



ISAKOS
CONGRESS
2023



Boston
Massachusetts
June 18–June 21

No Single Dominant Risk Factor for Noncontact ACL Injury: Key Thresholds and Relative Contributions of Knee Geometry and Anterior-Posterior Laxity

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Disclosures

T. Wickiewicz: Royalties received from Stryker

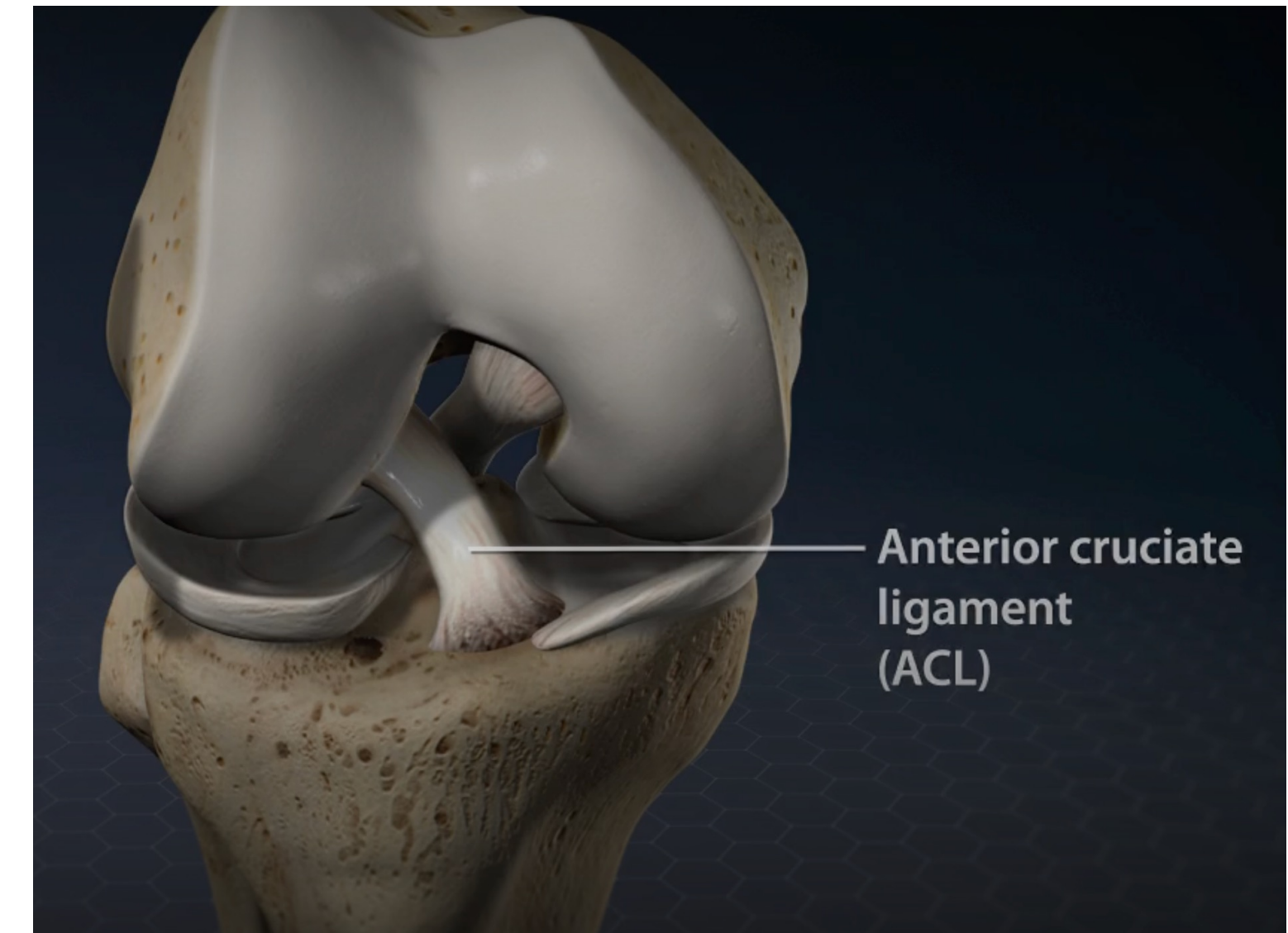
A. Pearle: Paid Consultant for DEPUY
Stock received from ENGAGE SURGICAL
Support received from STRYKER
Equity stake in ACLIP, Inc.

D. Nawabi: Paid Consultant for Conmed; Newclip



Introduction: risk factors

- Tibiofemoral geometry plays a role
- Increased knee laxity seen in injured athletes
- Combinations of geometric variables are associated with risk
- These associations differ between females and males
 - Females: decreased femoral notch width + decreased lateral meniscus height
 - Males: decreased ACL volume + decreased lateral meniscus-bone wedge angle



<https://www.hopkinsmedicine.org/health/conditions-and-diseases/knee-pain-and-problems>



<https://link.springer.com/article/10.1007/s00167-010-1295-x>



<https://drrobertlaprademd.com/lachmans-test/>

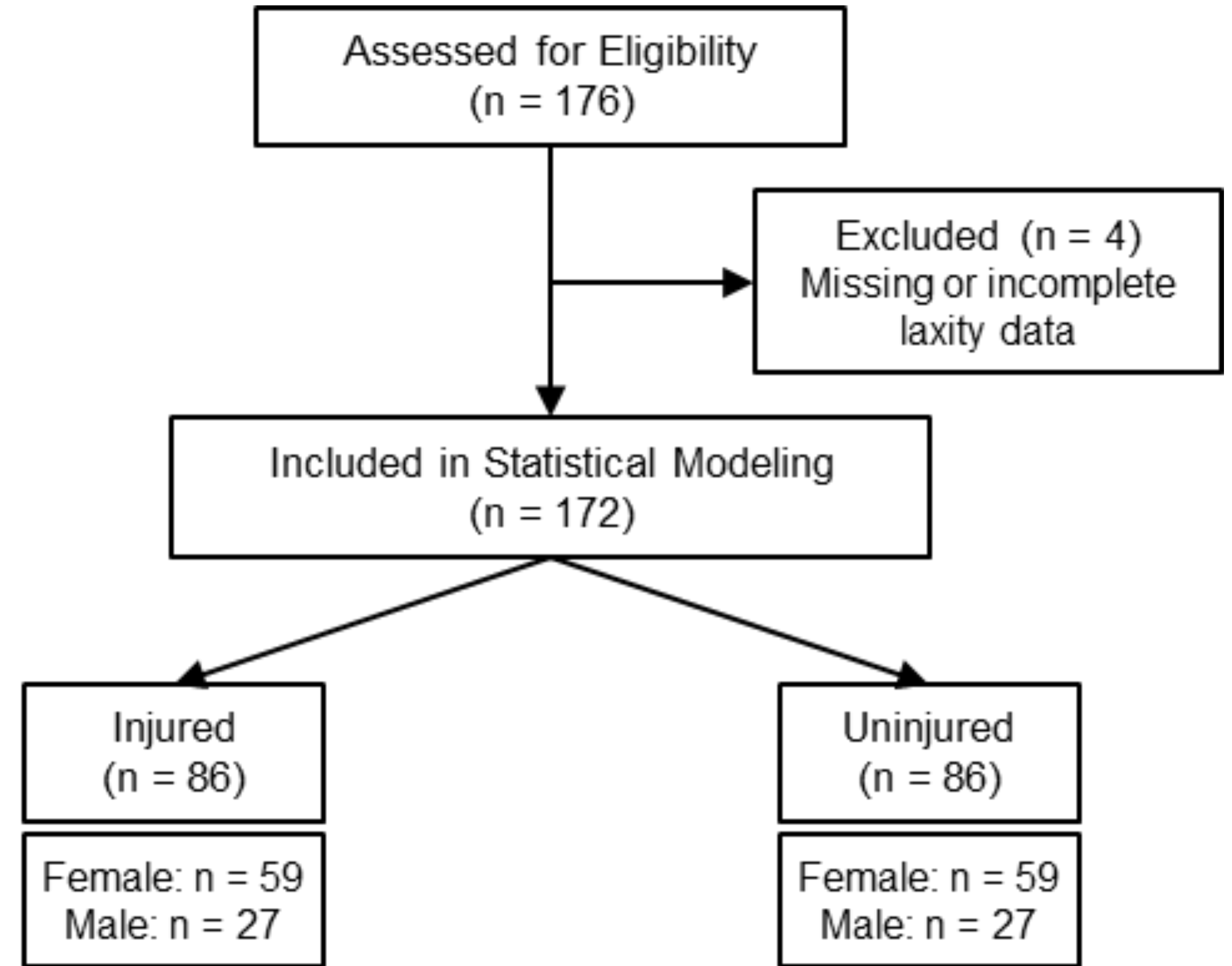
To quantify risk of first-time, noncontact ACL injury associated with knee laxity and tibiofemoral geometry in high school and collegiate athletes

Strategy:

- Use a generalized additive model (GAM) to characterize risk profiles
 - Determine which variables are most contributory
 - Assess for nonlinear relationships
 - Identify key thresholds associated with rapid changes in risk

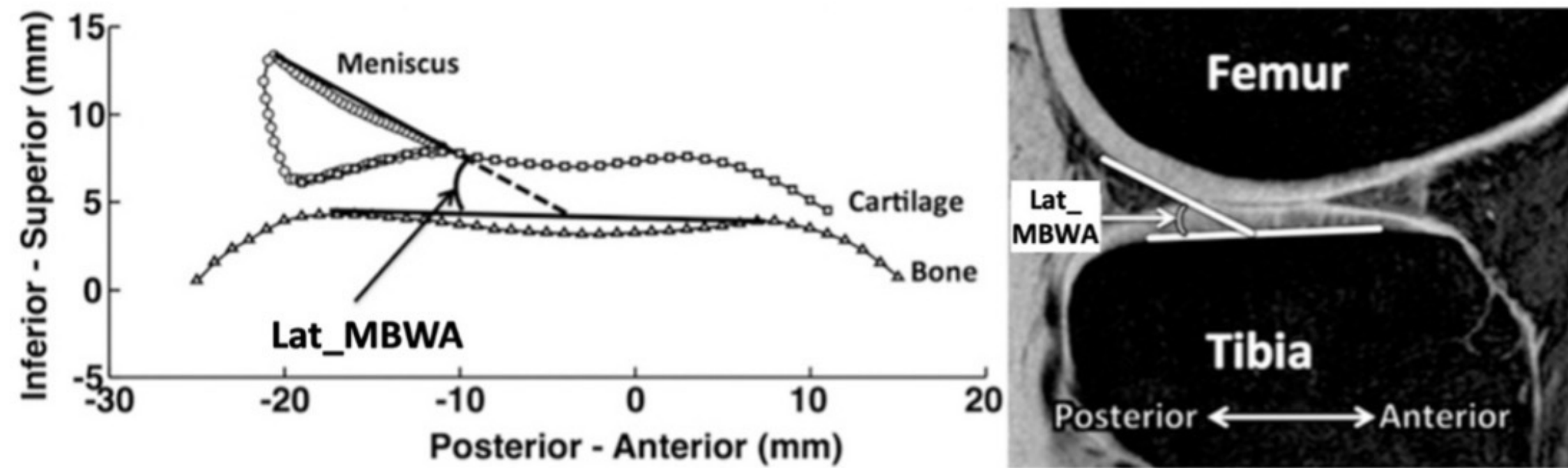
Methods

- Data acquired from patients with first-time, noncontact ACL injury and from uninjured control participants
- Noncontact injury determined by the medical care provider at institution where injury occurred
- Over four years, grade 3 ACL injury events were identified as they occurred in 86 athletes at 36 sites

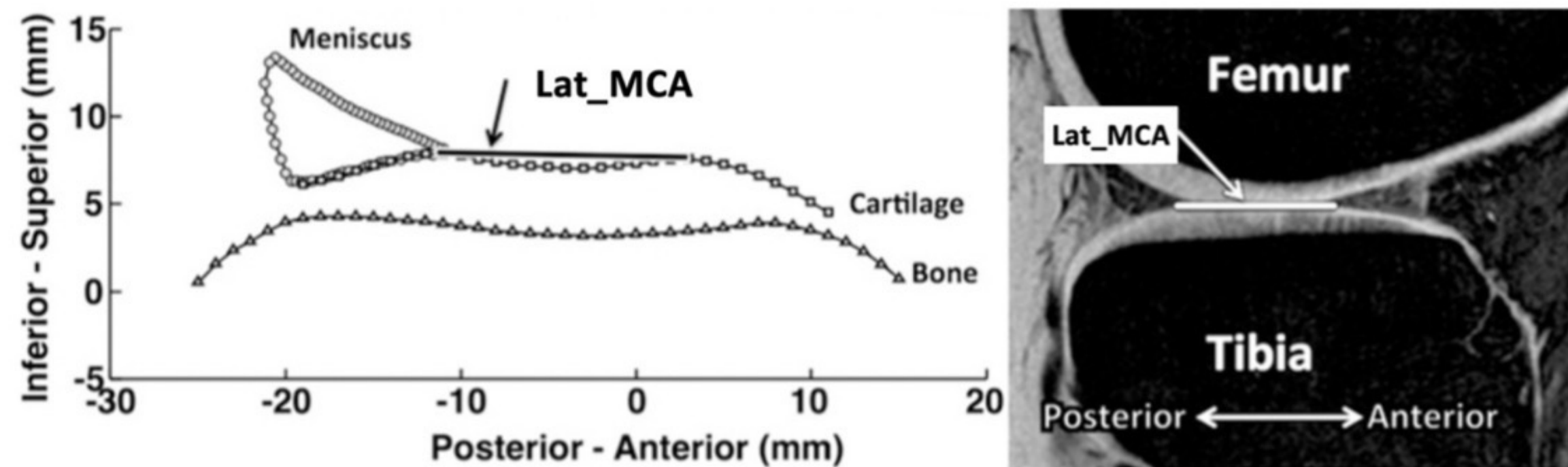


Methods

Meniscus-bone wedge angle

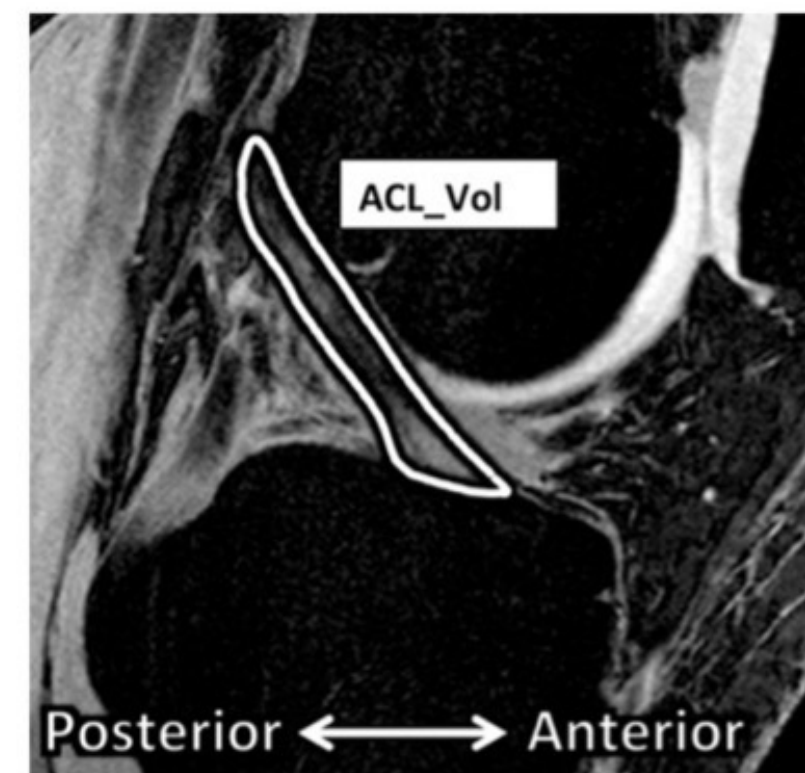


Articular cartilage slope

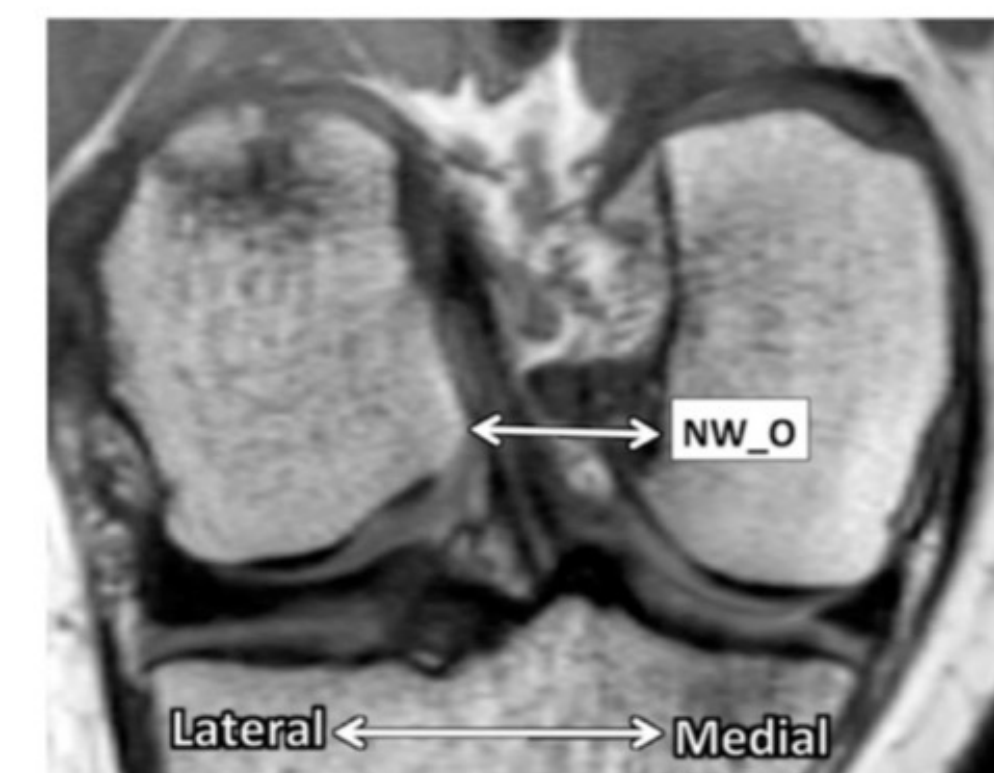


- Anatomic measurements from MRI
- AP laxity of tibia relative to femur measured with KT-2000 arthrometer
- Risk factors for injury assessed using a GAM for females and for males
- GAM revealed partial dependencies of factors

ACL volume

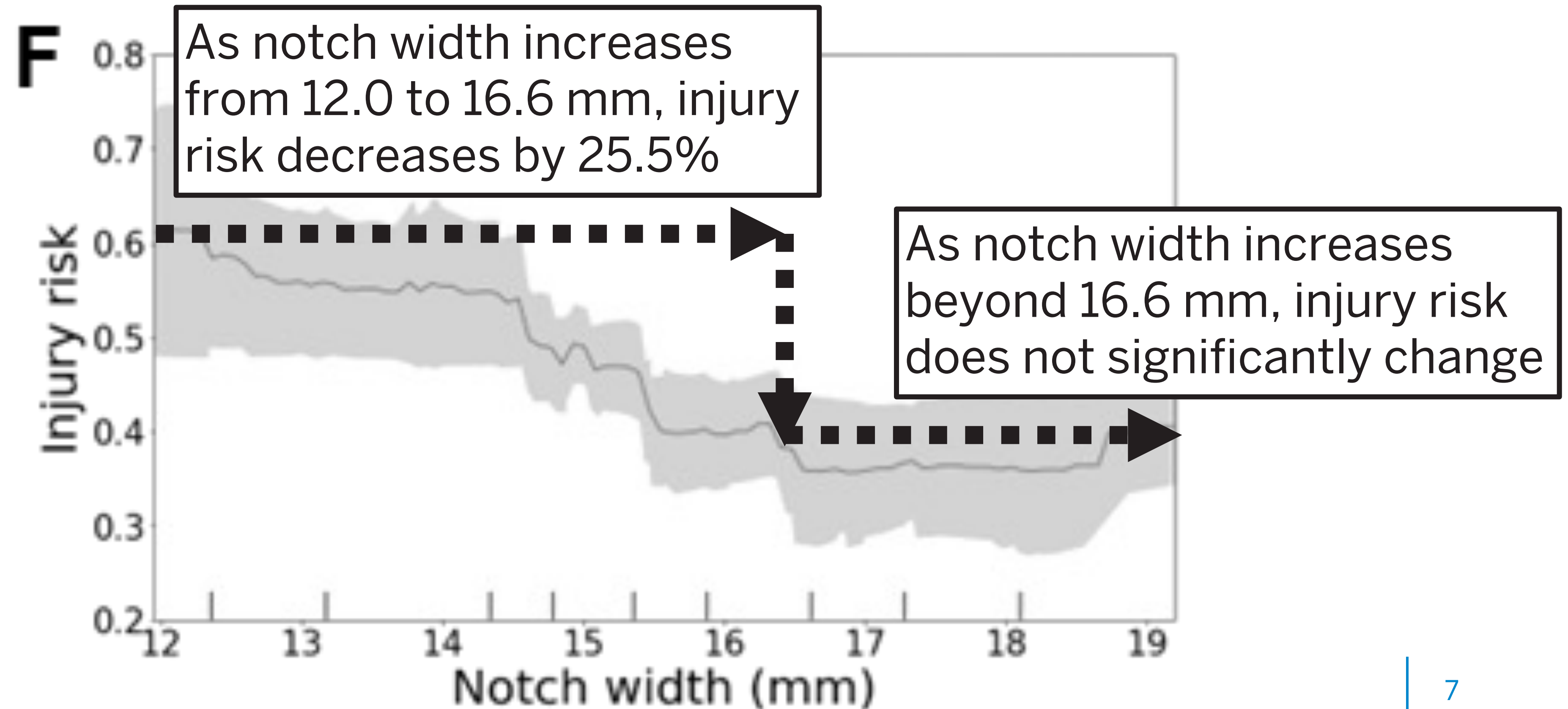


femoral notch width



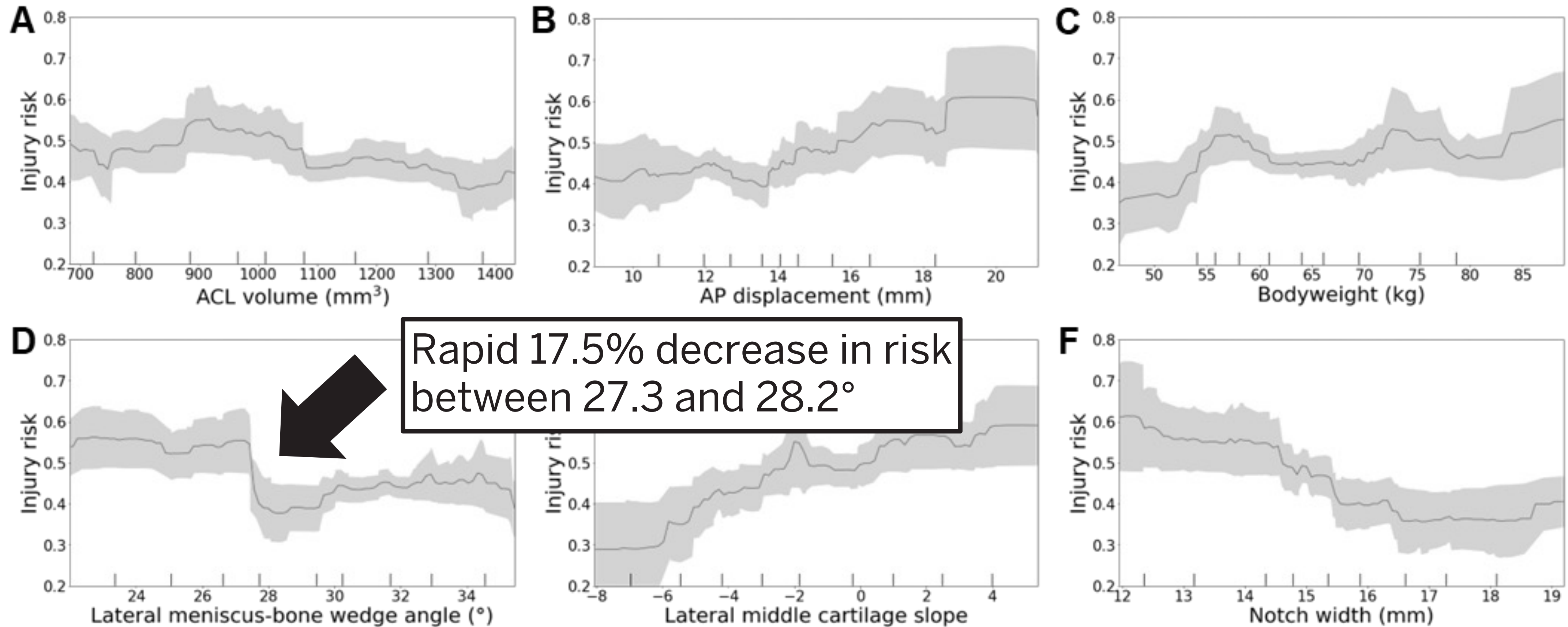
Methods: outcome measure

Partial dependence plots from GAM represent the estimated probability of injury as a function of each variable:



Results: partial dependence plots

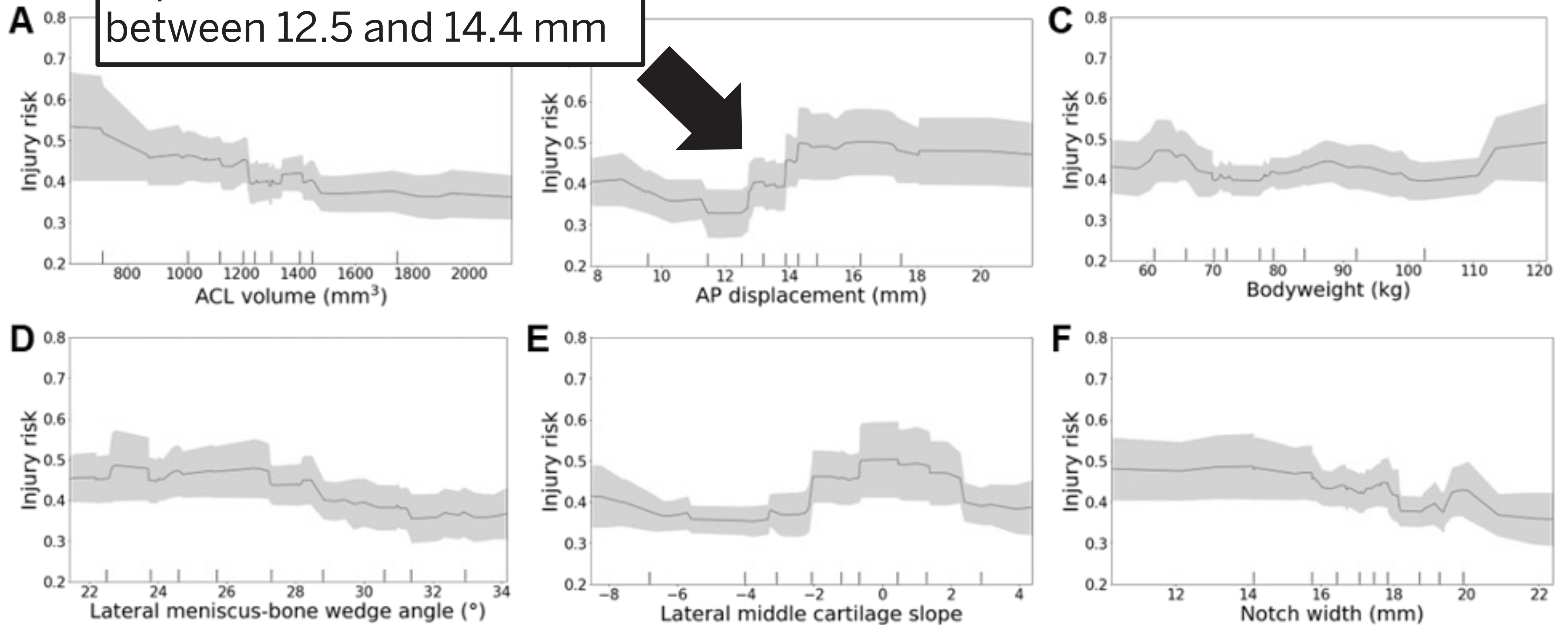
Female athletes



Results: partial dependence plots

Male athletes

Rapid 16.7% increase in risk between 12.5 and 14.4 mm



- Unique risk model
 - Integrated measures of AP laxity of the knee, geometries of the tibiofemoral bones and soft tissues, and bodyweight
 - Used novel statistical tool to identify thresholds where injury risk changes
- No single geometric or laxity risk factor provided a dominant contribution to risk of injury in either the female or male cohorts
 - No variable contributed an average percent change in risk of injury of more than 8.6%
 - No variable contributed an average percent change in risk of injury of less than 2.0%
- Our analyses revealed critical “threshold” ranges associated with marked increases or decreases in ACL injury risk for some variables

Conclusions

- This analysis quantified AP laxity and knee joint geometry as combined risk factors for first-time, noncontact ACL injury in female and male high school and college athletes
- Of the six variables studied, there was no single dominant geometric or laxity risk factor for ACL injury in either female or male cohorts
- Geometric and laxity risk factors likely act together to increase risk of noncontact ACL injury
- Several risk factors exhibited thresholds where a pronounced increase or decrease in risk of first-time, noncontact ACL injury occurred
- These thresholds could provide targets for conservative or surgical intervention

Funding sources

- National Institutes of Health
 - National Institute of Arthritis and Musculoskeletal and Skin Diseases
 - R01AR050421
 - R21AR073388
 - Gosnell Family
 - Steers Family
 - Ludwig Family
 - Clark Foundation
 - Kirby Foundation

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