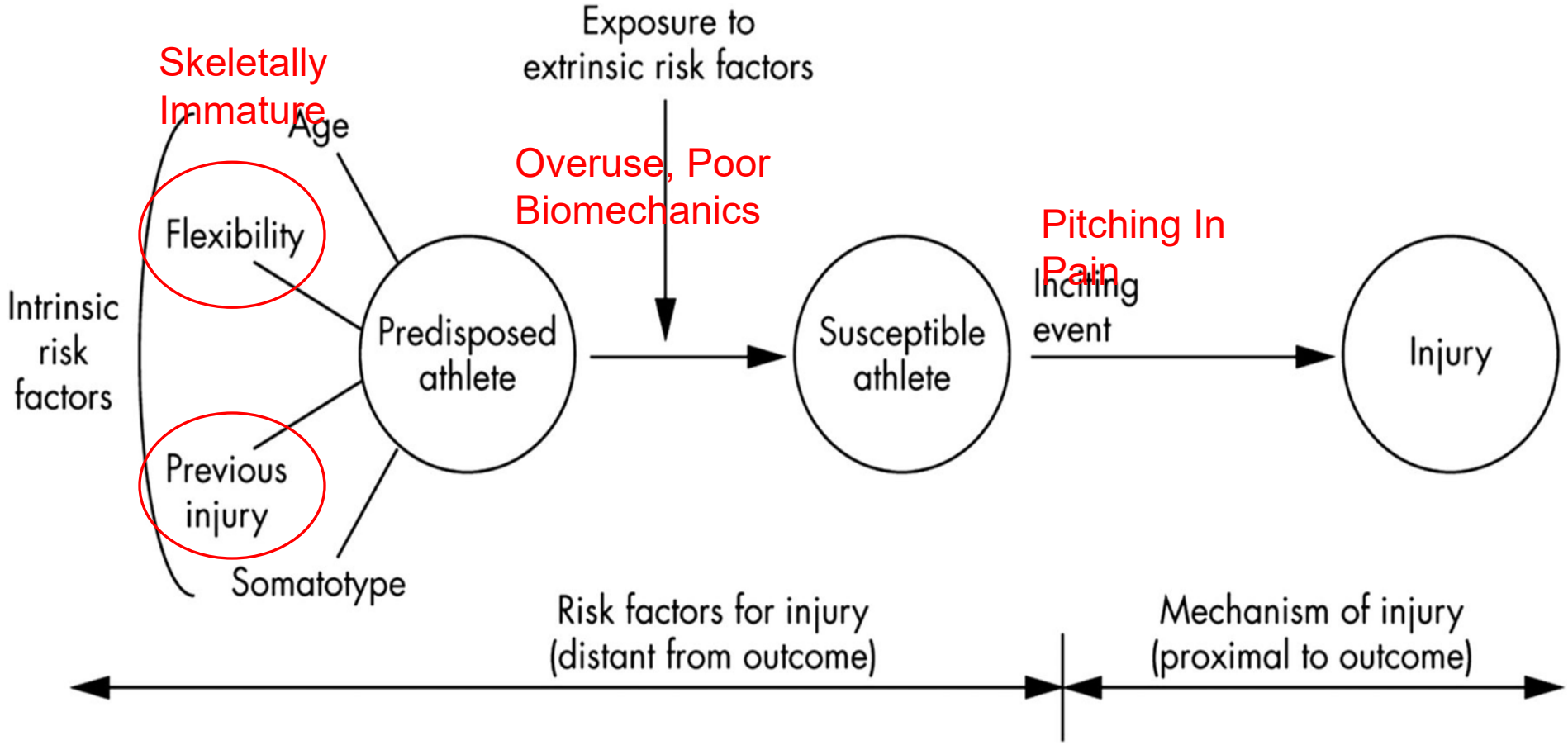
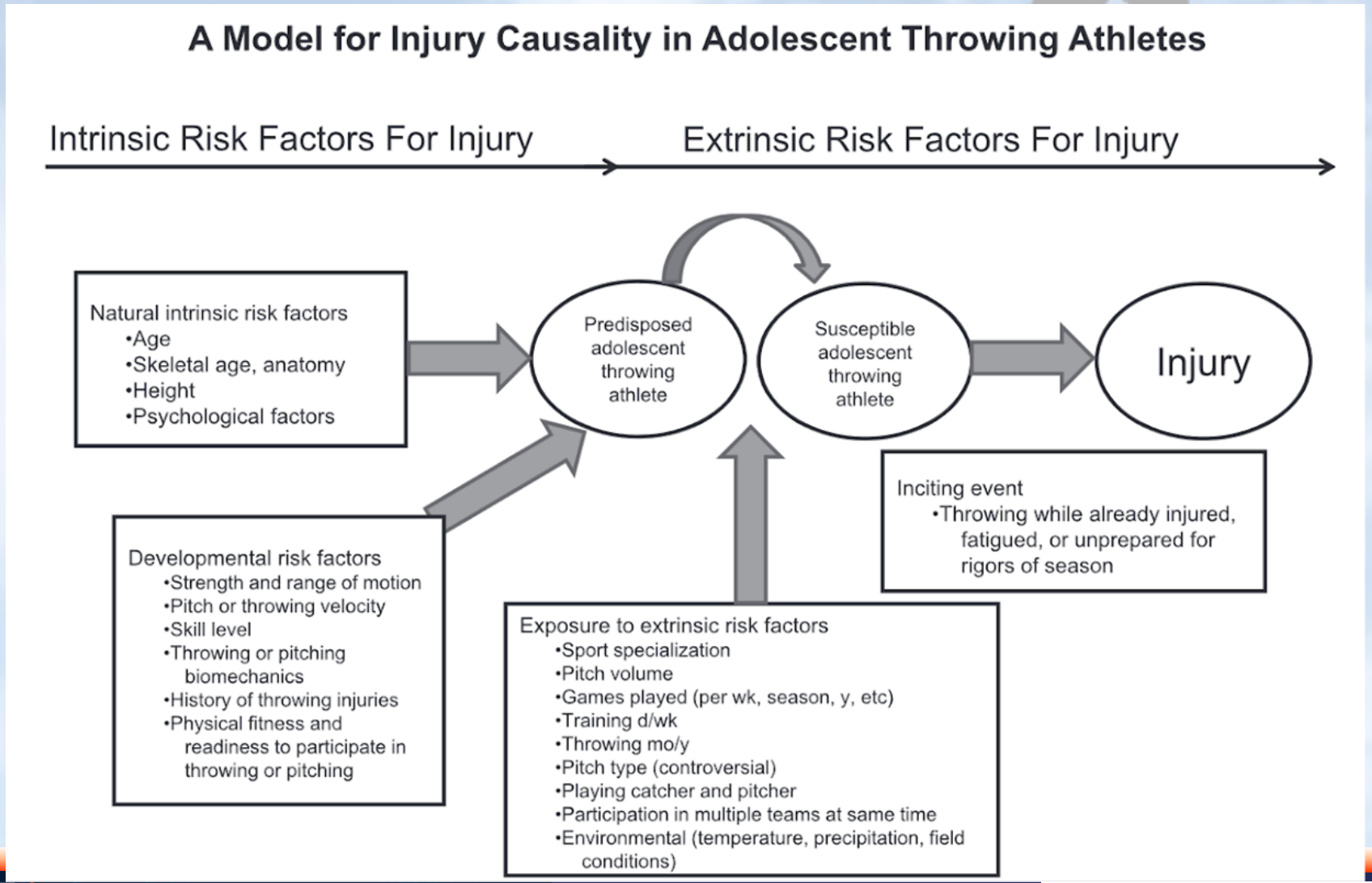


Windt J, Gabbett TJ. How do training and competition workloads relate to injury? The workload-injury aetiology model. Br J Sports Med. 2017 Mar;51(5):428-435. doi: 10.1136/bjsports-2016-096040.

A Model for Injury Causality in Adolescent Throwing Athletes



Pitching with Arm Fatigue

Average > 80 pitches = 4x risk of surgery

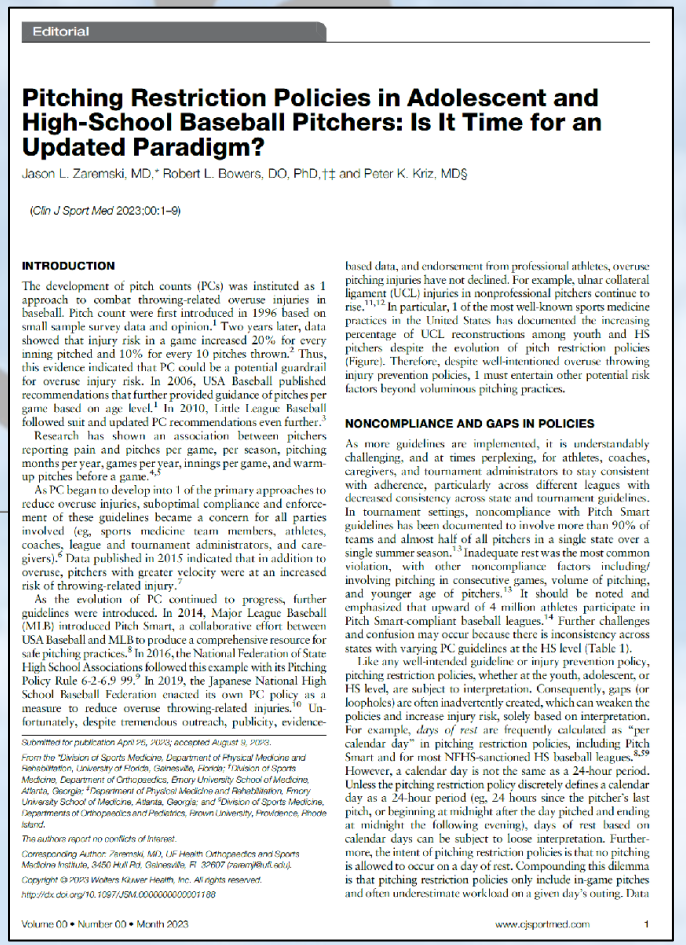
Pitch competitively > 8 months/year = 5x likelihood of injury

Pitching regularly with fatigued arm = 36x as likely to have an injury and potentially need surgery!

Olsen SJ, et al. AJSM. 2006

UCL Injuries & Baseball Developmental Model: Time For New Paradigm?

- **Pitching Restriction Policies (pitch counts, days of rest)**
  - non-compliance, gaps in policies
  - inconsistencies across state & tournament/showcase guidelines
  - ? decrease pitch count max 2° to increase in mean velocity among HS pitchers?
- **Workload**
  - combination of volume, intent/effort
  - warm-up, bullpen, in-game pitches
  - on-ramping, in-season, deload, recovery (workload management)
- **Velocity and Weighted Ball Programs**
  - risk/reward
  - standardization of programs? Avoid under 15-16 yo?
- **Off-season training programs**
  - throw year-round or eliminate all throwing for 2-3 continuous months?
  - Strength and conditioning, mobility, functional movement
- **UCL-R/repair**
  - disturbing trends or inevitable right of passage?
  - how will emerging techniques (repair, hybrid) impact prevention efforts, career longevity for both non-elite and elite players?



Editorial

Pitching Restriction Policies in Adolescent and High-School Baseball Pitchers: Is It Time for an Updated Paradigm?

Jason L. Zaremski, MD,* Robert L. Bowers, DO, PhD,†‡ and Peter K. Kriz, MD§

(*Clin J Sport Med* 2023;00:1–9)

INTRODUCTION

The development of pitch counts (PCs) was instituted as 1 approach to combat throwing-related overuse injuries in baseball. Pitch count were first introduced in 1996 based on small sample survey data and opinion.[1] Two years later, data showed that injury risk in a game increased 20% for every inning pitched and 10% for every 10 pitches thrown.[2] Thus, this evidence indicated that PC could be a potential guardrail for overuse injury risk. In 2006, USA Baseball published recommendations that further provided guidance of pitches per game based on age level.[1] In 2010, Little League Baseball followed suit and updated PC recommendations even further.[3]

Research has shown an association between pitchers reporting pain and pitches per game, per season, pitching months per year, games per year, innings per game, and warm-up pitches before a game.[4,5]

As PC began to develop into 1 of the primary approaches to reduce overuse injuries, suboptimal compliance and enforcement of these guidelines became a concern for all parties involved (eg, sports medicine team members, athletes, coaches, league and tournament administrators, and caregivers).[6] Data published in 2015 indicated that in addition to overuse, pitchers with greater velocity were at an increased risk of throwing-related injury.[7]

As the evolution of PC continued to progress, further guidelines were introduced. In 2014, Major League Baseball (MLB) introduced Pitch Smart, a collaborative effort between USA Baseball and MLB to produce a comprehensive resource for safe pitching practices.[8] In 2016, the National Federation of State High School Associations followed this example with its Pitching Policy Rule 6-2-6,9 99.[9] In 2019, the Japanese National High School Baseball Federation enacted its own PC policy as a measure to reduce overuse throwing-related injuries.[10] Unfortunately, despite tremendous outreach, publicity, evidence-based data, and endorsement from professional athletes, overuse pitching injuries have not declined. For example, ulnar collateral ligament (UCL) injuries in nonprofessional pitchers continue to rise.[11,12] In particular, 1 of the most well-known sports medicine practices in the United States has documented the increasing percentage of UCL reconstructions among youth and HS pitchers despite the evolution of pitch restriction policies (Figure). Therefore, despite well-intentioned overuse throwing injury prevention policies, 1 must entertain other potential risk factors beyond voluminous pitching practices.

NONCOMPLIANCE AND GAPS IN POLICIES

As more guidelines are implemented, it is understandably challenging, and at times perplexing, for athletes, coaches, caregivers, and tournament administrators to stay consistent with adherence, particularly across different leagues with decreased consistency across state and tournament guidelines. In tournament settings, noncompliance with Pitch Smart guidelines has been documented to involve more than 90% of teams and almost half of all pitchers in a single state over a single summer season.[13] Inadequate rest was the most common violation, with other noncompliance factors including/involving pitching in consecutive games, volume of pitching, and younger age of pitchers.[13] It should be noted and emphasized that upward of 4 million athletes participate in Pitch Smart-compliant baseball leagues.[14] Further challenges and confusion may occur because there is inconsistency across states with varying PC guidelines at the HS level (Table 1).

Like any well-intended guideline or injury prevention policy, pitching restriction policies, whether at the youth, adolescent, or HS level, are subject to interpretation. Consequently, gaps (or loopholes) are often inadvertently created, which can weaken the policies and increase injury risk, solely based on interpretation. For example, *days of rest* are frequently calculated as "per calendar day" in pitching restriction policies, including Pitch Smart and for most NFHS-sanctioned HS baseball leagues.[8,9] However, a calendar day is not the same as a 24-hour period. Unless the pitching restriction policy discretely defines a calendar day as a 24-hour period (eg, 24 hours since the pitcher's last pitch, or beginning at midnight after the day pitched and ending at midnight the following evening), days of rest based on calendar days can be subject to loose interpretation. Furthermore, the intent of pitching restriction policies is that no pitching is allowed to occur on a day of rest. Compounding this dilemma is that pitching restriction policies only include in-game pitches and often underestimate workload on a given day's outing. Data

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The authors report no conflicts of interest.

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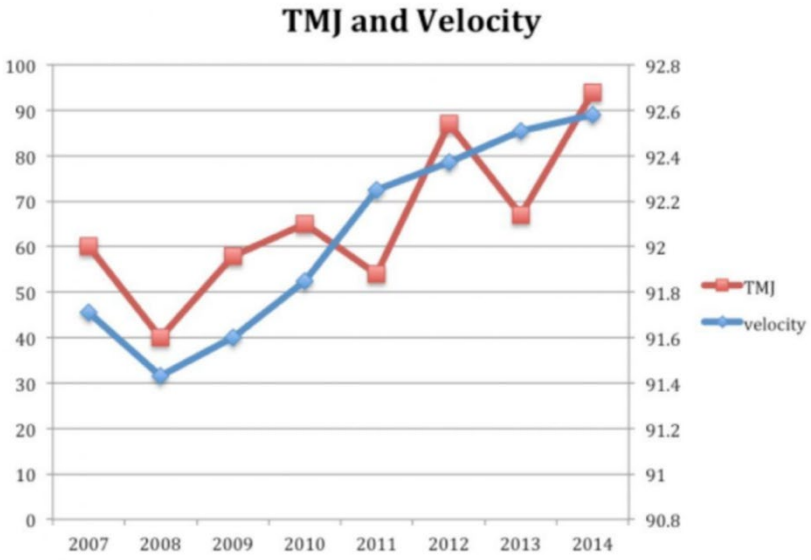
http://dx.doi.org/10.1097/JSM.0000000000001188

Zaremski, Kris, and Bowers. CJSM. 2023

Throw Harder = More Likely to Injure UCL



https://mikereinold.com/tag/weighted-ball-program/

Association of Maximum Pitch Velocity and Elbow Injury in Professional Baseball Pitchers

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From †Harbin Clinic Orthopaedics and Sports Medicine, Rome, Georgia, ‡Wake Forest University, Department of Orthopaedic Surgery, Winston-Salem, North Carolina, §Steadman-Hawkins Clinic Denver, Greenwood Village, Colorado, ‖Steadman-Hawkins Research Foundation, Vail, Colorado, and the ¶Steadman-Hawkins Clinic of the Carolinas, Greenville, South Carolina

[Athletic Training]

CEU

Pitch Velocity Is a Predictor of Medial Elbow Distraction Forces in the Uninjured High School–Aged Baseball Pitcher

Wendy J. Hurd, PhD,*† Reza Jazayeri, MD,‡ Karen Mohr, PT,‡ Orr Limpisvasti, MD,‡ Neal S. ElAttrache, MD,‡ and Kenton R. Kaufman, PhD†

More Concerns:
Too Fast Too Quickly Too Furious

Pitch Velocity = ↑ Elbow Pain

The Influence of Pitch Velocity on Medial Elbow Pain and Medial Epicondyle Abnormality Among Youth Baseball Players

Daisuke Kurokawa,*†‡ MD, PhD, Takayuki Muraki,‡§ PT, PhD, Hiroaki Ishikawa,‡§ PT, PhD, Kiyotsugu Shinagawa,‡‖ MD, Hideaki Nagamoto,‡¶ MD, PhD, Hiroyuki Takahashi,‡# MD, PhD, Nobuyuki Yamamoto,‖ MD, PhD, Minoru Tanaka,‡** MD, and Eiji Itoi,‖ MD, PhD
Investigation performed at Tohoku University, Sendai, Japan

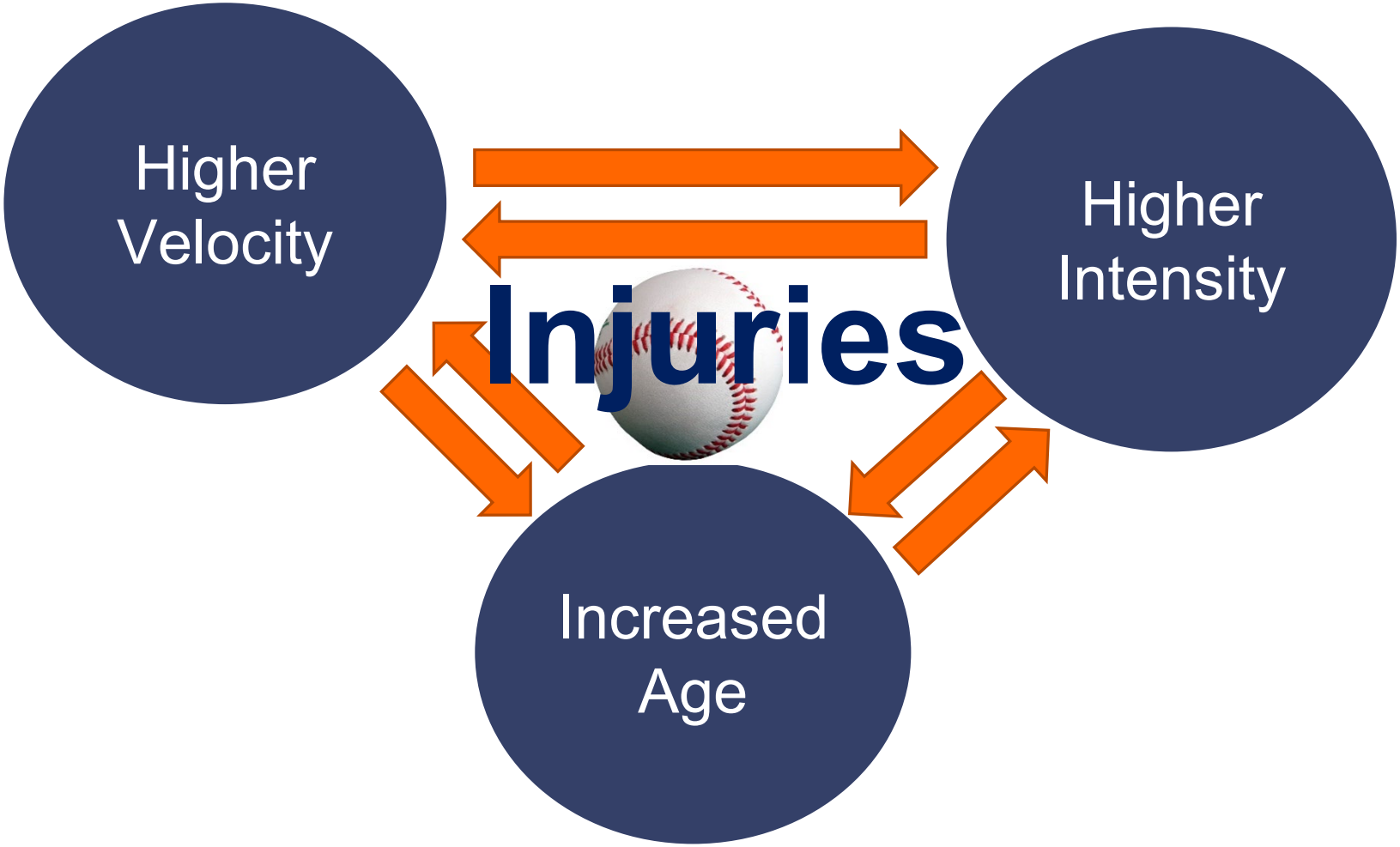
- 256 elementary school players (mean age 11.6 yrs; range 9-12 yrs)
- *A 10-km/h (6.2mph)* ↑ in pitch velocity = ↑ risk of medial epicondyle abnormality and medial elbow pain by 3x

What Does the Data Show?
Average Fastball at MLB Level

	Pitchers >95.0 mph ave 4 seam FB min 100 pitches	Pitchers >98.0 mph ave 4 seam FB min 100 pitches
2024	10% Increase and 2-3 Fold increase!	
2023		
2022		
2021		
2020*		
2019		
2018		
2017		

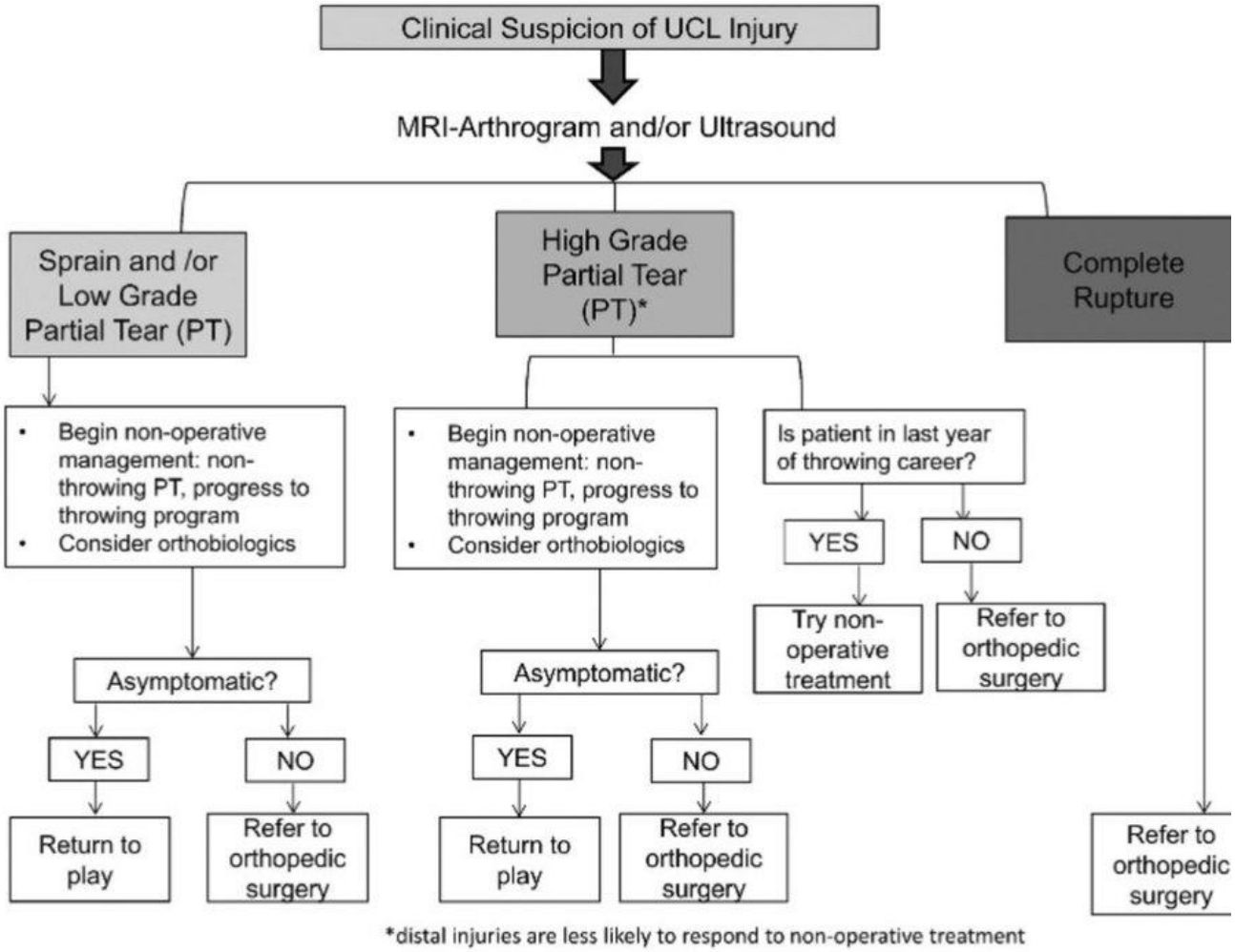
*Pandemic shortened season

https://baseballsavant.mlb.com/leaderboard/pitch-arsenals?year=2023&min=250&type=avg_speed&hand=R



Zaremski et al, AJSM 2024

My Treatment Algorithm



Zaremski, Vincent, K, Vincent H. Elbow UCL: Injury, Treatment Options, and Recovery in Overhead Throwing Athletes. CSMR 18(9):p 338-345, 2019.

1 Slide on Orthobiologics

Does PRP Improve UCL Injuries? Well...not exactly

Orthobiologic Treatment of Throwing Related Injuries in Sport: A Focused Review of the Published Literature

Robert L. Bowers, DO, PhD, CAQSM, FAAPMR;[1,2] Caroline M. Fryar, MD;[3] Kevin Cipriano, MD;[1,2] and Jason L. Zaremski, MD, CAQSM, FAAPMR, FACSM, FAMSSM[3]

Abstract

Because of the growth and development of orthobiologics, in particular platelet-rich plasma, as a potential treatment modality in sports related injuries, it is imperative that providers are aware of the up-to-date published data on the usage of this treatment. While some data are promising, prospective studies are needed to determine the effectiveness of platelet-rich plasma treatment for throwing related injuries. There are limitations with all of the published data that include their retrospective nature, heterogeneity between study designs, and platelet-rich plasma characteristics if reported. While platelet-rich plasma may be used as a likely safe adjuvant to conservative and surgical treatments, prospective randomized controlled studies using appropriately reported platelet-rich plasma concentrations and characteristics will help physicians make more definitive recommendations in regard to platelet-rich plasma treatment. Based on the currently available published data, this treatment may be trialed in the right setting and based on severity and location of injury.

nosis and management are paramount to minimize time away from sport, as well as minimize recurrence of injury. Common injuries in throwing athletes at all levels of sport include rotator cuff tendinopathy, long head of the biceps tendinopathy, glenoid labral injuries, overuse elbow and shoulder injuries, posteromedial elbow impingement, as well as the elbow medial ulnar collateral ligament (MUCL) tears (5–7).

Increasing popularity of baseball and softball combined with the volume and rate of shoulder and elbow related injuries has led to newer modalities of treatment being proposed for these types of injuries. Orthobiologics (OB) are one of these potential treatment modalities. However, there has not been a review of the literature focused

Bowers RL, Fryar CM, Cipriano K, Zaremski JL. Orthobiologic Treatment of Throwing Related Injuries in Sport: A Focused Review of the Published Literature. Curr Sports Med Rep. 2023 Jun 1;22(6):199-203.

Clinical Relevance and Take Home Tools

In light of these data, the baseball medicine community needs to better understand the following:

1) **The primary risk factors for UCL injuries**

2) **Development of improved injury prevention strategies.**

3) **Upgraded training methods to minimize risk of UCL injuries**

Thank you!

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Any questions?