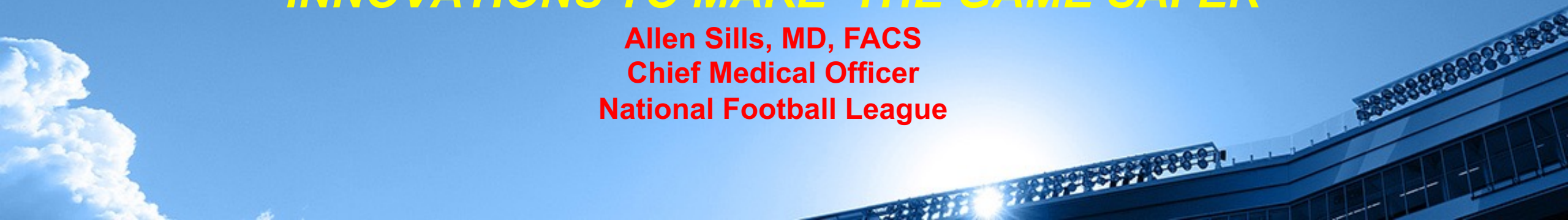
HAMSTRING AND ANKLE INJURY REDUCTION STRATEGIES

INNOVATIONS TO MAKE THE GAME SAFER

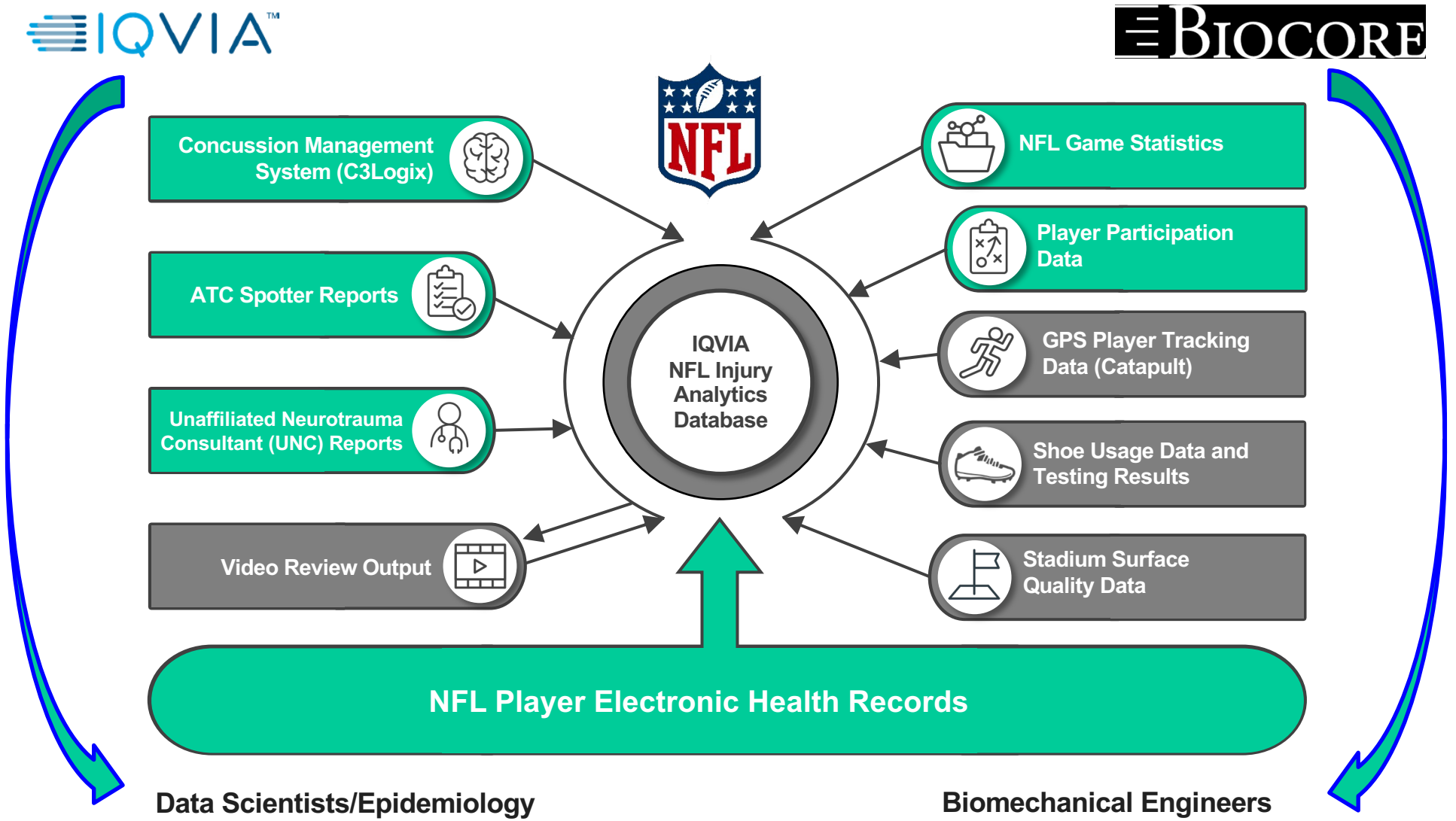
Allen Sills, MD, FACS
Chief Medical Officer
National Football League



Risk reduction strategies

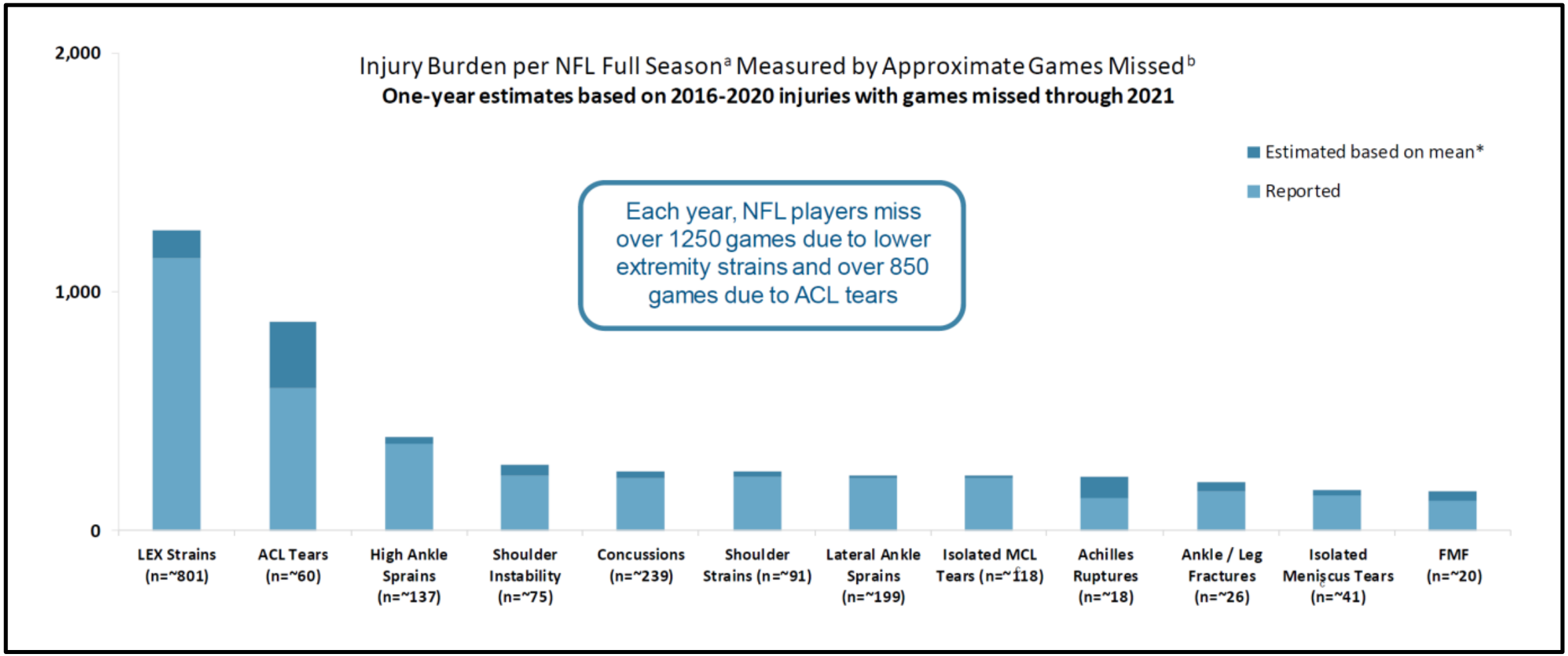
- Equipment
- style of play/rules
- training and teaching
- Supervision and medical support

DATA SOURCES

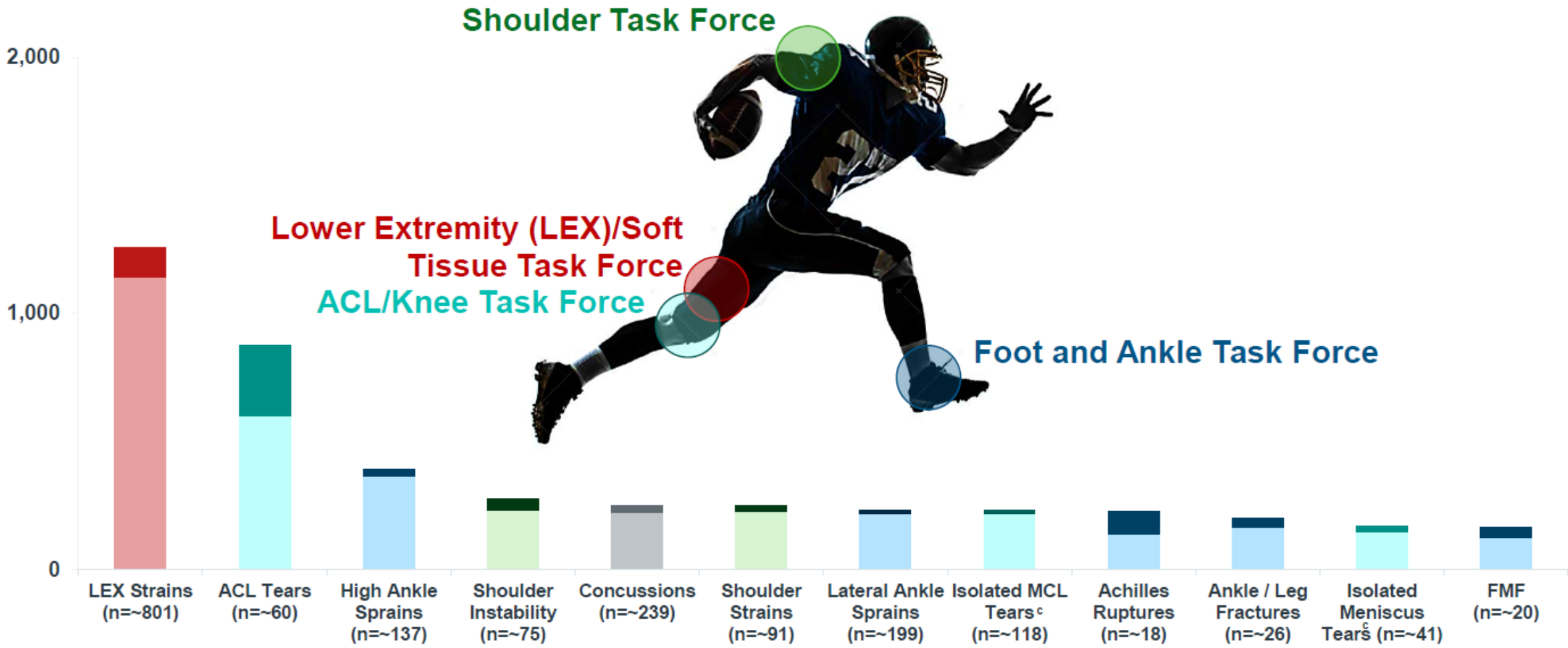


Injury Burden – setting priorities

Injury Burden



The NFL has created specific task forces to address key injuries



* Return dates are missing for 5-38% of injuries; games missed is estimated by using the mean. These estimates do not take into account football-related and other non-injury related factors for return to play.
[a] Total incidence across 2016-2020 within NFL Calendar years in order of chart: 4,006 (LEX Strains), 298 (ACL), 685 (HAS), 377 (Shoulder Inst.), 1,196 (Conc.), 454 (Shoulder Strains), 996 (LAS), 590 (Iso. MCL), 89 (AR), 130 (A/L Fx), 205 (Iso. Meniscus), 98 (FMF).
[b] Games missed are approximated, leading to potential inaccuracy of values when players switched clubs, were waived, or put on IR.
[c] Isolated injuries are those without concomitant ligamentous pathology and may be accompanied by other non-ligamentous injuries.

MSK TASK FORCES

- LEX Soft tissue
- Knee ligament
- Foot/Ankle
- Shoulder
- Sports science



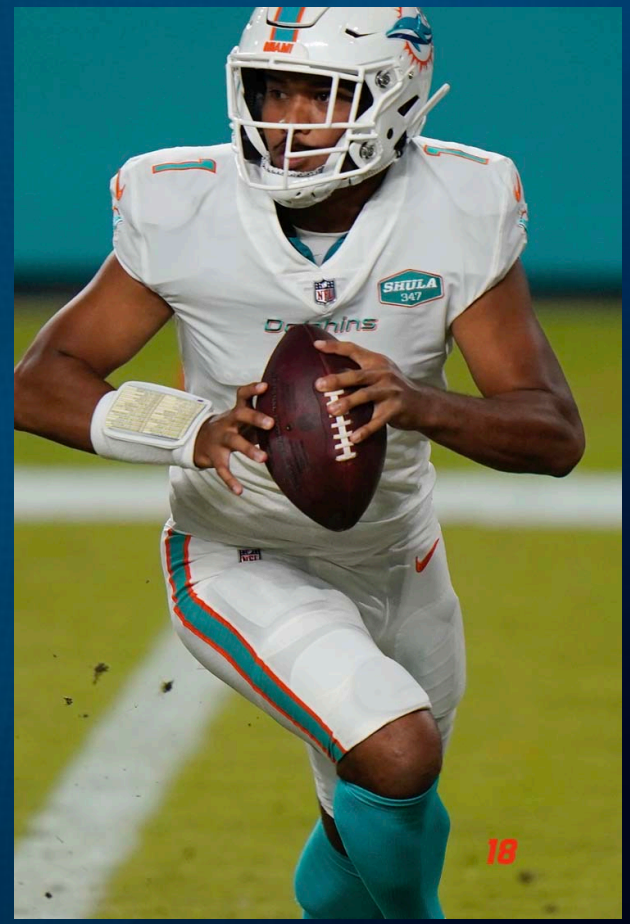





LEX injury: Most Burdensome in NFL and Most Complex

- We are bringing to bear all scientific tools we have (surveys, epi, biomechanics, surface science)
- Alignment of these data sources is important to point us to countermeasures with highest potential for positive impact on injury prevention

Lower Extremity Injury Reduction

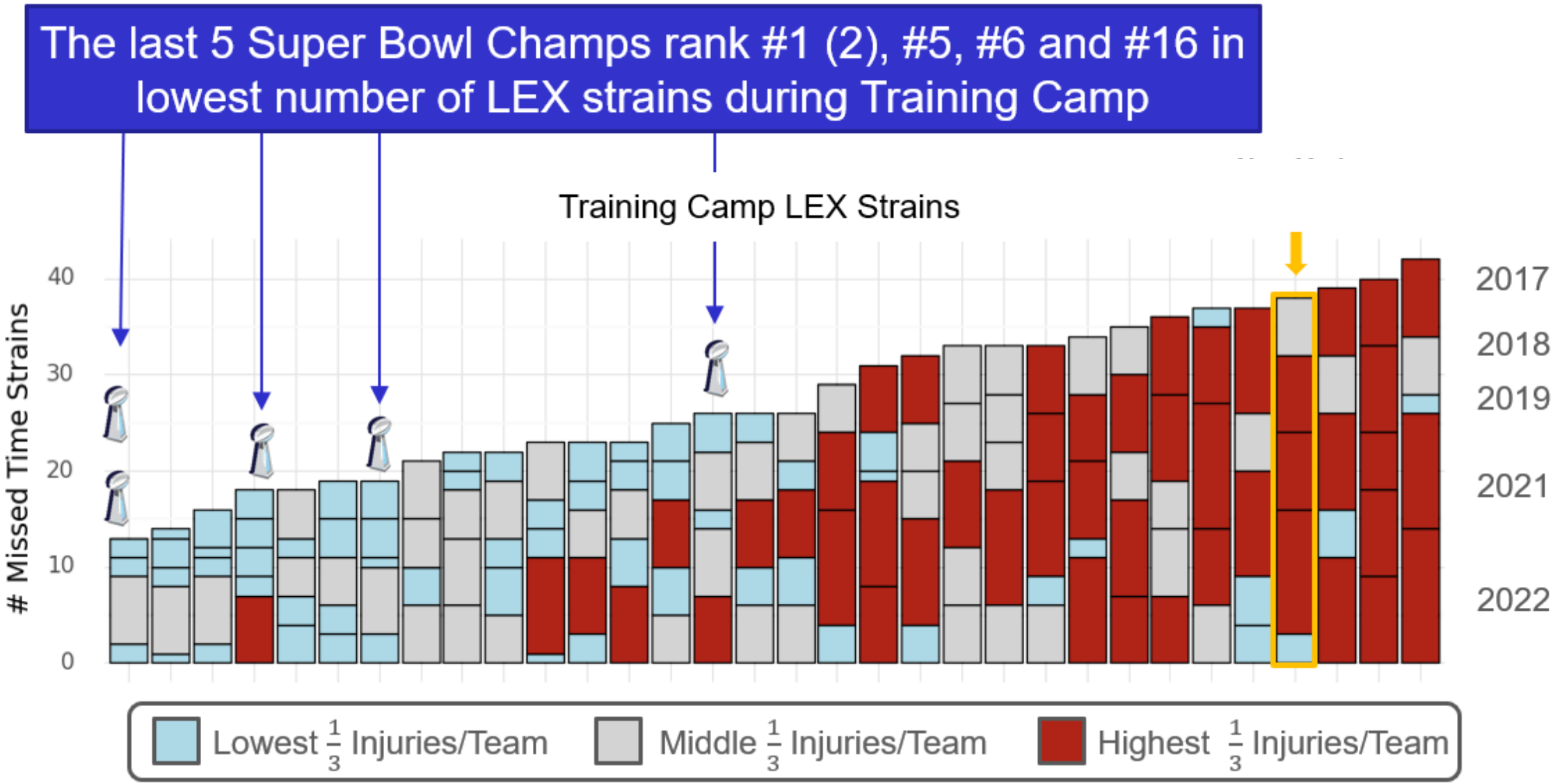


2023 Health & Safety Priorities

2023 Key Priorities	
Priority #1: LEX Injury Reduction	• Continue gradual ramp-up activity during the first 8 days of Training Camp • Limit practice/walkthrough block sizes to no more than 5 practices in a row • Hold joint practices between preseason games 1-3 • Monitor intensity and load leading up to and during RS practices in wks 1-5 • Modify conditioning tests for linemen to align with on-field demands
Priority #2: Head Impact Reduction	• Use team-specific head impact data to remove avoidable head contact • Expand Guardian Cap usage • Promote position-specific helmet use for QB and OL

Key point: Real-time data and tools are available

Reminder from Last Year: Reducing Strains is a Winning Strategy

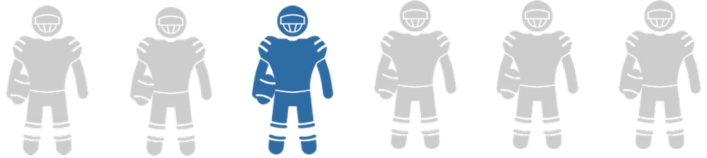


Reducing strains is key to player availability for the full season

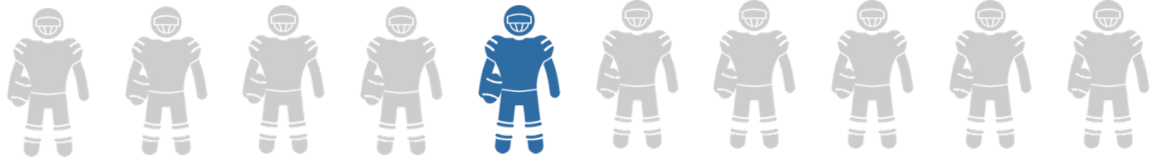
- Players getting preseason strains are making the roster: ~50-60% of LEX strains in preseason are among players who make the 53-man roster
- ~30% of preseason missed-time LEX strains led to a subsequent regular season or postseason LEX strain*

Strains have high recurrence

1 in 6 hamstring strains will result in another same-side strain within a year

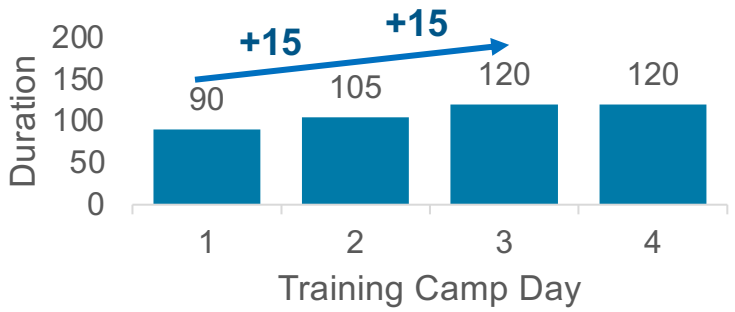


1 in 10 for adductor strain



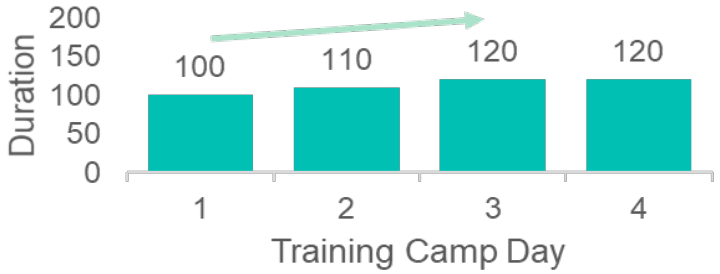
Training Camp Ramp-Up Strategies

Clear ~15-minute Ramp



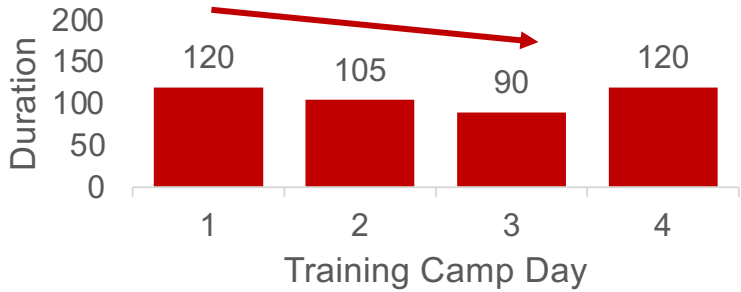
79%

<10-minute Ramp

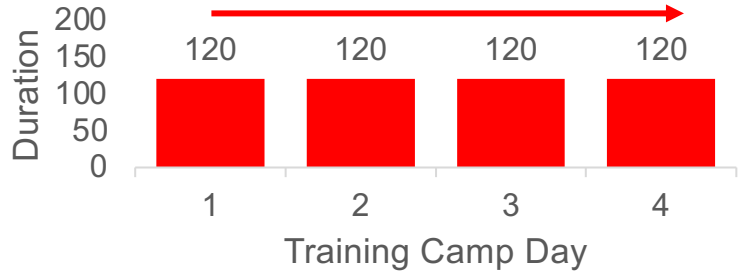


57%

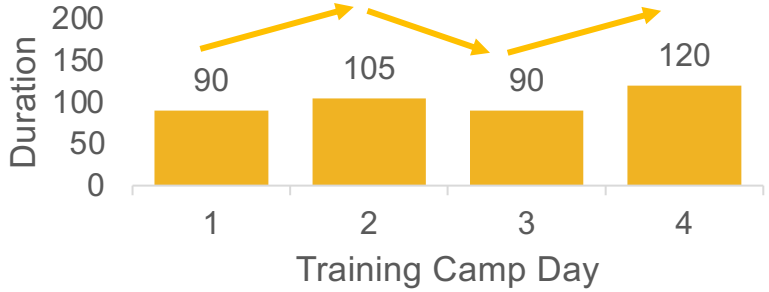
Reverse Ramp



Stable Duration



High-Low



80%

*Percent of Clubs that decreased non-Contact TC injuries in 2022 vs. 2021

Preseason: Use a Strategic Approach to Optimize Player Availability

Training Camp

Continue gradual duration ramp implemented last season

Days 2-5

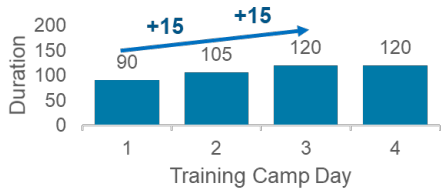
1. **Gradually increase duration by ~15 minutes**/day

OR

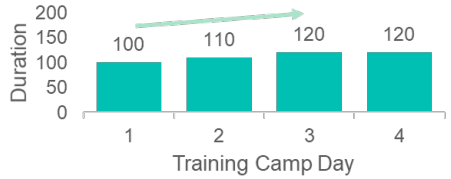
Use **high-low approach** of 90 105-90-120 practice min/day

2. Focus on **on-field conditioning and training** vs. practice activities

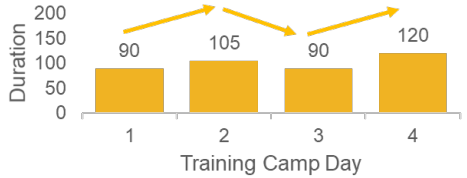
Clear ~15-minute Ramp



<10-minute Ramp



High-Low



Day 1 (Vet Report) Day 2 Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9 Day 10 Day 11 Day 12 Day 13 Day 14 Day 15 Day 16 Day 17 Day 18 Day 19 Day 20 Day 21 Day 22 Day 23 Day 24 Day 25 Day 26 Day 27 Day 28 Day 29 Day 30 Day 31 Day 32 Day 33 Day 34 Day 35 Day 36 Day 37 Day 38 Day 39 Day 40 Day 41 Day 42 Day 43

Goal: Gradually increase activities over preseason and reduce sudden spikes in activity levels

Preseason: Use a Strategic Approach to Optimize Player Availability

Training Camp	Preseason Games	Bye Week

Continue gradual duration ramp implemented last season

RECOMMENDATION: Practice block sizes are ideally 3-4 days max

Days 2-5

1. **Gradually increase duration by ~15 minutes**/day

OR

Use **high-low approach** of 90 105-90-120 practice min/day

2. Focus on **on-field conditioning and training** vs. practice activities

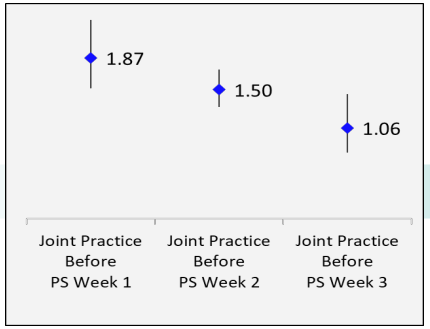
Days 6-9

Reduce duration on the first day of contact practice by 15 minutes and **re-ramp duration**

New: Clubs will have flexibility for day off on day 5 or 6 to enable strategic load management

Rest of Preseason

1. Limit practice/walkthrough block sizes to ideally 3-4 days in a row and no more than 5 days in a row in week 2 of Training Camp
2. Players need exposure to game-like conditions
3. Hold joint practices before 2nd or 3rd preseason game

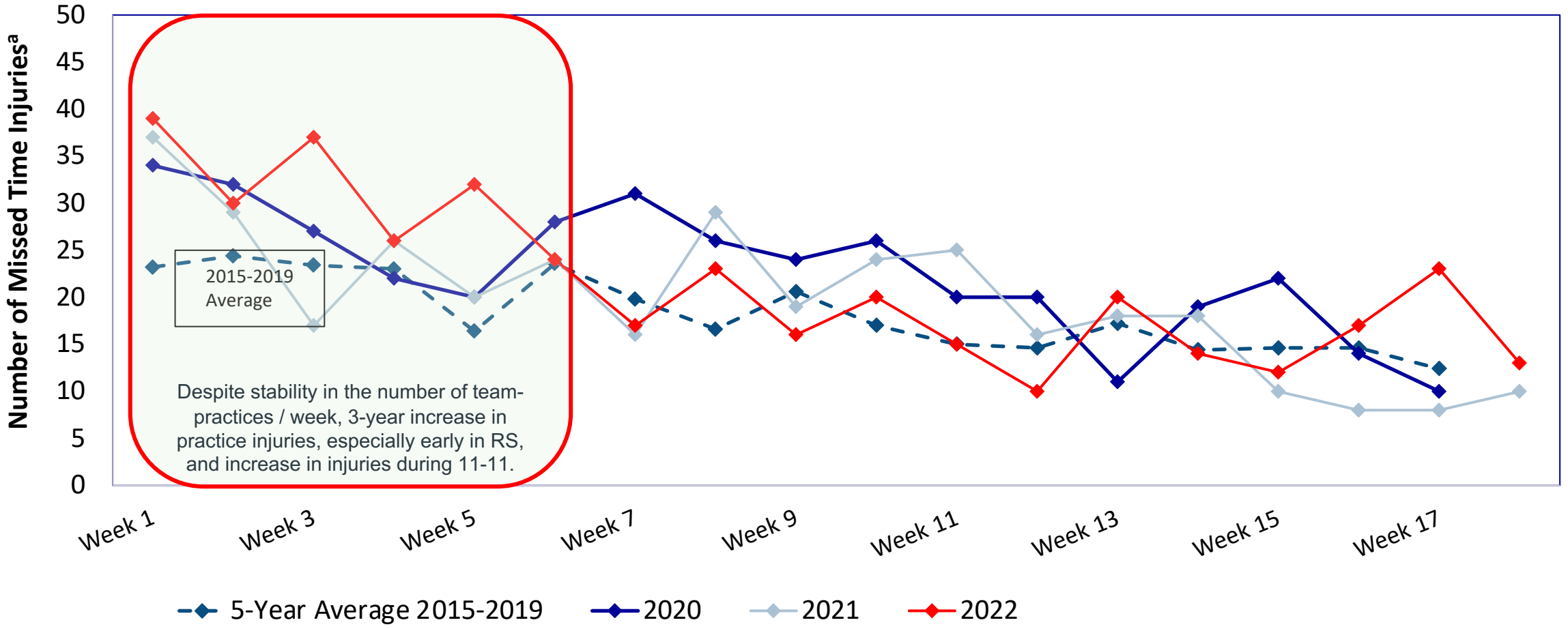


Day 1 (Yet Report) Day 2 Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9 Day 10 Day 11 Day 12 Day 13 Day 14 Day 15 Day 16 Day 17 Day 18 Day 19 Day 20 Day 21 Day 22 Day 23 Day 24 Day 25 Day 26 Day 27 Day 28 Day 29 Day 30 Day 31 Day 32 Day 33 Day 34 Day 35 Day 36 Day 37 Day 38 Day 39 Day 40 Day 41 Day 42 Day 43

Goal: Gradually increase activities over preseason and reduce sudden spikes in activity levels

Practices in RS Weeks 1-5 have had higher injury rates the last 3 years

Regular Season Practice Injuries by Week - 2015-2022



The NFL season structure changed in 2021 to include 17 regular season games, compared to 16 regular season games in prior years.

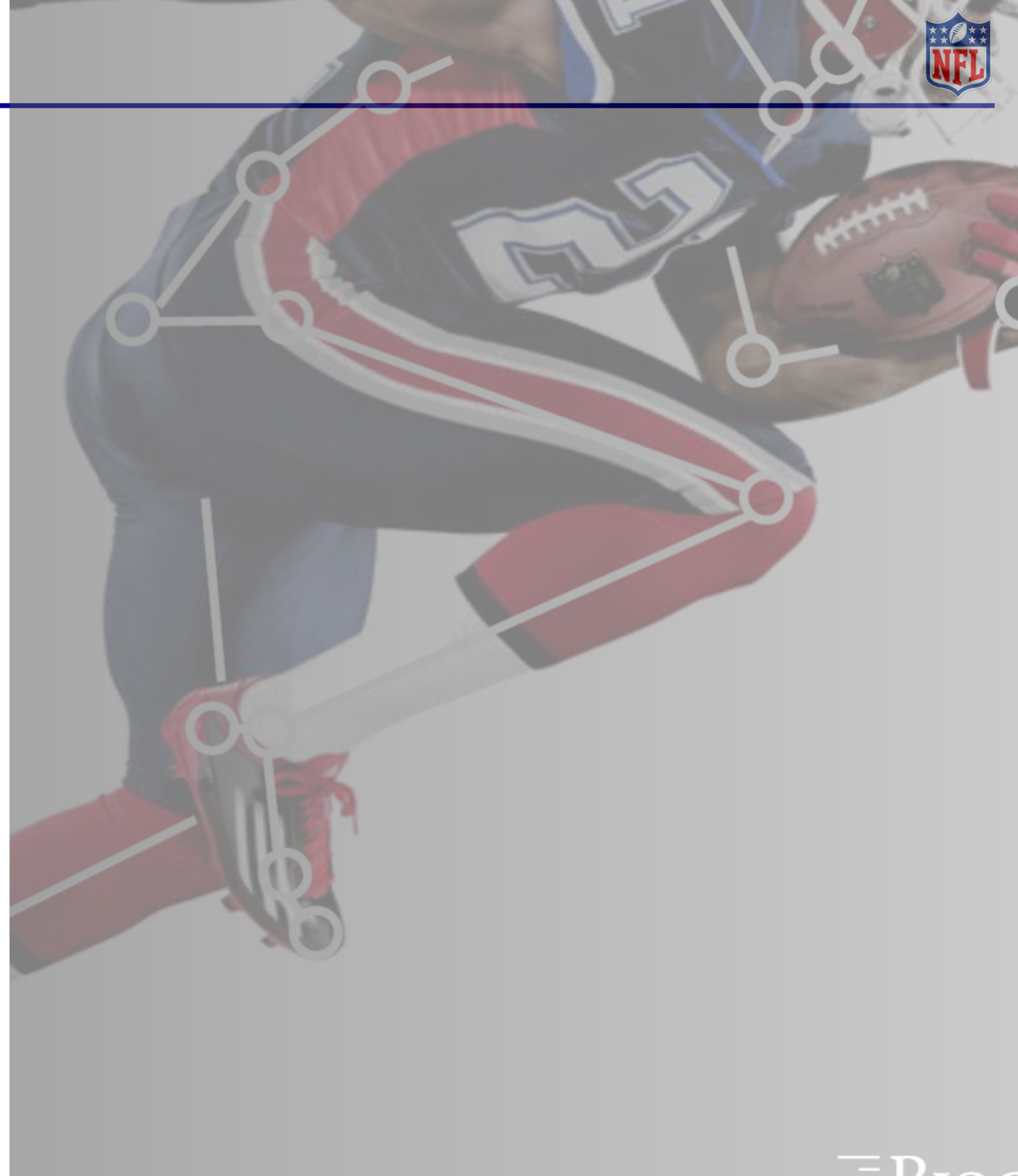
Preseason LEX Strains by Week

2017-2022; Games, practice, and other activities

Week	3-Year Avg 2017-2019	2021	2022	% (n) Change vs. 2021	% (n) Change vs. 3-Year Avg
Rookie TC	8.6	9	6	-33% (-3)	-31% (-2.6)
TC Week 1	105	90	63	-30% (-27)	-40% (-42)
TC Week 2	117.3	144	113	-22% (-31)	-4% (-4.3)
TC Week 3[b]	0.3	43	33	-23% (-10)	TC decrease of 25%
HOF Game	1.3	2	0	-100% (-2)	-100% (-1.3)
PS Week 1	33.3	29	29	0% (-0)	-13% (-4.3)
PS Week 2	71.3	72	74	+3% (+2)	-4% (-2.7)
PS Week 3	47.0	44	46	+5% (+2)	-2% (-1.0)
PS Week 4[c]	34.7	10	10	0% (-0)	-71% (-24.7)
Total	**419**	**443**	**374**	**-16% (-69)**	**-11% (-45)**

Biomechanical Movement Analysis

- 15 Clubs have volunteered to participate
- 4 required testing points (off-season/pre-season)
- 3–5-minute assessment
- Battery of tests being finalized
- **Individual, team reporting to enhance player care**
- Robust dataset for use in DA modeling

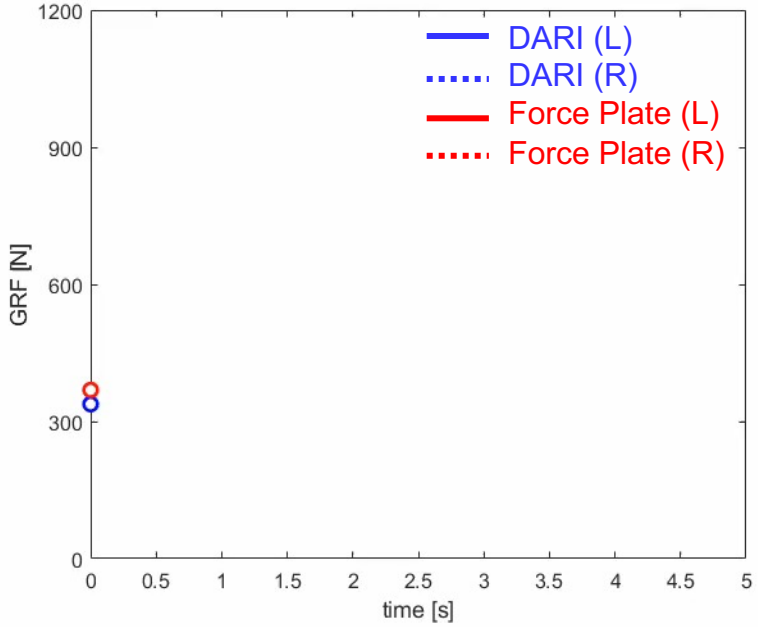


Evaluation Results (DARI Motion)

Video

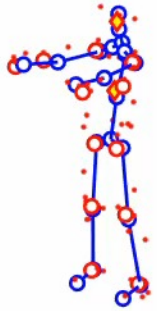
Overlaid Skeleton

Ground Reaction Force

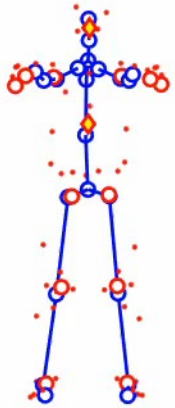


DARI
vs
VICON

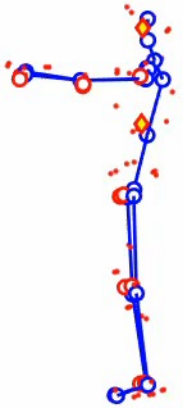
Joint Centers
Markers



Perspective



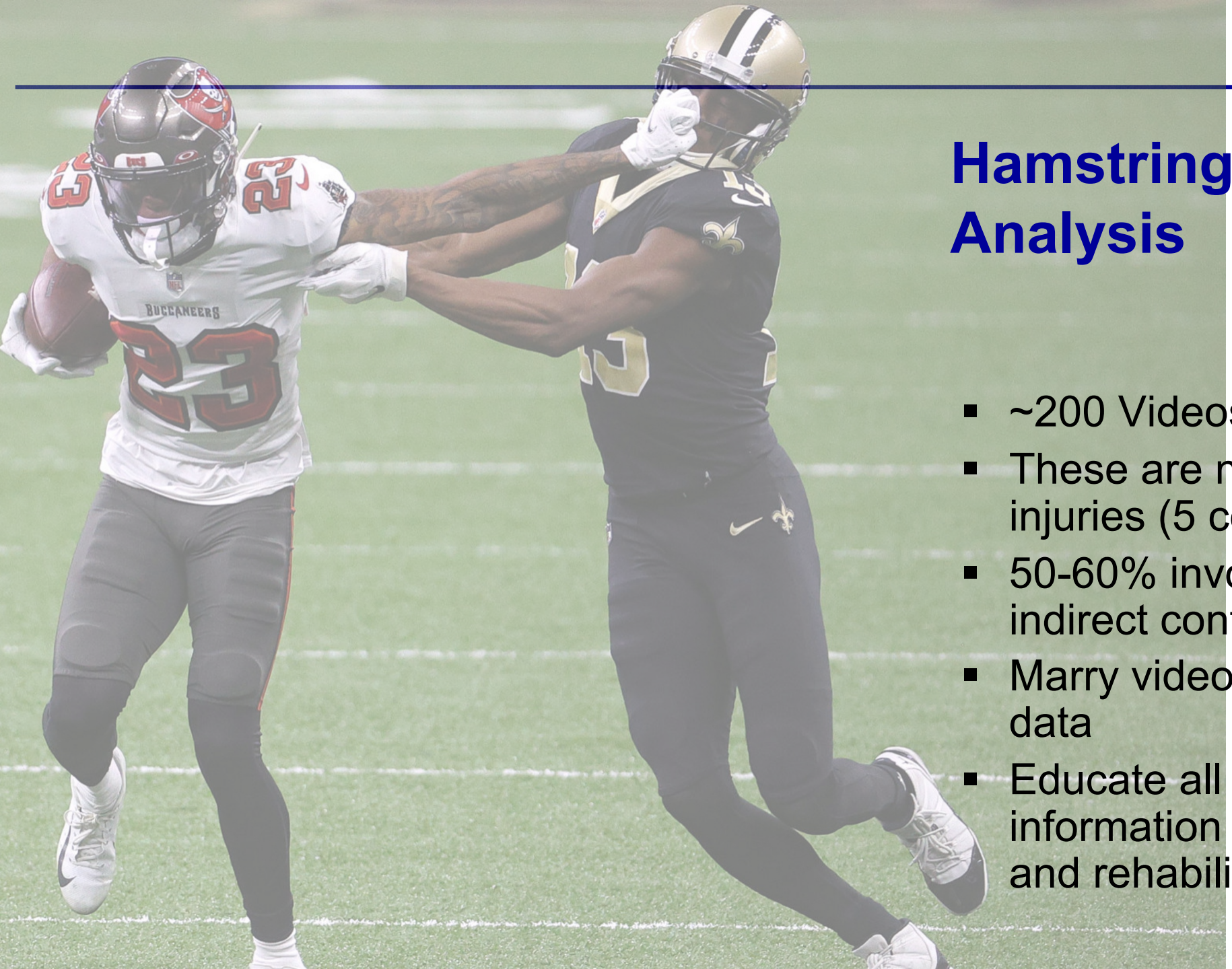
Front



Side

Hamstring Imaging Review

- 128 Images Reviewed by 3 MSK Radiologists
- Overwhelming majority of injuries are those to the biceps femoris (central/distal)
- Combine with Epi data
- Dissemination of information
  - Imaging guidance
  - Infographic



Hamstring Injury Video Analysis

- ~200 Videos reviewed
- These are not simply sprint-type injuries (5 common mechanisms)
- 50-60% involve some type of indirect contact
- Marry video data up with imaging data
- Educate all stakeholders on this information → Improved training and rehabilitation programs

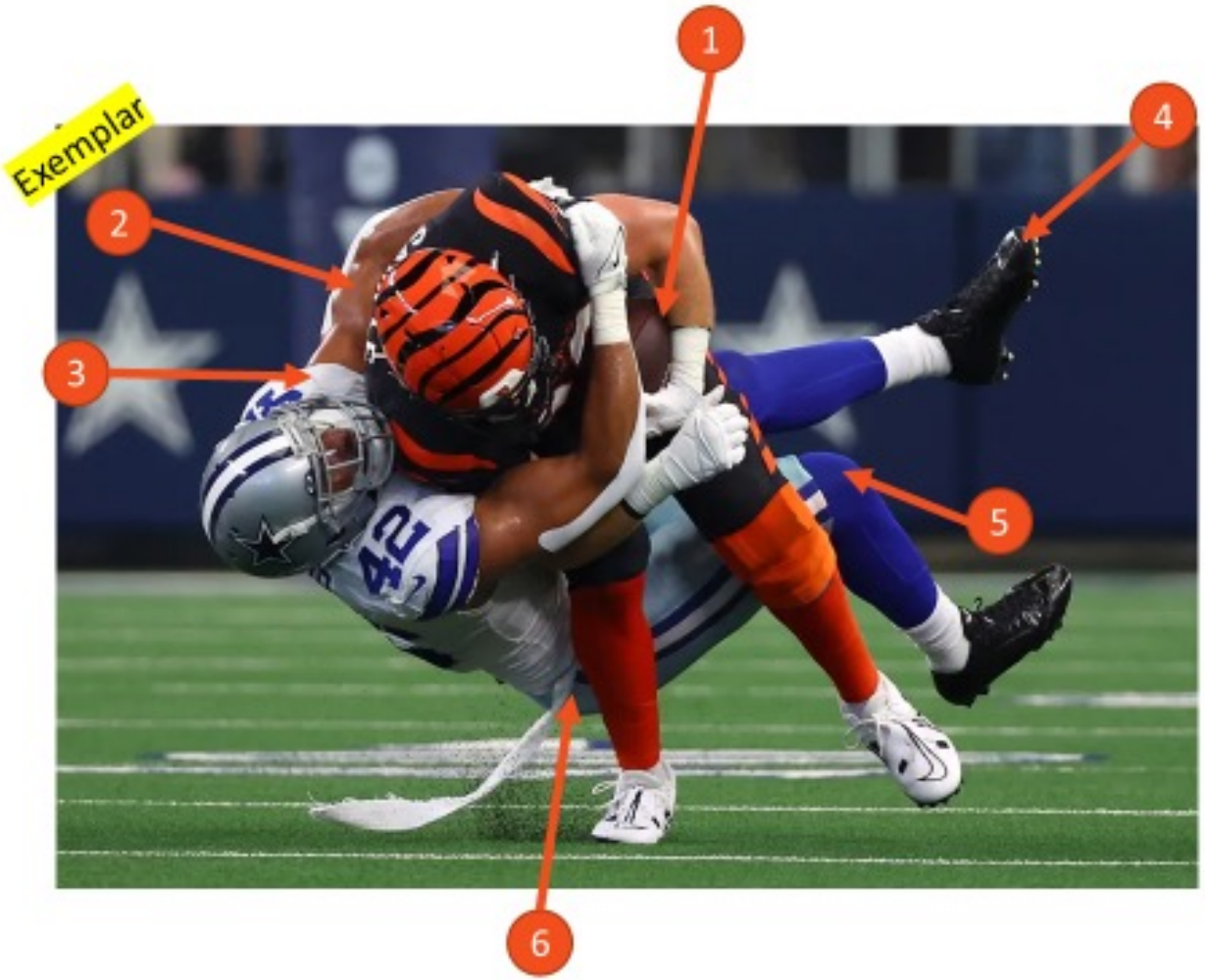
Nordbord Data Analysis

- 16 Clubs provided Nordbord data – over 3000 tests
- Lacks standardization with data collection and storage
- Analysis is on-going by IQVIA
- Insight into eccentric strength and asymmetry as risk factors for hamstring strain in NFL players

Hip Drop Tackle

What is a "Hip Drop Tackle" (HDT)

1) Always a **tackle on ball carrier**
2) Tackle wraps **arms around hips/torso**
3) Tackler **maintains grip** on ball carrier
4) Tackler **unweights their feet**
5) Tackler **flexes hips to pull knees up**
6) Tackler **twist hips** into seated posture



Incidence, absolute risk, and relative risk of HDT

Preliminary Findings

1. Estimated* incidence of **once per game**
   - ~1% of all tackles are HDT
   - Extrapolates to ~250 HDT / regular season

2. Estimated† injury from HDT happens about **once per week**
   - **13-19 injuries per regular season**

3. HDTs cause injury **20x** more often than other tackles
   - **1 in 20 HDT causes injury**
   - Median burden for HDT 'missed time' ankle injury is **44 days** (vs 27 for other tackle types)

4. **High Ankle Sprain** is most frequent
   - **~1 in 4 HDT injuries involve knee**

*Based on VR of ~4400 tackles (19%) of 2022 Tackles
†Based on all LEX injuries on ball carrier in 2022

BIOCORE
Biomechanics | Consulting | Research

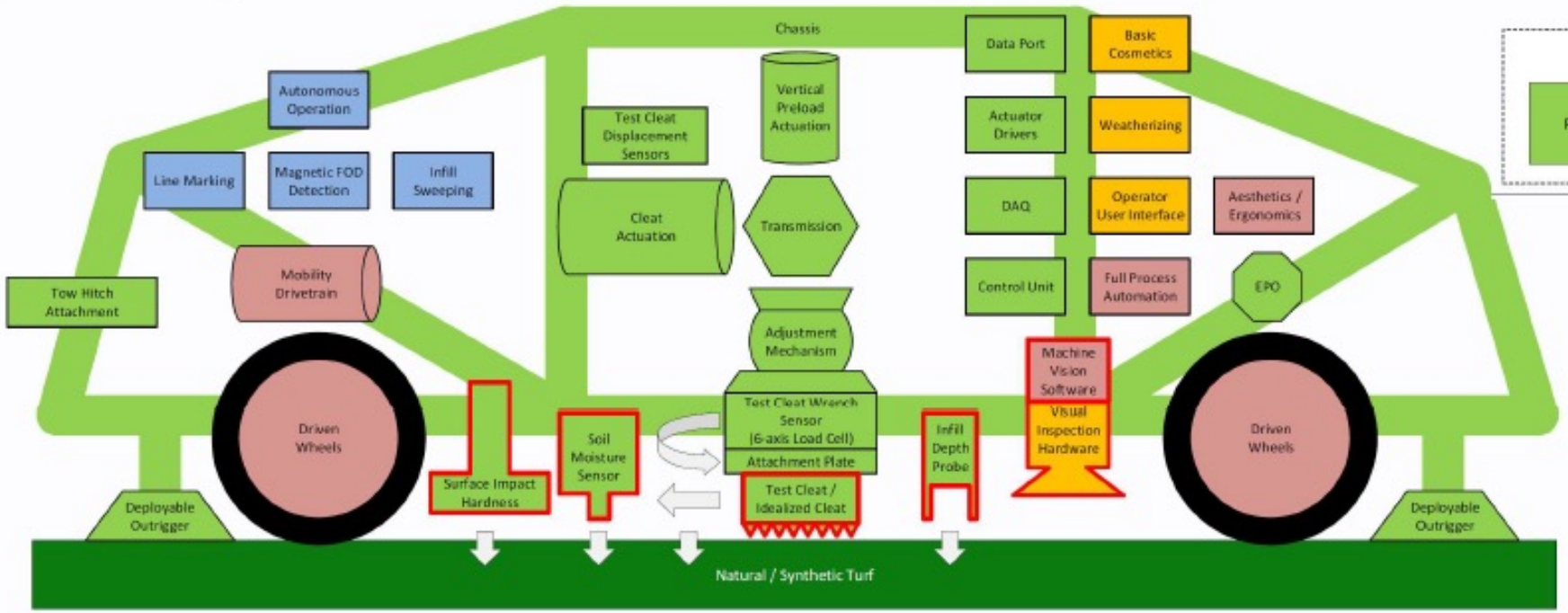
Turf & Cleats

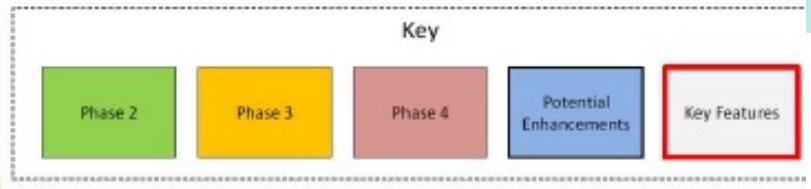
Operationalize Turf Tester

Phase 2 – Functional Prototype

Phase 3 – Minimum Viable Product

Phase 4 – Production Ready Device





Standard Performance Evaluations

- 5 artificial turfs + natural
  - Range of “slipperiness” from installed stadiums with and without issues
  - U Calgary – Field Turf

6 tests

3 Cone

10m sprint time

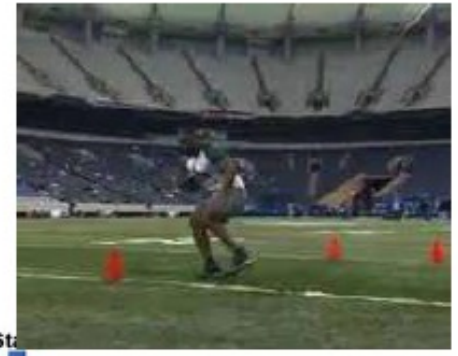
5-10-5 agility time

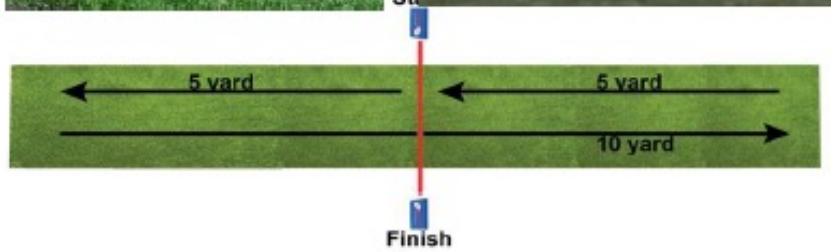
Sled Push

max horizontal jump distance

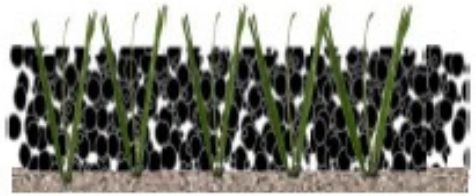
maximum vertical jump height

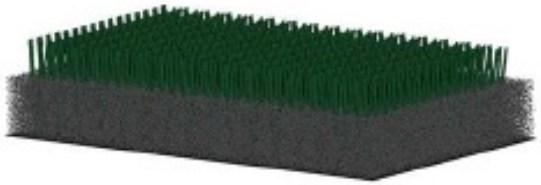
- 16 University Football players
- 8 linemen
- 8 skill position





Development of Parametric Turf FE Model





Benefits of Proposed Technology

- Turf FE model developed will provide free-use, state-of-the-art computational tools for manufacturers (shoe and turf) and the broader research community, to stimulate rapid and significant advances and new innovations in turf and cleat design

Challenges

- Advanced modeling technique (meshless) needs to be incorporated to properly model the turf composed of different components

Fiber (FEM)
- elastic stiffness
- thickness
- distance
- length

Infill (DEM)
- size (distribution) / mass
- internal interaction characteris
  (stiffness, friction, damping etc
- external friction

Backing Layer (FEM)
- elastic stiffness
- thickness

Pad Layer (FEM)
- viscoelastic stiffness
- thickness


NFL