



ACL Injury Prevention: What can we do to mitigate risk?

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- Soccer is the most widely played sport
 - 300 million registered players globally
Dvorak 2005, FIFA 2006
 - 2nd most popular sport in the USA: 24.4 million participants
US Census 2012, Jeffrey 2014
 - USA: 1.6 million female players (13.36 globally)
Barreira, 2016
 - 1st US female collegiate game played in 1977,
> 1200% growth in 40 years
Wimmer-Schwarb, 2019



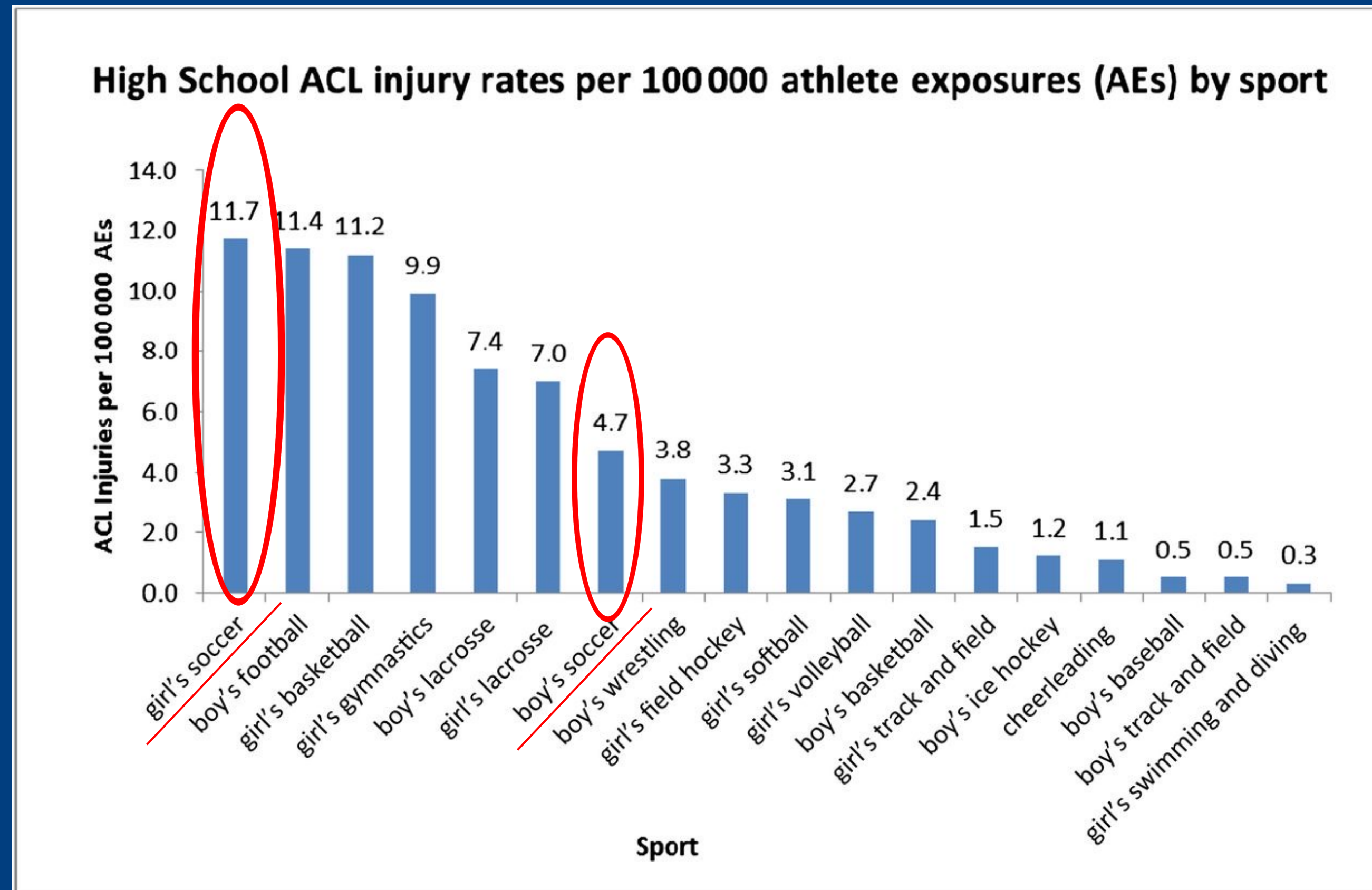
However, injuries continue to occur, and in some cases increase...

Can we mitigate ACL injury risk?



ACL INJURIES IN SOCCER

High School ACL Injury Rate: Girl's soccer #1, Boy's soccer #3



Yard, Comstock R, Collins C, 2009



LaBella, 2014

<http://pediatrics.aappublications.org/content/133/5/e1437>

- 186,544 injuries in soccer annually < 18 years of age
- 43,125 ACL injuries occur annually in HS sports in the US

Joseph, 2013

ACL INJURIES IN COLLEGE SOCCER

- ACL Injury rates in the NCAA

Arendt and Dick, 1995

- Data collected over a 5-year period (1989-1993)

- 0.31 Women

- 0.13 Male

- NCAA ACL injury rates in females are nearly 3-6 times greater than males

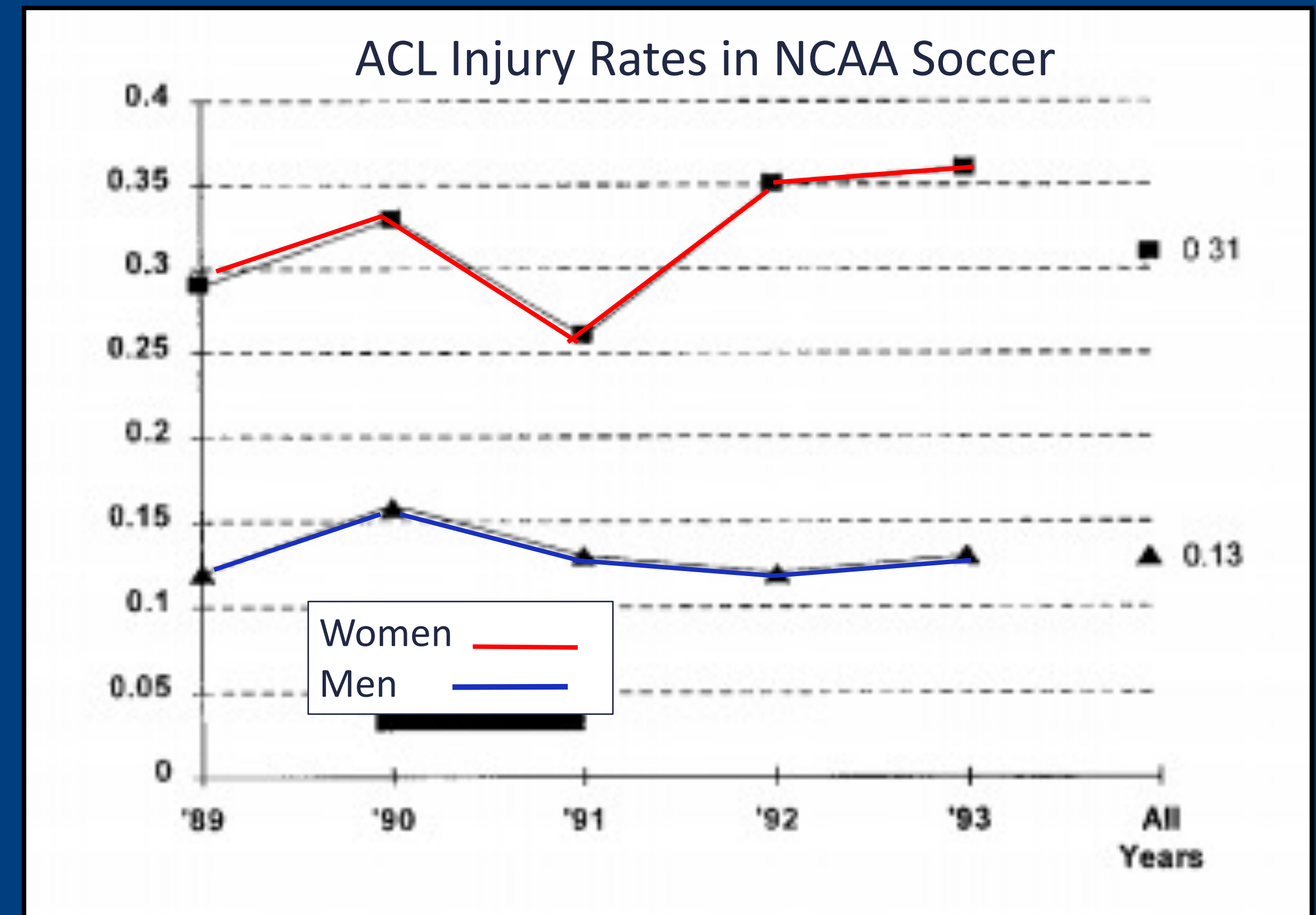
Arendt, 1999

- Within 7 years of an ACL injury, 65% no longer play soccer

Brophy, 2012

- 1 in 19 female college soccer players will tear her ACL

Yang, 2012





Anterior Cruciate Ligament Injury, Return to Play, and Reinjury in the Elite Collegiate Athlete

Analysis of an NCAA Division I Cohort

Ganesh V. Kamath,^{*†} MD, Timothy Murphy,[†] MD, R. Alexander Creighton,[†] MD,
Neal Viradia,[†] MD, Timothy N. Taft,[†] MD, and Jeffrey T. Spang,[†] MD

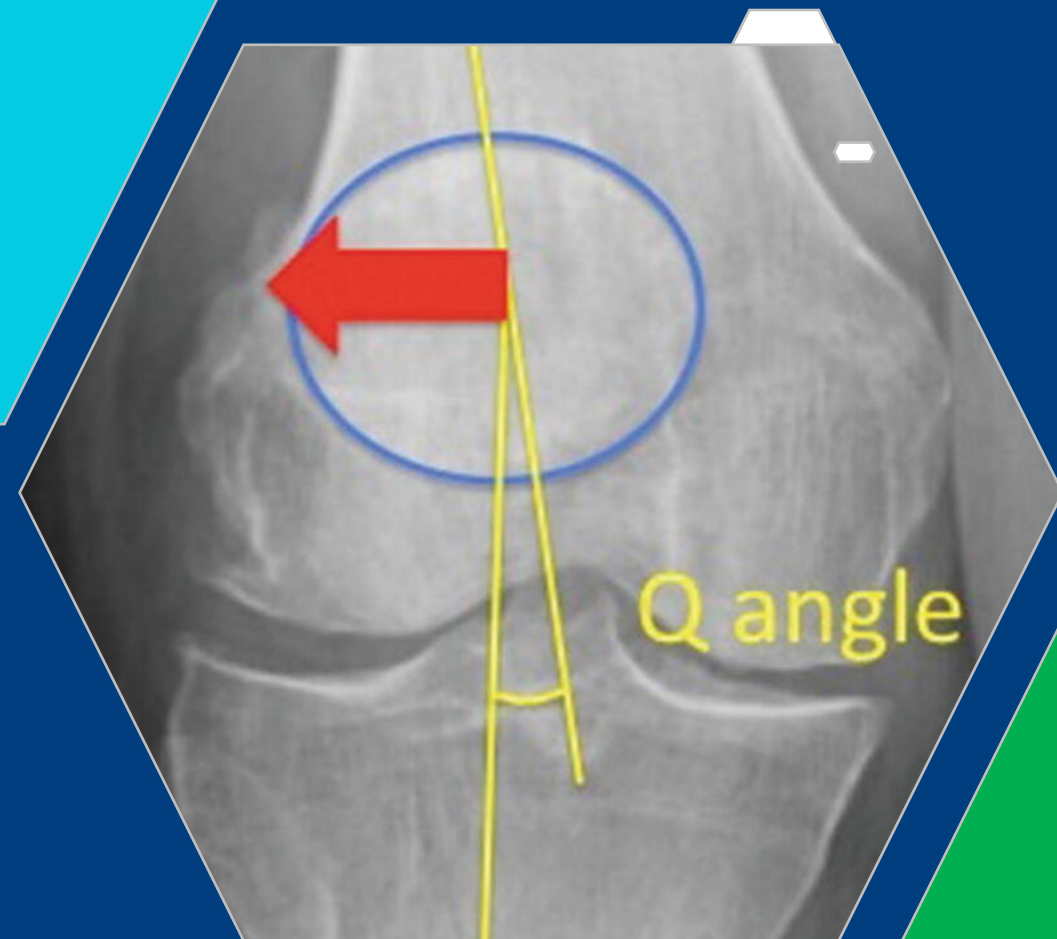
- 35 athletes had pre-collegiate reconstruction:
 - 17.1% reinjury to ipsilateral ACL & 20% injury to contralateral ACL
- 54 with intra-collegiate reconstruction
 - 1.9% reinjury rates to ipsilateral ACL & 11.1% injury to contralateral ACL

Can we do better?

Would an injury mitigation intervention be feasible and effective?

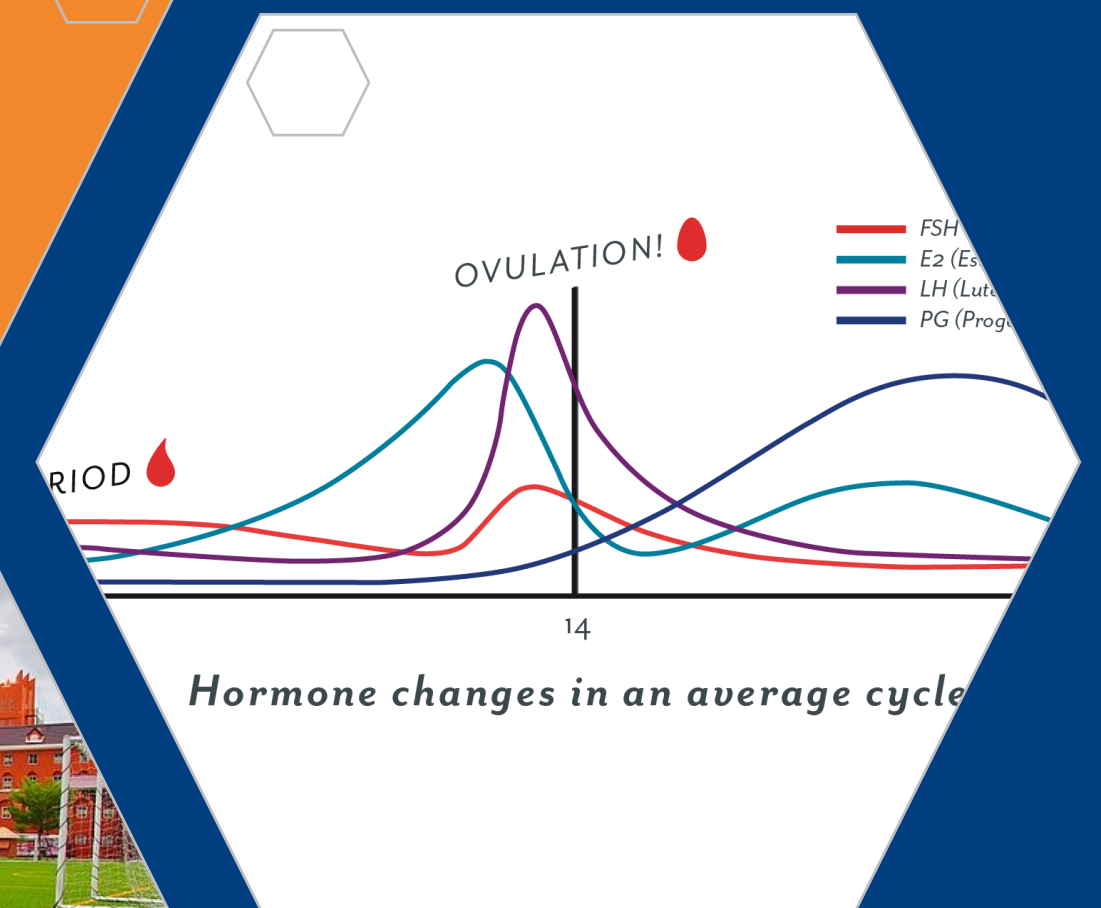
HISTORICALLY: 4 ACL CATEGORICAL RISK FACTORS

Anatomy



Q angle

Hormones



Environment



Biomechanics



EXPANDED ACL CATEGORICAL RISK FACTORS



Three video analysis studies for mechanism of ACL injury

Defending Puts the Anterior Cruciate Ligament at Risk During Soccer: A Gender-Based Analysis

Robert H. Brophy, MD,^{*†} Jeffrey Stepan, MD,[‡] Holly J. Silvers, MPT,[§] and Bert R. Mandelbaum, MD^{||}

- 73% defending, 51% Tackling & 15% cutting
- Hip & knee extension, knee valgus, foot planted, & unanticipated event



Three distinct mechanisms predominate in non-contact anterior cruciate ligament injuries in male professional football players: a systematic video analysis of 39 cases

Markus Waldén,^{1,2} Tron Krosshaug,³ John Bjørneboe,³ Thor Einar Andersen,³ Oliver Faul,³ Martin Hägglund^{2,4}

- 44% while defending (n=11)
- 20% landing after heading (n=5)
- 24% direct contact with leg or knee (n=6)

- Indirect contact = to non-contact injury
- Pressing/tackling, tackled, regaining balance after kicking & landing from jump
- ACL's more prevalent in 1st half

Systematic video analysis of ACL injuries in professional male football (soccer): injury mechanisms, situational patterns and biomechanics study on 134 consecutive cases

Francesco Della Villa ,¹ Matthew Buckthorpe,¹ Alberto Grassi,² Alberto Nabiuzzi,¹ Filippo Tosarelli,¹ Stefano Zaffagnini,² Stefano Della Villa¹

US SOCCER VIDEO ANALYSIS

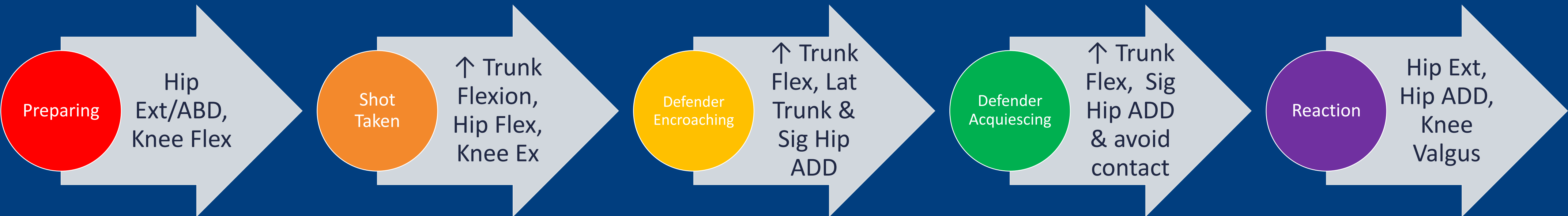


Analysis of mechanism





US SOCCER VIDEO ANALYSIS



Analysis of mechanism

EVOLUTION OF INJURY PREVENTION

Santa Monica Orthopaedic and Sports



Medicine Research Foundation

EXERCISE 1

Week 1-6
Trunk rotation
Push-up plus position on elbows
Alternating trunk rotation
3 x 8-16 reps

Week 7-12
Plank with passing
Pair exercise
Push-up plus position
Players roll ball to each other
Alternating hands
3 x 8-16 reps

Week 13-18
Push-up plus backward slide
Push-up plus
Side backwards
Maintain neutral spine
Return to start position
3 x 8-16 reps

The 11+
A complete warm-up program

F-MARC
FIFA

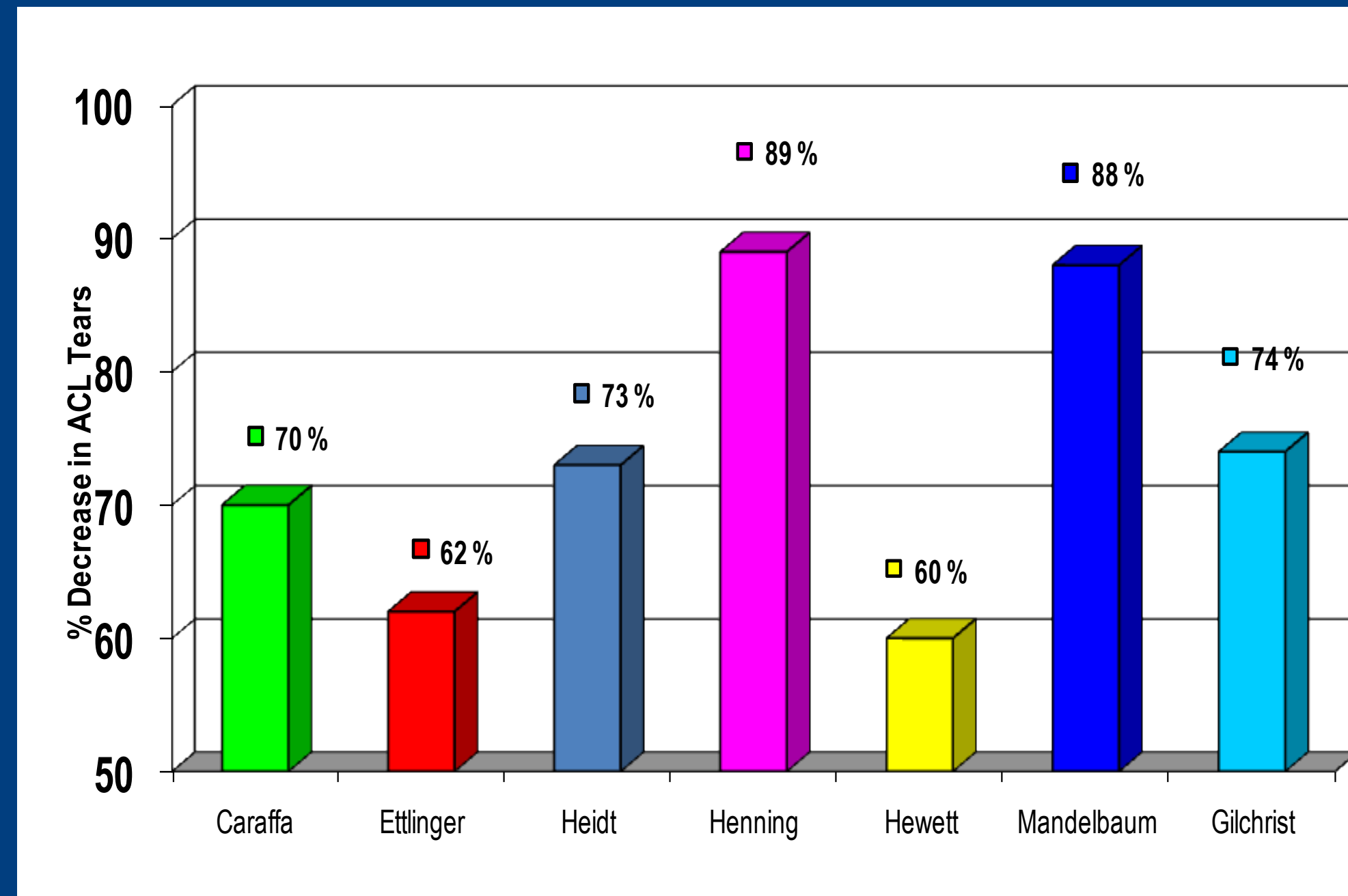
KNÄKONTROLL

SPORTSMETRICS™ USA

Cincinnati SportsMedicine & Orthopaedic Center

EXERCISE 7 ROLL OVER

11+ KIDS



FIFA 11+S

Part I - Warm-up exercises*

- 1 Run
Relaxed walking or running, the speed can be progressively increased. 5 min
- 2 Throw the ball in the chest line
Ask for help from a partner. With both hands in front of the body, throw and catch the ball, first with your elbows flexed and then with your arms over your head. 1 min
- 3 Spinning movements with the hands
Interlace the fingers and make spinning movements with the hands. 1 min

Part II - strength and balance of the shoulder, elbow, wrist, and finger muscles**



Effectiveness of a Neuromuscular and Proprioceptive Training Program in Preventing Anterior Cruciate Ligament Injuries in Female Athletes

2-Year Follow-up

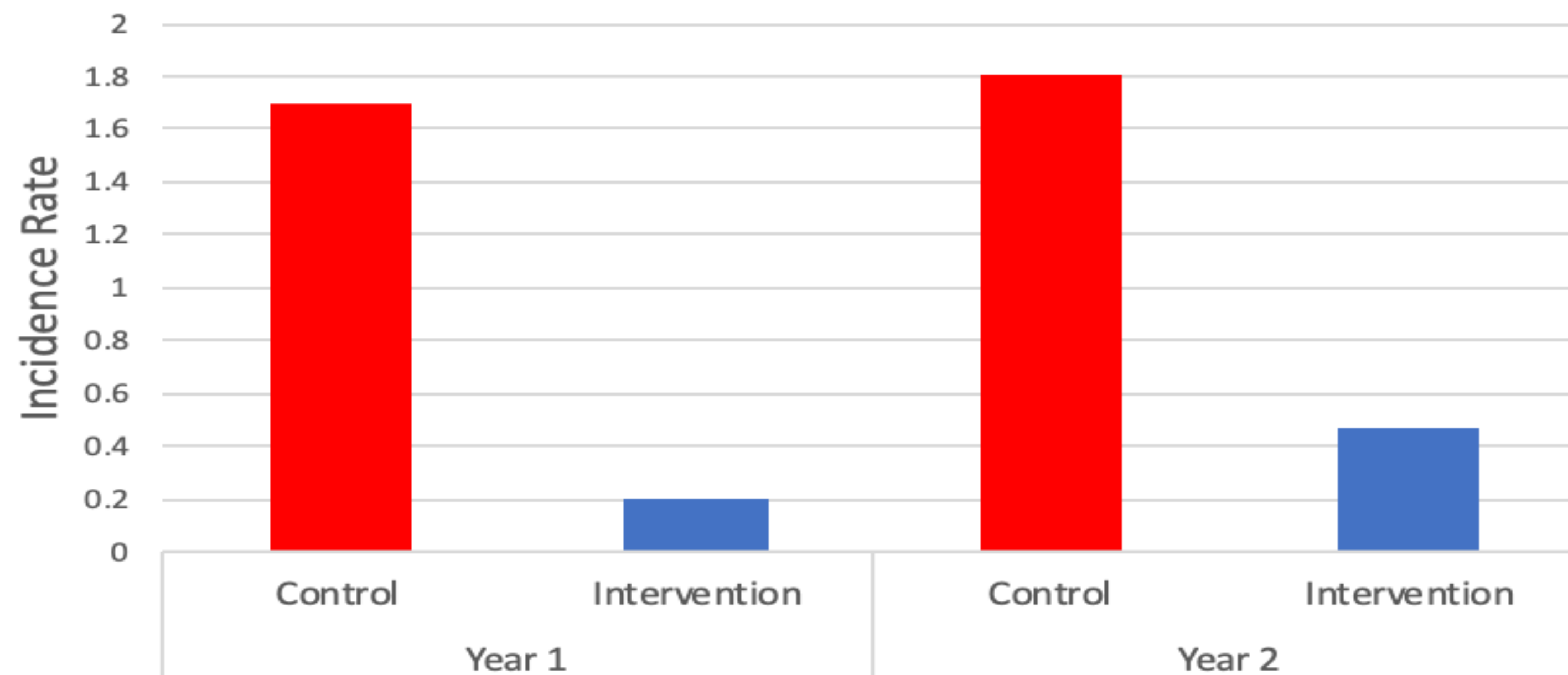
Bert R. Mandelbaum,* MD, Holly J. Silvers,*[†] MPT, Diane S. Watanabe,* MA, ATC, John F. Knarr,* PT, ATC, Stephen D. Thomas,* MPT, Letha Y. Griffin,[‡] MD, Donald T. Kirkendall,[§] PhD, and William Garrett, Jr.,^{||} MD, PhD

Santa Monica Orthopaedic and Sports



Medicine Research Foundation

ACL Injuries in Female Club Soccer Players



Year 1: 88% ↓

RR = 0.11, p= .0001
(95% CI, 0.03-0.48)

Year 2: 74% ↓

RR=0.26, p= .005 (95%
CI, 0.09-0.73)

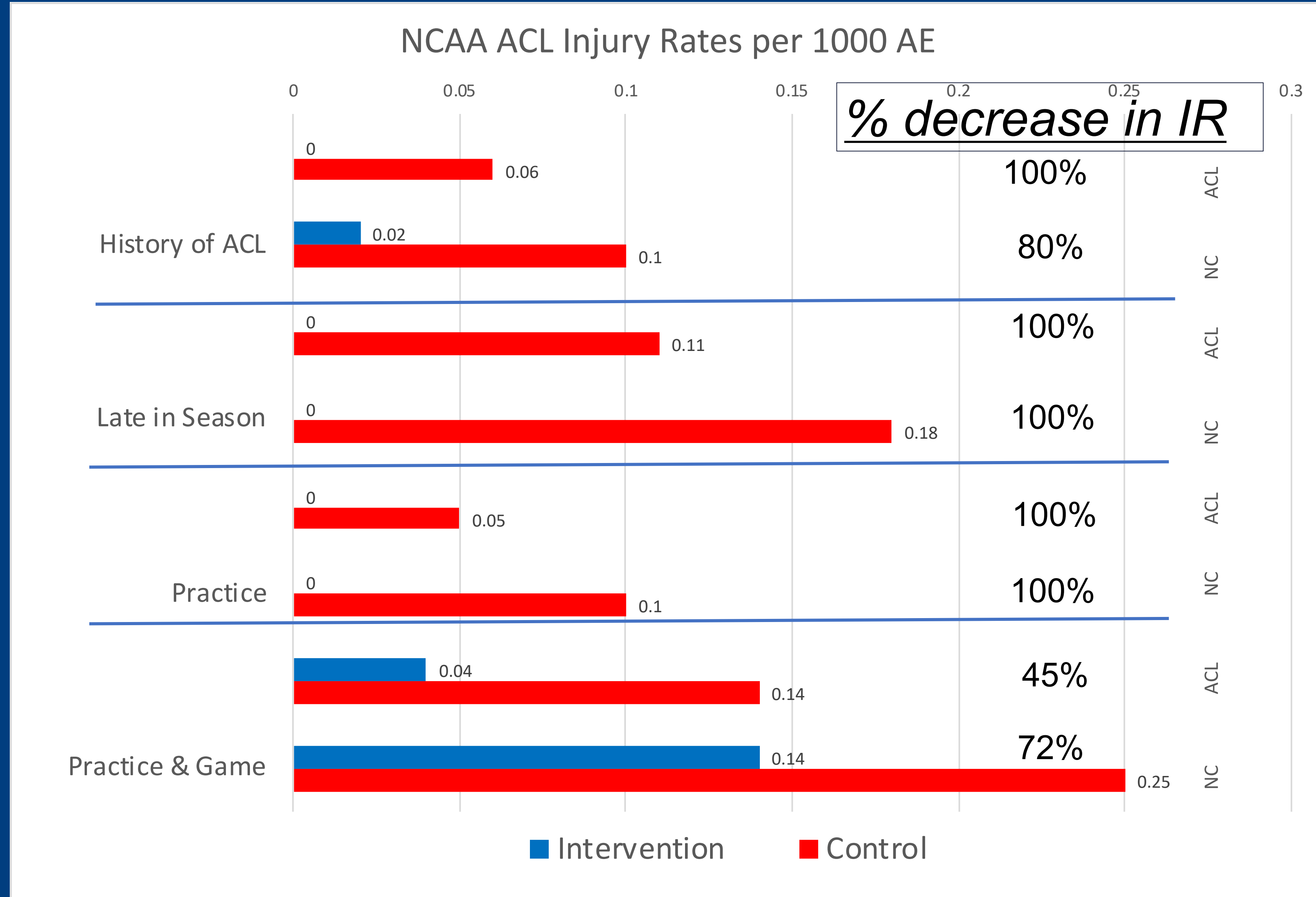
A Randomized Controlled Trial to Prevent Noncontact Anterior Cruciate Ligament Injury in Female Collegiate Soccer Players

Julie Gilchrist,^{*†} MD, Bert R. Mandelbaum,[‡] MD, Heidi Melancon,[§] MPH, George W. Ryan,^{||} PhD, Holly J. Silvers,[‡] MPT, Letha Y. Griffin,[¶] MD, PhD, Diane S. Watanabe,[‡] MA, ATC, Randall W. Dick,[#] MS, and Jiri Dvorak,^{**} MD



- NCAA Div. I women's soccer - PEP
61 Teams (833 Control / 561 Intervention)
- Injury Rate:
0.04 Intervention vs. 0.15 Control
- Non-Contact ACL Injuries occurred over three times more frequently in control vs. intervention

PEP ACL PREVENTION



DEVELOPMENT OF FIFA 11+

- International group: Oslo, Switzerland and USA in 2005
- The FIFA 11+: dynamic warm-up designed to ↓ ALL injury
- On-field warm-up: 15 – 20 minutes with no additional equipment necessary
- Imparts physiological & neuromuscular preparedness
- Addresses musculature not directly associated w/ sport



- Initially tested in large RCT in Norwegian female soccer players: N = 1892, aged 13-17

Soligard, 2008

–32% ↓ in all injuries

–53% ↓ in overuse injury and a 45% ↓ in severe injury



Table 2 | Intention to treat analysis of warm-up exercise programme (intervention) in young female footballers. Values are numbers (percentages) of injured players

| | Intervention group (n=1055) | Control group (n=837) | Intraclass correlation coefficient* | Inflation factor* | NNT | Rate ratio (95% CI)† | P value |
|--------------------------|--------------------------------|--------------------------|--|----------------------|-----|-------------------------|---------|
| All injuries | 135 (13.0) | 166 (19.8) | 0.096 | 2.86 | 15 | 0.68 (0.48 to 0.98) | 0.041 |
| Match injuries | 96 (9.1) | 114 (13.6) | 0.045 | 1.87 | 22 | 0.72 (0.52 to 1.00) | 0.051 |
| Training injuries | 50 (4.7) | 63 (7.5) | 0.044 | 1.86 | 36 | 0.68 (0.41 to 1.11) | 0.120 |
| Lower extremity injuries | 121 (11.5) | 143 (17.1) | 0.088 | 2.70 | 18 | 0.71 (0.49 to 1.03) | 0.072 |
| Knee injuries | 33 (3.1) | 47 (5.6) | 0.028 | 1.54 | 40 | 0.62 (0.36 to 1.05) | 0.079 |
| Ankle injuries | 45 (4.3) | 49 (5.9) | 0.026 | 1.50 | 63 | 0.81 (0.50 to 1.30) | 0.378 |
| Acute injuries | 112 (10.6) | 130 (15.5) | 0.070 | 2.35 | 20 | 0.74 (0.51 to 1.08) | 0.110 |
| Overuse injuries | 27 (2.6) | 48 (5.7) | 0.040 | 1.76 | 32 | 0.47 (0.26 to 0.85) | 0.012 |
| Severe injuries | 45 (4.3) | 72 (8.6) | 0.028 | 1.54 | 23 | 0.55 (0.36 to 0.83) | 0.005 |

NNT=number needed to treat.

*Generalised estimating equation model with clubs as cluster unit.

†Cox model calculated according to method of Lin and Wei,²⁵ which takes cluster randomisation into account.

Does the 11+ Program decrease the rate of ACL injury in soccer players?



11+ ANALYSIS OF ACL INJURY RATE

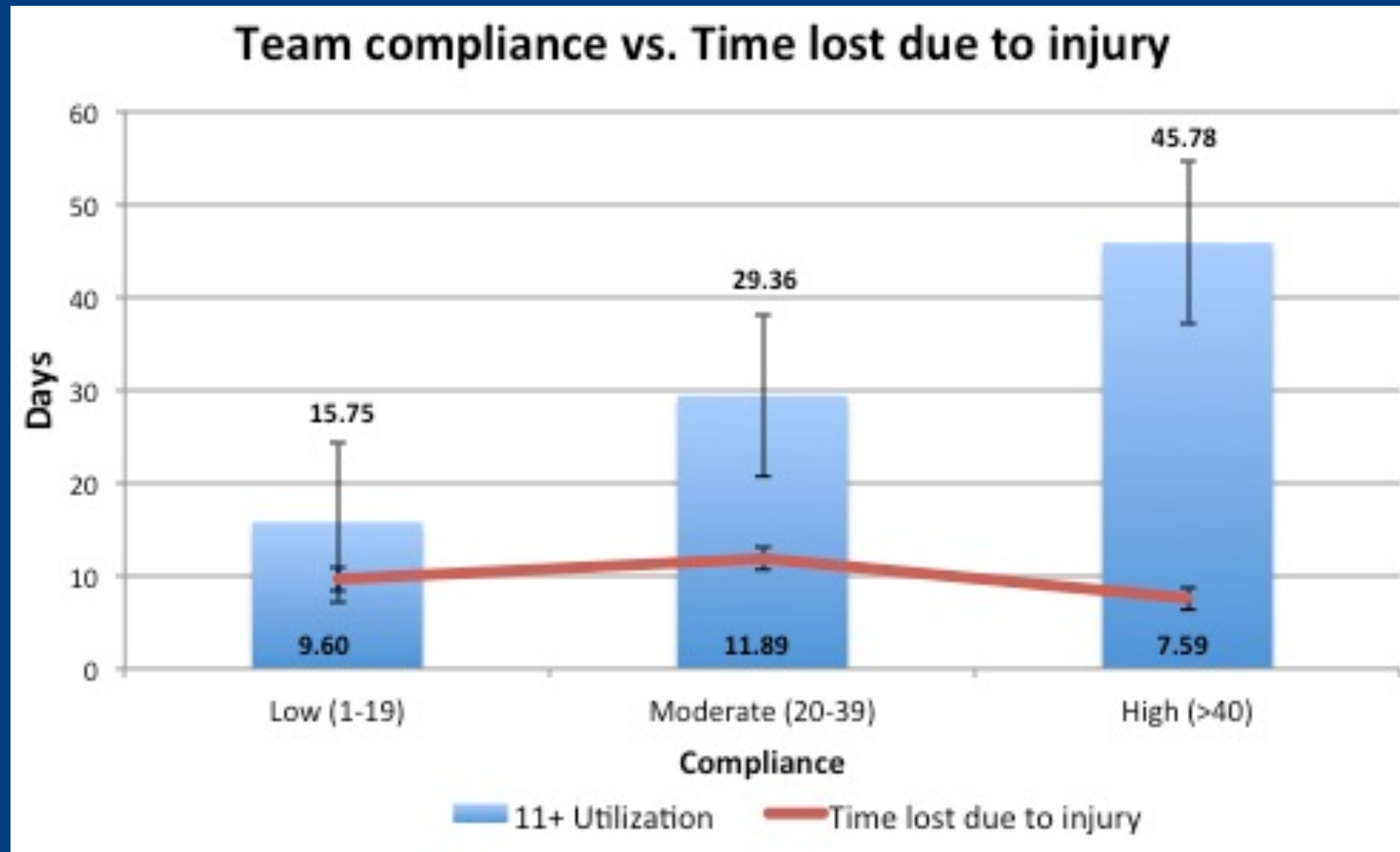
| | Control | | Intervention | | | RR (95% CI) | P value | |
|------------------|-------------|-----------|--------------|-------------|-----------|-------------|------------------|---------|
| | | N / % | IR | | N / % | IR | RR (95% CI) | P value |
| Total Injuries | Total | 665/100% | 15.04 | Total | 285/100% | 8.09 | 0.54 (0.49-0.59) | <0.001* |
| | Game | 392/58.9% | 28.77 | Game | 185/64.9% | 16.92 | 0.59 (0.52-0.68) | <0.001* |
| | Practice | 273/41.1% | 8.93 | Practice | 100/35.1% | 4.01 | 0.46 (0.38-0.57) | <0.001* |
| Knee Injuries | | N / % | IR | | N / % | IR | RR (95% CI) | P value |
| | Total | 102/15.3% | 2.307 | Total | 34/11.9% | 0.965 | 0.42 (0.29-0.61) | <0.001* |
| Mechanism of ACL | | N / % | IR | | N / % | IR | RR (95% CI) | P value |
| | Total | 16 /2.41% | 0.362 | Total | 3/1.05% | 0.085 | 0.24 (0.07-0.81) | 0.021* |
| | Contact | 6/0.90% | 0.135 | Contact | 1/0.35% | 0.028 | 0.21 (0.03-1.74) | 0.148 |
| | Non-contact | 10/1.50% | 0.226 | Non-contact | 2/0.70% | 0.057 | 0.25 (0.06-1.15) | 0.049* |

- Significant decrease in Total ACL IR (76%, p=0.021)
 - Significant decrease in Non-contact ACL IR (75%, p=0.049)
 - No statistical difference in contact ACL IR (p=0.148)

11+ COMPLIANCE AND TIME LOSS

Does compliance impact time loss due to injury?

- Statistical difference between High compliance and Low/Moderate groups ($p = .004$, $R^2 = .29$)



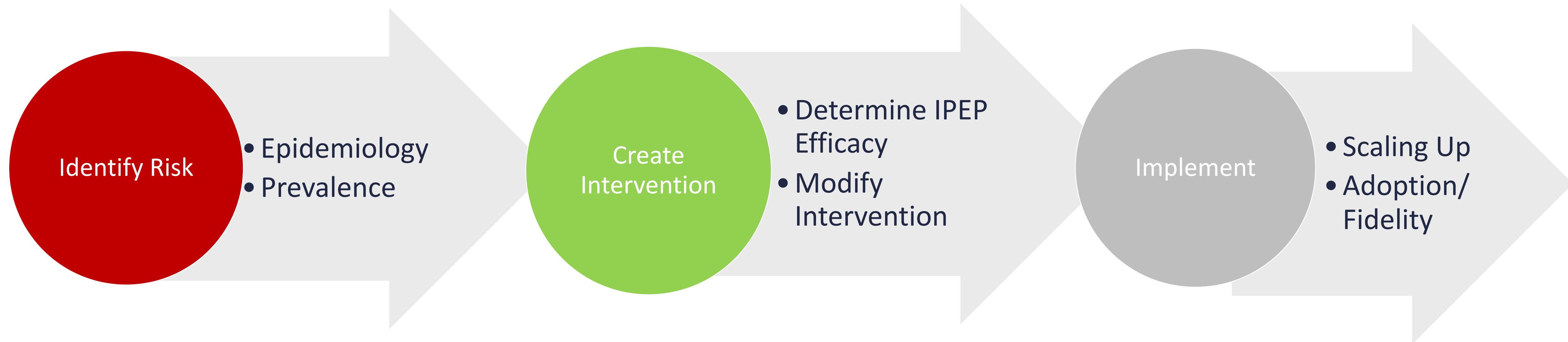
High adherence to a neuromuscular injury prevention programme (FIFA 11+) improves functional balance and reduces injury risk in Canadian youth female football players: a cluster randomised trial

- Pre and Post season Performance assessment
- Explored different delivery methods: supervised/unsupervised
- N = 266 players
- High adherence to the 11+ = significant improvements in functional balance & ↓ IR (IRR = 0.28)

Another  for Adherence!

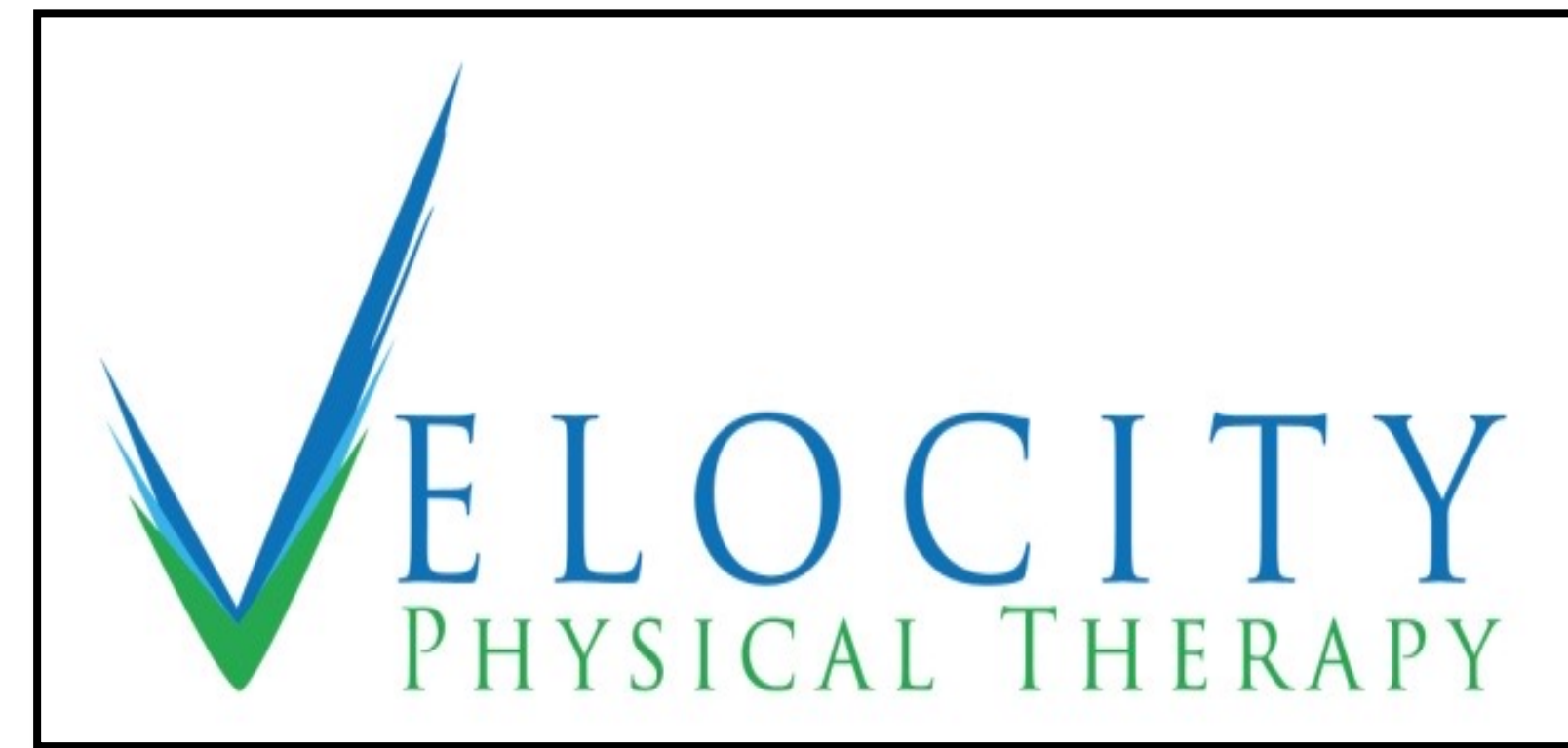
Why is Compliance so Challenging?


- Injuries in sport are an important public health problem
- IPEP's (Injury Prevention Exercise Programs) have been scientifically vetted to ↓ injury rates
- Translating IPEP into practice has been difficult



- Determine if ACL risk can be detected in pretesting
 - Determine if the screening tool has the intended specificity to identify high risk or ability to RTP
 - Refine existing injury IPEP's and therapy to reflect new knowledge
 - Be mindful of the neural components to ACL (EMG, Cortico-Motor Control)
 - Provide equal resources to female athletics to mitigate risk
 - Quality & availability of medical staff
 - May improve compliance to IPP
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Thank You!



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