IS ALL ARTIFICIAL TURF CREATED EQUAL?
The Latest in Football and Soccer Player Injury Research

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Initial Research

Incidence, Causes, and Severity of High School Football Injuries on FieldTurf Versus Natural Grass

A 5-Year Prospective Study

Michael C. Meyers,*† PhD, FACSM, and Bill S. Barnhill,‡ MD
From the †Human Performance Research Center, West Texas A&M U
and ‡Panhandle Sports Medicine Associates, Amarillo, Texas

Background: Numerous injuries have been attributed to playing on artificial turf. Recently, F
the playing characteristics of natural grass. No long-term study has been conducted compa
ball injuries between the 2 playing surfaces.

Hypothesis: High school athletes would not experience any difference in the incidence, c
injuries between FieldTurf and natural grass.

Study Design: Prospective cohort study.

Methods: A total of 8 high schools were evaluated over 5 competitive seasons for injury incidence, injury category, time of injury,

✓Higher incidences of minor injuries (0-day time loss injuries, noncontact injuries, surface/epidermal injuries, and muscle-related trauma) were reported on FieldTurf.

✓Higher incidences of substantial and severe trauma (22+ days time loss injuries, head and neural trauma, and ligament injuries) were reported on natural grass.

Follow-up Research

- FieldTurf has been recommended as a practical option to natural grass in the prevention of injuries at the high school level of play

- To quantify the incidence, mechanisms, and severity of game-related college injuries on FieldTurf versus natural grass

Meyers, 2010; Meyers & Barnhill, 2004

Follow-up Research

Incidence, Mechanisms, and Severity of Game-Related College Football Injuries on FieldTurf Versus Natural Grass

A 3-Year Prospective Study

Michael C. Meyers,* PhD, FACSM
From the Department of Health and Human Development, Montana State Univer
Montana

Background: Numerous injuries have been attributed to playing on artificial turf. More recently, FieldTurf wa
cate the playing characteristics of natural grass. No long-term studies have been conducted comparing ga
football injuries between the 2 playing surfaces.

Hypothesis: Collegiate athletes do not experience any difference in the incidence, mechanisms, and sev
injuries between FieldTurf and natural grass.

Study Design: Cohort study; Level of evidence, 2.

Methods: Twenty-four universities were evaluated over 3 competitive seasons for injury incidence, injury ca
injury time loss, player position, injury mechanism, primary type of injury, grade and anatomical location of

✓Higher incidences of total, minor, substantial and severe trauma (22+ days time loss injuries, head and neural trauma, and ligament injuries) were reported on natural grass.

✓Lower incidences of injuries (shoe-surface contact injuries, high ankle/ syndesmotic sprains, joint/muscle trauma, and injuries during adverse field conditions) were reported on FieldTurf.

Collegiate FB Research

- Prospective cohort study
- Total of 31 NCAA Division-1A (FBS) universities
- Total of 1,164 games
  - 595 FieldTurf (51.1%)
  - 569 Natural Grass (48.9%)
- Seven-year period of competitive seasons and bowl games from 2006-2012
- Various stadiums
  - ACC, Big 12, Big East, Big Ten, Conference USA, MAC, Mountain West, Pac-12, SEC, Sun Belt, WAC
- School selection based on:
  - Availability of surfaces
  - Uniformity of sport-skill
  - Full-time ATC staff

Collegiate FB Summary

- 24% Fewer Substantial Injuries
- 20% Fewer Severe Injuries
- 12% Fewer Cranial/Cervical Injuries
- 9% Lower Knee Injuries Combined
- 13% Fewer Shoulder Injuries Combined
- 60% Fewer Rotator Cuff Tears
- 27% Lower Incidence of Shoulder Lesions
- 11% Less Injury From Shoe Surface Interaction at Contact
- 20% Fewer Ligament Tears
- 20% Fewer Muscle Strains/Tears

Collegiate FB Summary

- 27% Lower Incidence of 2nd Degree Trauma
- 14% Lower Incidence of 3rd Degree Trauma
- 25% Fewer Injuries During Adverse Weather
- 9% Fewer Injuries on Newer Playing Surfaces
- 23% Fewer Injuries on 4 - 8+ Year Old Surfaces
- 74% Fewer Injuries on 8+ Year Old Surfaces
- 20% Fewer Player-to-Turf / Surface Impact Injuries
- 14% Muscle-Tendon Overload Injuries
- 10% Fewer Elective Imagery/Surgical Procedures
- 10% Less Lower Extremity Joint Trauma
- 24% Fewer High Ankle Sprains

INCIDENCE, MECHANISMS, AND SEVERITY OF MATCH-RELATED COLLEGE MEN'S SOCCER INJURIES ON FIELDTURF VERSUS NATURAL GRASS

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Methods – NCAA Men's Soccer

- Prospective cohort study
- Total of 11 NCAA Division-1A universities
- Total of 765 matches
  - 380 FieldTurf (49.7%)
  - 385 Natural Grass (50.3%)
- Six-year period of competitive seasons and post-season matches from 2007-2012
- Various stadiums
  - Big East, Ivy League, Missouri Valley
- School selection based on:
  - Availability of surfaces
  - Uniformity of sport-skill
  - Full-time ATC staff

NCAA Men's Soccer Summary

- 25% ⬇ Incidence of Total Trauma
- 22% ⬇ Incidence of Minor Trauma
- 46% ⬇ Incidence of Substantial Trauma
- 41% ⬇ Injuries During Adverse Weather
- 48% ⬇ Injuries on New Playing Surfaces
- 66% ⬇ Injuries on 8+ Year Old Surfaces
- 30% ⬇ Player-to-Player Injuries

On *FieldTurf* when compared to natural grass

NCAA Men's Soccer Summary

- 28% ⇩ Shoe Surface-Contact Injuries
- 38% ⇩ Shoe Surface-Noncontact Injuries
- 16% ⇩ Player-to-Turf / Impact Injuries
- 44% ⇩ Injuries Tackled From Side/Behind
- 23% ⇩ Elective Imagery/Surgical Procedures
- 23% ⇩ Lower Extremity Trauma Combined
- 82% ⇩ Studded Cleat-Related Injuries

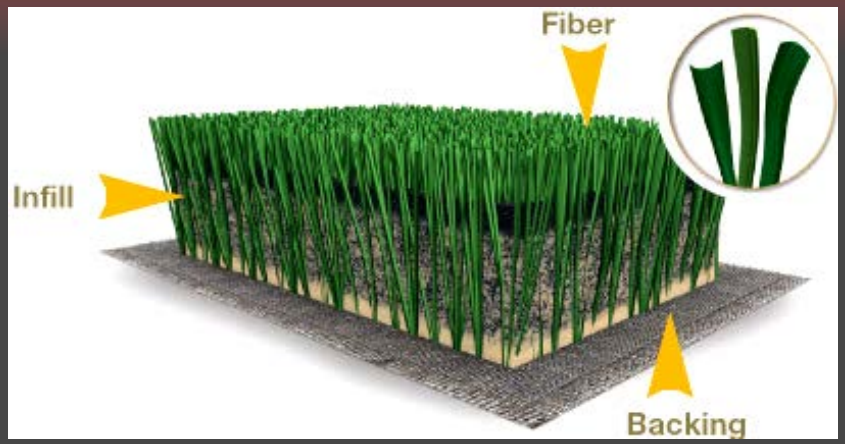
On *FieldTurf* when compared to natural grass

Conclusion

- FieldTurf is, in many cases, a safer alternative to natural grass

Follow-up Research

- Rather than playing on the polyethylene turf fibers, shoe:surface interaction actually occurs between the cleat and the various proprietary sand/rubber infill composites of varying weight.



- At the time, however, the influence of surface infill weight on football trauma was unknown.

INCIDENCE, MECHANISMS, AND SEVERITY OF GAME-RELATED HIGH SCHOOL FOOTBALL INJURIES ACROSS ARTIFICIAL TURF SYSTEMS OF VARIOUS INFILL WEIGHT

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National Recognition

- *Sports Trauma and Overuse Prevention (STOP) Sports Injury Award*

American Orthopaedic Society for Sports Medicine (AOSSM) Annual Meeting
Colorado Springs, CO
July, 2016

Research

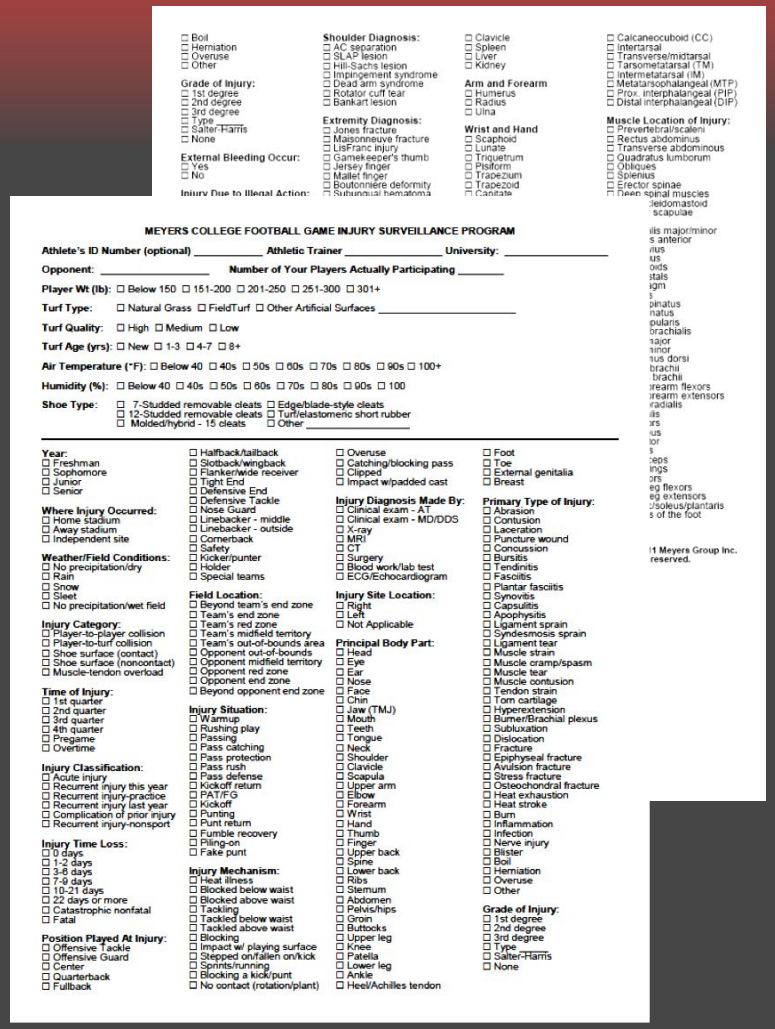
- Official Journals of The American Orthopaedic Society for Sports Medicine (AOSSM)
- Members include team physicians involved in most professional, Olympic, and collegiate sports
- Tier 1 journal in research
- Both medically and scientifically peer-reviewed
- Rated #1 Orthopedic journal in the world over the last 5 years

Methods

- Prospective cohort, double-blind study focusing on competitive season and playoff games from 2010-2016
- Total of 57 high schools participating across four states (TX, So Cal, PA, MT)
- Artificial turf systems were divided into four sand/rubber infill weight groups based on lbs per square foot:
  - ≥ 9.0
  - 6.0 – 8.9
  - 3.0 – 5.9
  - 0.0 – 2.9

Methods

- Two-sided, single page injury surveillance form
  - 52 Categories
  - 485 Variables
- Double blind study
- School selection based on:
  - Availability of surfaces
  - Uniformity of sport-skill
  - Full-time ATC staff
- Discussed with ATCs prior to season
- Written informed consent
- Injuries evaluated by ATCs and team physicians
- Follow-up to confirm diagnoses
- Injuries monitored beyond season
- Compiled ≤ 7 days after game



MEYERS COLLEGE FOOTBALL GAME INJURY SURVEILLANCE PROGRAM

Athlete's ID Number (optional) _____ Athletic Trainer _____ University: _____

Opponent: _____ Number of Your Players Actually Participating _____

Player Wt (lb): ☐ Below 150 ☐ 151-200 ☐ 201-250 ☐ 251-300 ☐ 301+

Turf Type: ☐ Natural Grass ☐ FieldTurf ☐ Other Artificial Surfaces _____

Turf Quality: ☐ High ☐ Medium ☐ Low

Turf Age (yrs): ☐ New ☐ 1-3 ☐ 4-7 ☐ 8+

Air Temperature (°F): ☐ Below 40 ☐ 40s ☐ 50s ☐ 60s ☐ 70s ☐ 80s ☐ 90s ☐ 100+

Humidity (%): ☐ Below 40 ☐ 40s ☐ 50s ☐ 60s ☐ 70s ☐ 80s ☐ 90s ☐ 100

Shoe Type: ☐ 7-Studded removable cleats ☐ Edge/blade-style cleats ☐ 12-Studded removable cleats ☐ Turf/elastomeric short rubber ☐ Molded/hybrid - 15 cleats ☐ Other _____

Year: ☐ Freshman ☐ Sophomore ☐ Junior ☐ Senior

Where Injury Occurred: ☐ Home stadium ☐ Away stadium ☐ Independent site

Weather/Field Conditions: ☐ No precipitation/dry ☐ Rain ☐ Snow ☐ Sleet ☐ No precipitation/wet field

Injury Category: ☐ Player-to-player collision ☐ Player-to-turf collision ☐ Shoe surface (contact) ☐ Shoe surface (noncontact) ☐ Muscle-tendon overload

Time of Injury: ☐ 1st quarter ☐ 2nd quarter ☐ 3rd quarter ☐ 4th quarter ☐ Pregame ☐ Overtime

Injury Classification: ☐ Acute injury ☐ Recurrent injury this year ☐ Recurrent injury-practice ☐ Recurrent injury last year ☐ Complication of prior injury ☐ Recurrent injury-nonsport

Injury Time Loss: ☐ 0 days ☐ 1-2 days ☐ 3-6 days ☐ 7-9 days ☐ 10-21 days ☐ 22 days or more ☐ Catastrophic nonfatal ☐ Fatal

Position Played At Injury: ☐ Offensive Tackle ☐ Offensive Guard ☐ Center ☐ Quarterback ☐ Fullback ☐ Halfback/tailback ☐ Slotback/wingback ☐ Flanker/wide receiver ☐ Tight End ☐ Defensive End ☐ Defensive Tackle ☐ Nose Guard ☐ Linebacker - middle ☐ Linebacker - outside ☐ Cornerback ☐ Safety ☐ Kicker/punter ☐ Holder ☐ Special teams

Field Location: ☐ Beyond team's end zone ☐ Team's end zone ☐ Team's red zone ☐ Team's midfield territory ☐ Team's out-of-bounds area ☐ Opponent out-of-bounds ☐ Opponent midfield territory ☐ Opponent red zone ☐ Opponent end zone ☐ Beyond opponent end zone

Injury Situation: ☐ Warmup ☐ Rushing play ☐ Passing ☐ Pass catching ☐ Pass protection ☐ Pass rush ☐ Pass defense ☐ Kickoff return ☐ PAT/FG ☐ Kickoff ☐ Punting ☐ Punt return ☐ Fumble recovery ☐ Piling-on ☐ Fake punt

Injury Mechanism: ☐ Heat illness ☐ Blocked below waist ☐ Blocked above waist ☐ Tackling ☐ Tackled below waist ☐ Tackled above waist ☐ Blocking ☐ Impact w/ playing surface ☐ Stepped on/fallen on/kick ☐ Sprints/running ☐ Blocking a kick/punt ☐ No contact (rotation/plant) ☐ Overuse ☐ Catching/blocking pass ☐ Clipped ☐ Impact w/padded cast

Injury Diagnosis Made By: ☐ Clinical exam - AT ☐ Clinical exam - MD/DDS ☐ X-ray ☐ MRI ☐ CT ☐ Surgery ☐ Blood work/lab test ☐ ECG/Echocardiogram

Injury Site Location: ☐ Right ☐ Left ☐ Not Applicable

Principal Body Part: ☐ Head ☐ Eye ☐ Ear ☐ Nose ☐ Face ☐ Chin ☐ Jaw (TMJ) ☐ Mouth ☐ Teeth ☐ Tongue ☐ Neck ☐ Shoulder ☐ Clavicle ☐ Scapula ☐ Upper arm ☐ Elbow ☐ Forearm ☐ Wrist ☐ Hand ☐ Thumb ☐ Finger ☐ Upper back ☐ Spine ☐ Lower back ☐ Ribs ☐ Sternum ☐ Abdomen ☐ Pelvis/hips ☐ Groin ☐ Buttocks ☐ Upper leg ☐ Knee ☐ Patella ☐ Lower leg ☐ Ankle ☐ Heel/Achilles tendon ☐ Foot ☐ Toe ☐ External genitalia ☐ Breast

Primary Type of Injury: ☐ Abrasion ☐ Contusion ☐ Laceration ☐ Puncture wound ☐ Concussion ☐ Bursitis ☐ Tendinitis ☐ Fasciitis ☐ Plantar fasciitis ☐ Synovitis ☐ Capsulitis ☐ Apophysitis ☐ Ligament sprain ☐ Syndesmosis sprain ☐ Ligament tear ☐ Muscle strain ☐ Muscle cramp/spasm ☐ Muscle tear ☐ Muscle contusion ☐ Tendon strain ☐ Torn cartilage ☐ Hyperextension ☐ Burner/Brachial plexus ☐ Subluxation ☐ Dislocation ☐ Fracture ☐ Epiphyseal fracture ☐ Avulsion fracture ☐ Stress fracture ☐ Osteochondral fracture ☐ Heat exhaustion ☐ Heat stroke ☐ Burn ☐ Inflammation ☐ Infection ☐ Nerve injury ☐ Blister ☐ Boil ☐ Herniation ☐ Overuse ☐ Other

Grade of Injury: ☐ 1st degree ☐ 2nd degree ☐ 3rd degree ☐ Type ☐ Salter-Harris ☐ None

☐ Boil ☐ Herniation ☐ Overuse ☐ Other

Grade of Injury: ☐ 1st degree ☐ 2nd degree ☐ 3rd degree ☐ Type ☐ Salter-Harris ☐ None

External Bleeding Occur: ☐ Yes ☐ No

Injury Due to Illegal Action:

Shoulder Diagnosis: ☐ AC separation ☐ SLAP lesion ☐ Hill-Sachs lesion ☐ Impingement syndrome ☐ Dead arm syndrome ☐ Rotator cuff tear ☐ Bankart lesion

Extremity Diagnosis: ☐ Jones fracture ☐ Maisonneuve fracture ☐ LisFranc injury ☐ Gamekeeper's thumb ☐ Jersey finger ☐ Mallet finger ☐ Boutonnière deformity ☐ Subungual hematoma

☐ Clavicle ☐ Spleen ☐ Liver ☐ Kidney

Arm and Forearm ☐ Humerus ☐ Radius ☐ Ulna

Wrist and Hand ☐ Scaphoid ☐ Lunate ☐ Triquetrum ☐ Pisiform ☐ Trapezium ☐ Trapezoid ☐ Capitate

☐ Calcaneocuboid (CC) ☐ Intertarsal ☐ Transverse/midtarsal ☐ Tarsometatarsal (TM) ☐ Intermetatarsal (IM) ☐ Metatarsophalangeal (MTP) ☐ Prox. interphalangeal (PIP) ☐ Distal interphalangeal (DIP)

Muscle Location of Injury: ☐ Prevertebral/scaleni ☐ Rectus abdominus ☐ Transverse abdominous ☐ Quadratus lumborum ☐ Obliques ☐ Splenius ☐ Erector spinae ☐ Deep spinal muscles

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Meyers, Elledge, Sterling et al., 1990; Meyers & Barnhill, 2004; Meyers, 2010

Definitions

- Although any definition of injury and level of trauma lacks universal agreement and has its shortcomings, definition of injury was based on a combination of:
  - Functional outcome
  - Observation
  - Treatment

DeLee & Farney, 1992; Hagel et al., 2003; Meyers, 2010; Meyers & Barnhill, 2004; Noyes et al., 1988; Prager et al., 1989; Thompson et al.,1987

Definitions

- A reportable injury was defined as any game-related football trauma that resulted in:
  - An athlete missing all or part of a game
  - Time away from competition
  - Any injury reported or treated by ATC or physician
  - All cranial/cervical trauma reported

Meyers, 2010; Meyers & Barnhill, 2004

Definitions

- Injury Time Loss
  - Minor: 0-6 days time loss
  - Substantial: 7-21 days of time loss resulting in the athlete unable to return to the same collegiate competitive level of play
  - Severe: trauma that required 22 or more days of time loss

DeLee & Farney, 1992; Meyers, 2010; Meyers & Barnhill, 2004; Thompson et al., 1987

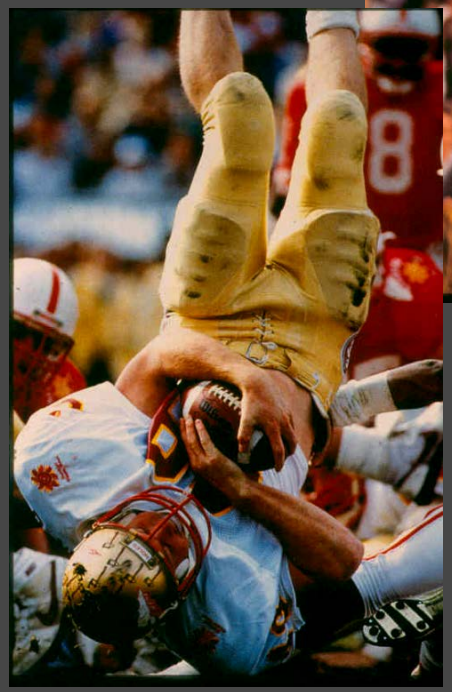
Statistical Analyses

- Data were grouped by:
  - Injury category
  - Time of injury
  - Injury classification
  - Injury time loss
  - Position played at time of injury
  - Injury mechanism
  - Injury situation
  - Field location of injury
  - Primary type of injury
  - Grade of injury
  - Anatomic location of injury
  - Type of tissue injured
  - Head diagnosis
  - Knee diagnosis
  - Shoulder diagnosis
  - Environmental factors
  - Cleat design
  - Elective imaging/surgery
  - Turf age
  - Specific lower extremity joint and muscle trauma
- Tabular-frequency distributions (SPSS)
- Injury Incidence Rate (IIR) per 10 games (# injuries / # games x 10)
- Multivariate analyses (MANOVAs, Wilks' Lambda criterion)
- Post hoc analyses (ANOVAs, Tukey HSD)
- Significance set *a priori* at $P < 0.05$

Results

- 1,837 high school games
  - 528 (28.8%) on ≥ 9.0 infill
  - 521 (28.4%) on 6.0 – 8.9 infill
  - 525 (28.6%) on 3.0 – 5.9 infill
  - 263 (14.2%) on 0.0 – 2.9 infill

- 4,655 injury cases
  - 917 injuries on ≥ 9.0 infill
  - 1,324 injuries on 6.0 – 8.9 infill
  - 1,590 injuries on 3.0 – 5.9 infill
  - 824 injuries on 0.0 – 2.9 infill



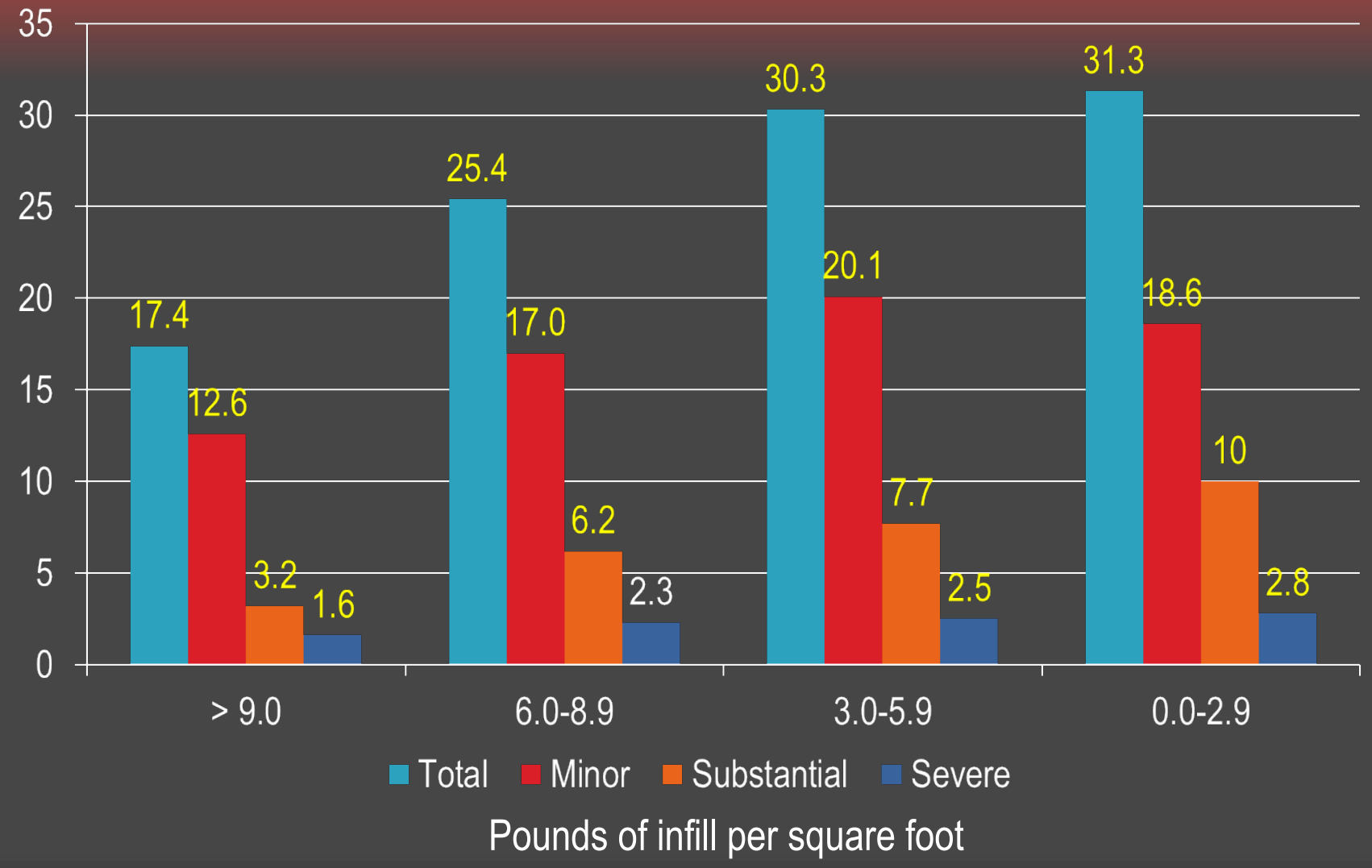
Results

- MANOVAs
  - Severity of injury (F = 5.087; $P = .0001$)
  - Injury category (F = 4.959; $P < .0001$)
  - Primary type of injury (F = 3.039; $P < .0001$)
  - Injury grade (F = 5.590; $P = .0001$)
  - Injury mechanism (F = 4.113; $P < .0001$)
  - Field conditions (F = 6.184; $P < .0001$)
  - Imaging/surgical procedure (F = 5.692; $P = .0001$)
  - Cleat design (F = 15.570; $P < .0001$)
  - Turf age (F = 21.621; $P < .0001$)

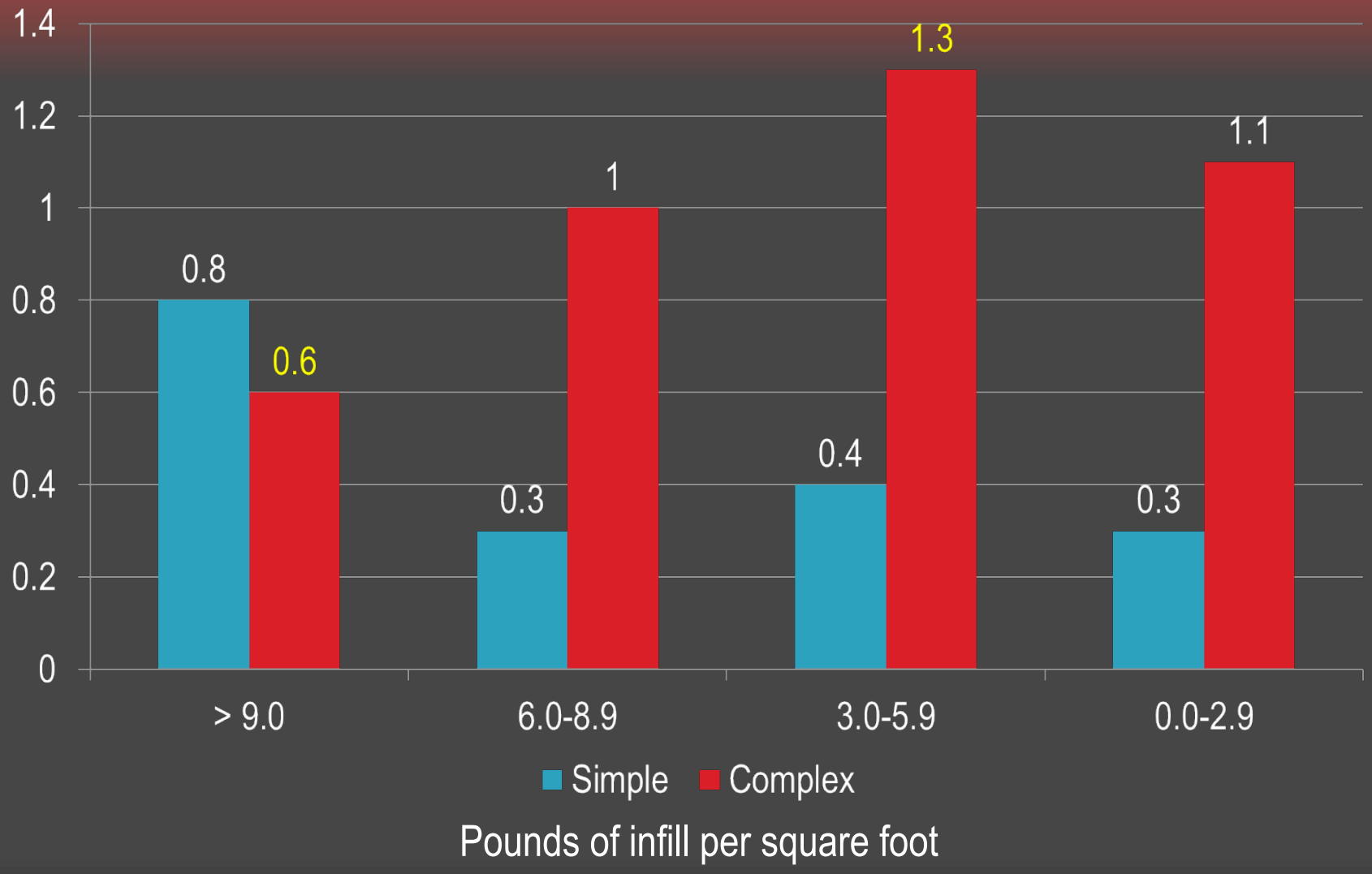
Results

- MANOVAs
  - Anatomical location (F = 2.721; *P* = .004)
  - Type of tissue (F = 5.160; *P* < .0001)
  - Specific body location (F = 2.132; *P* < .0001)
  - Lower extremity-joint (F = 1.783; *P* = .001)
  - Lower extremity-muscle (F = 3.013; *P* < .0001)
  - Injury situation (F = 1.505; *P* = .019)
  - Head (F = 3.577; *P* = .0001)
  - Knee (F = 1.715; *P* = .0001)
  - Skill position played (F = 0.932; *P* = .557)

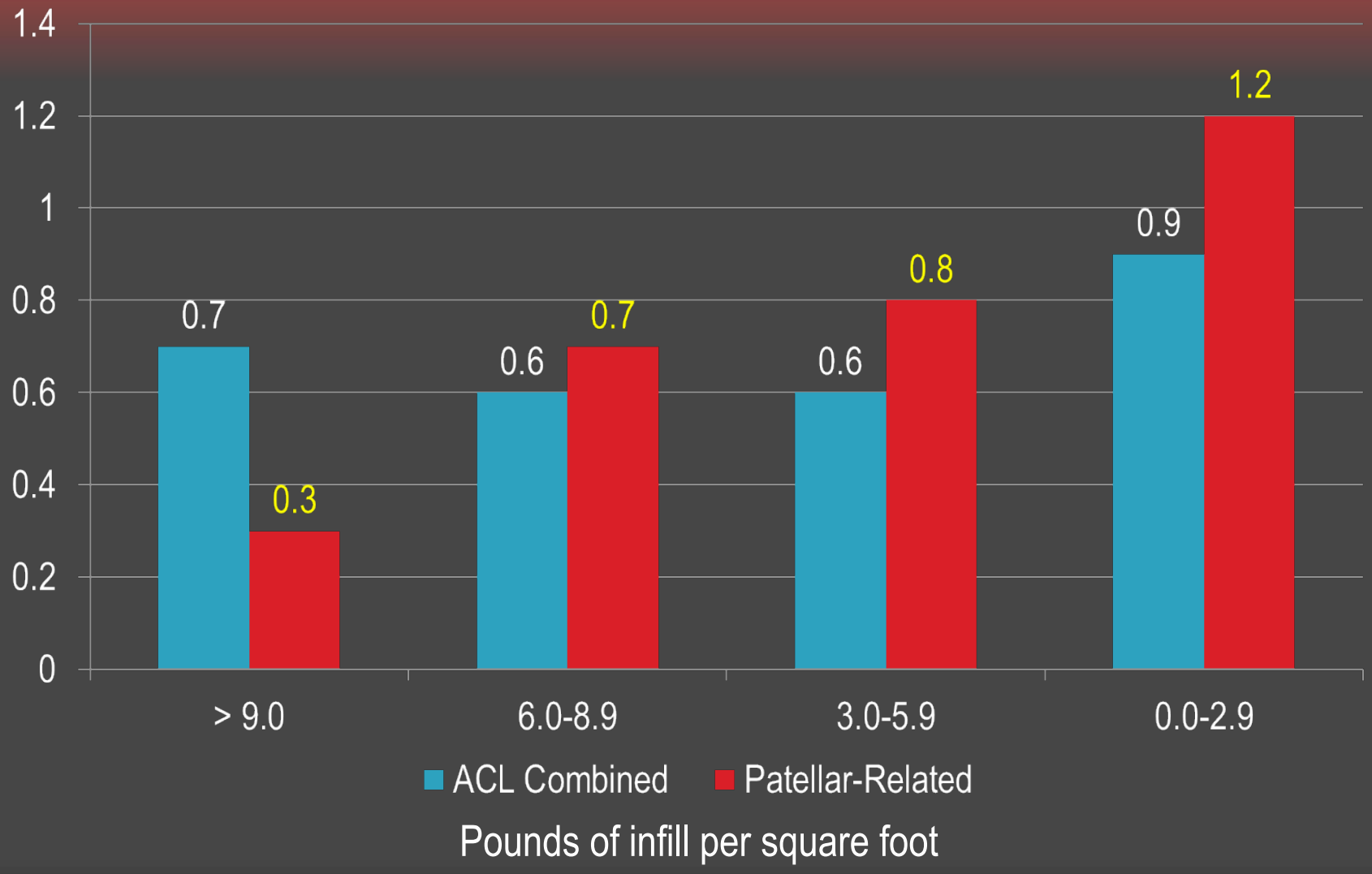
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Severity



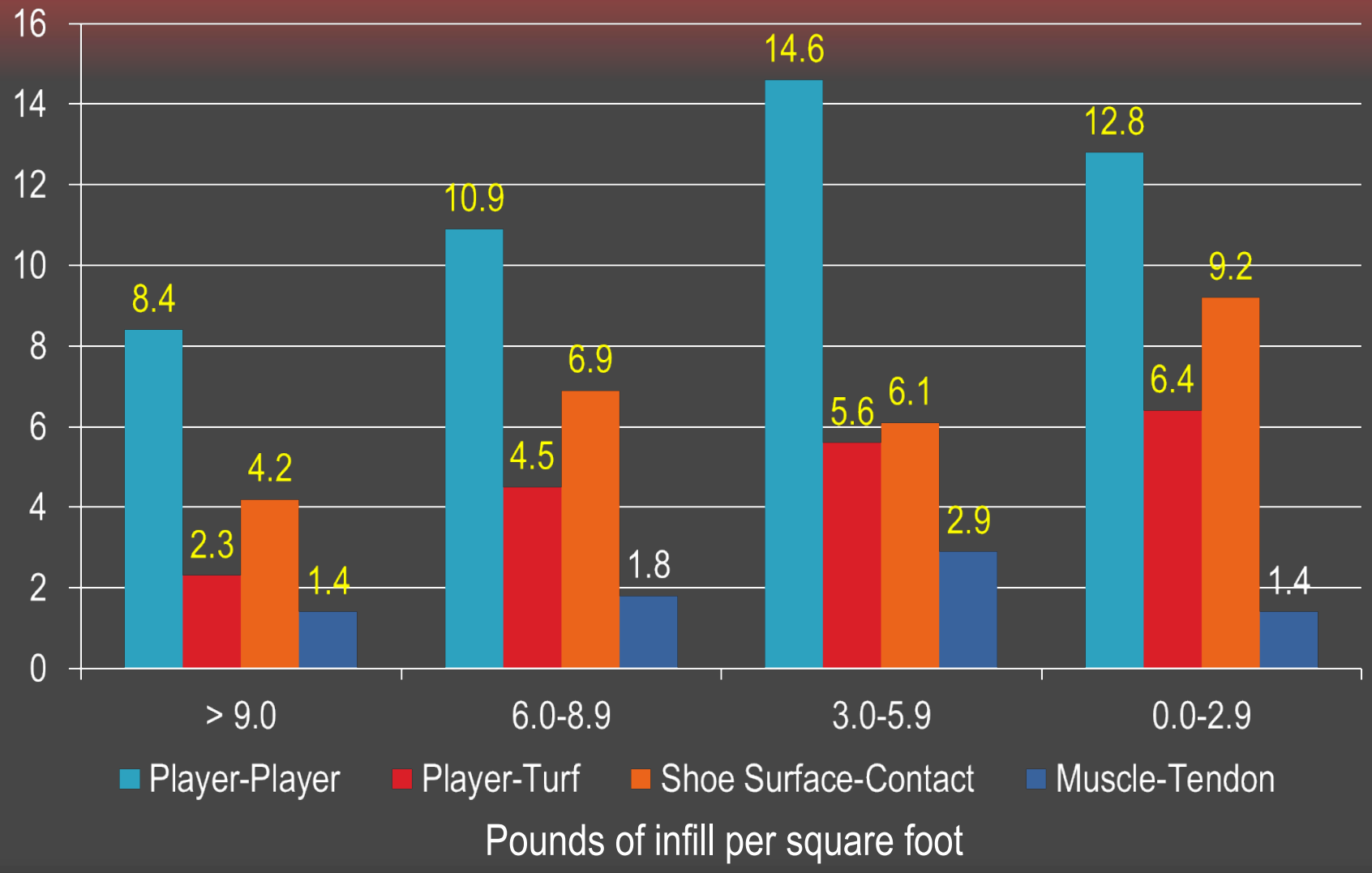
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Concussions



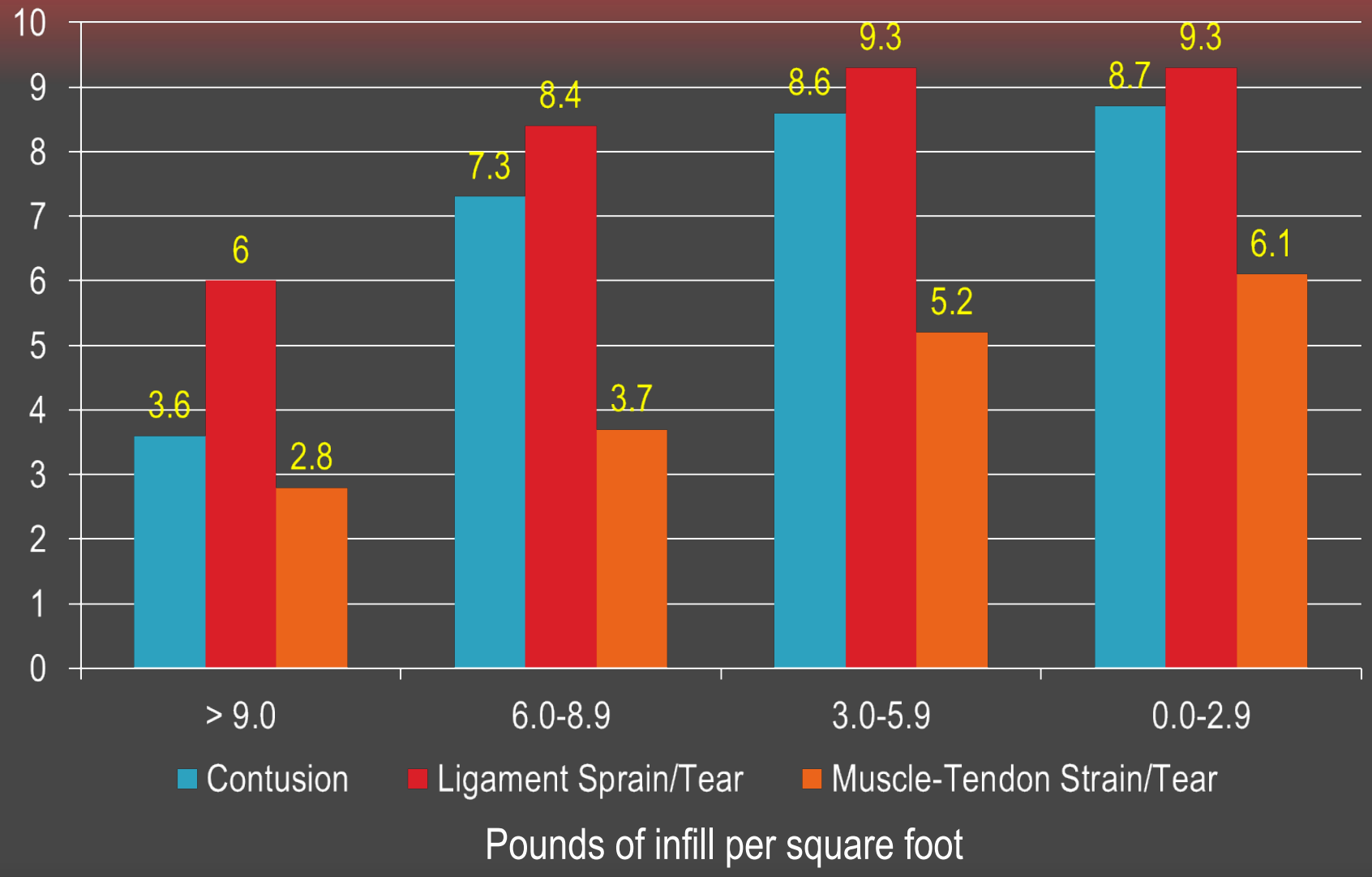
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Knee Trauma



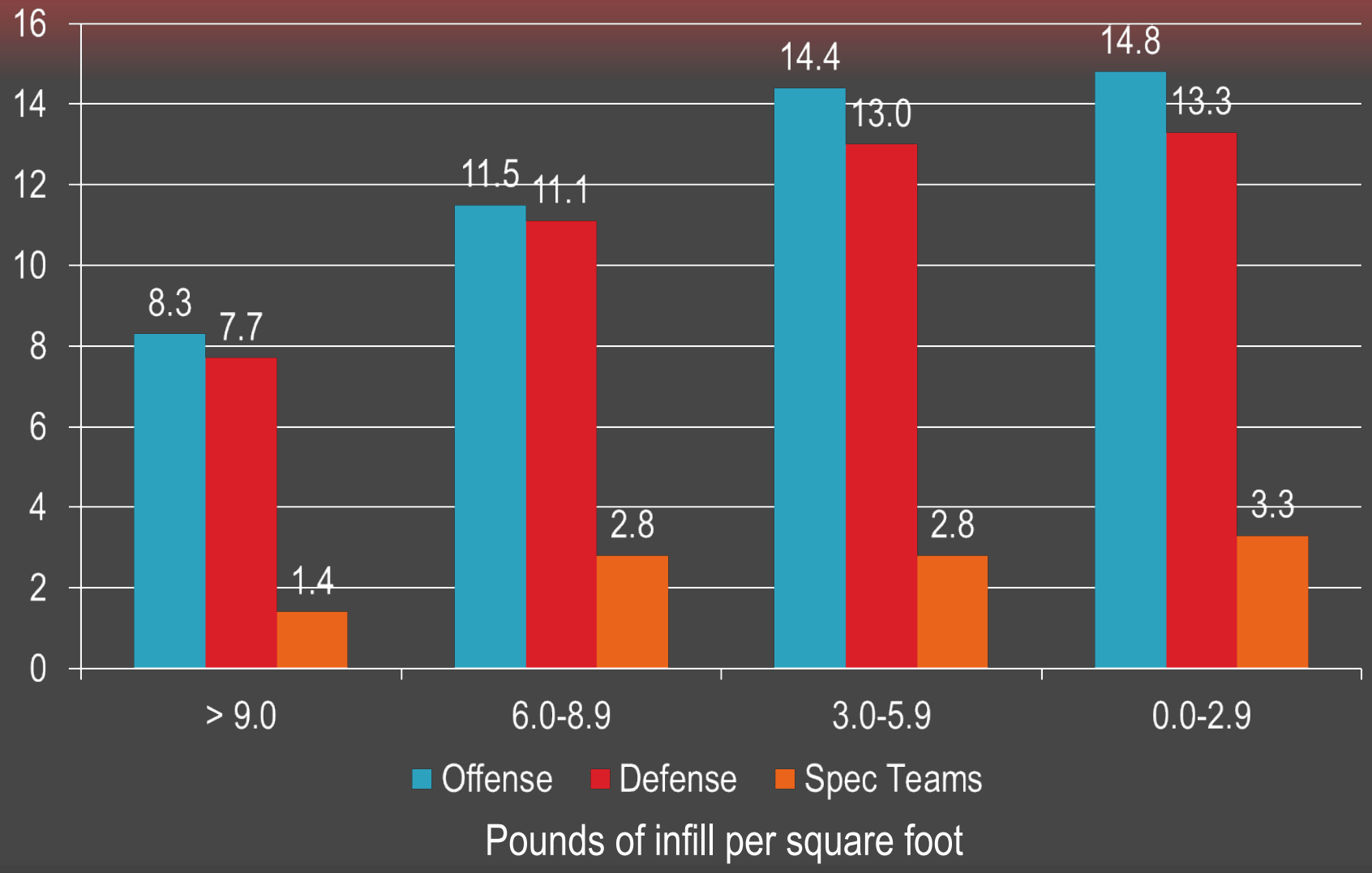
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Injury Category



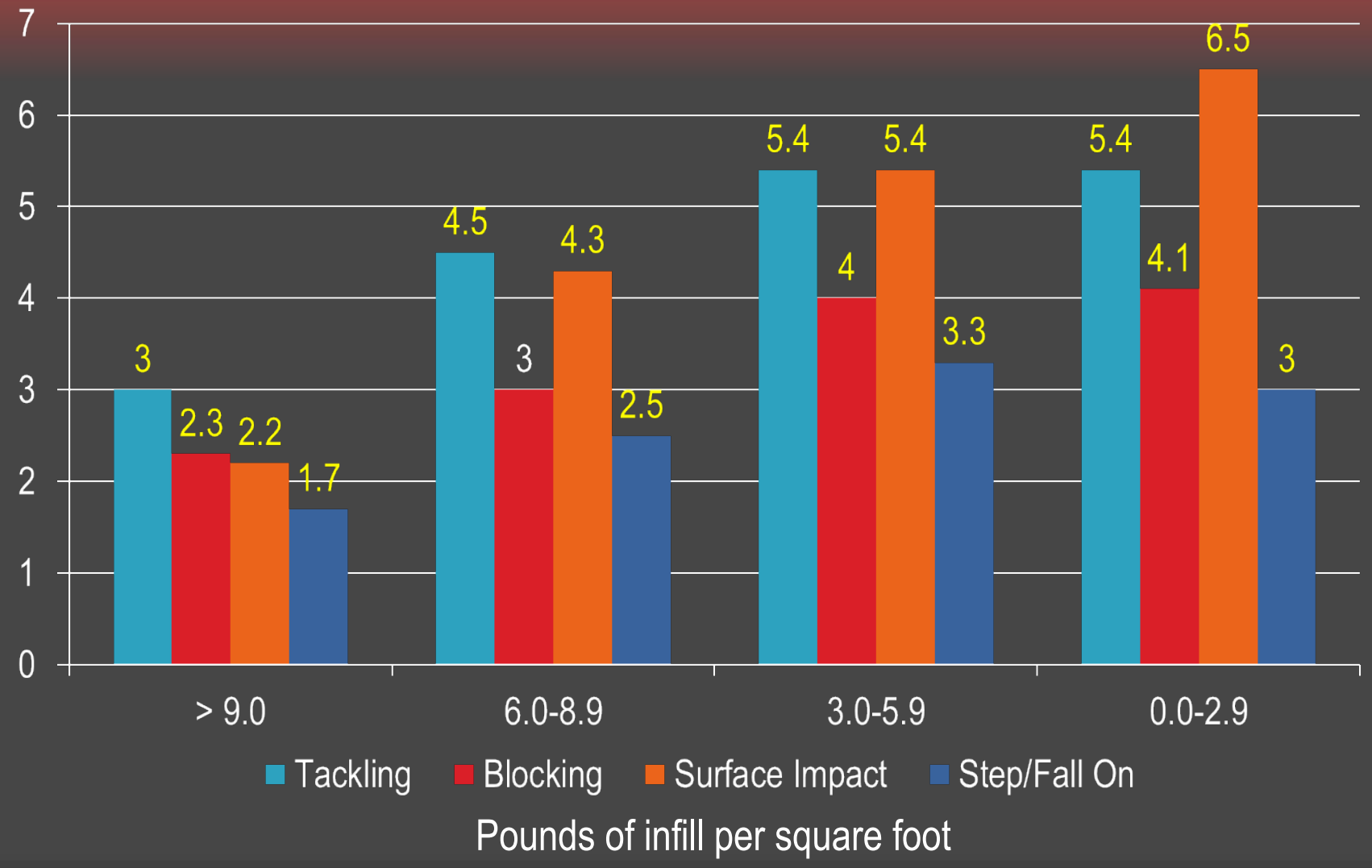
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Type of Injury



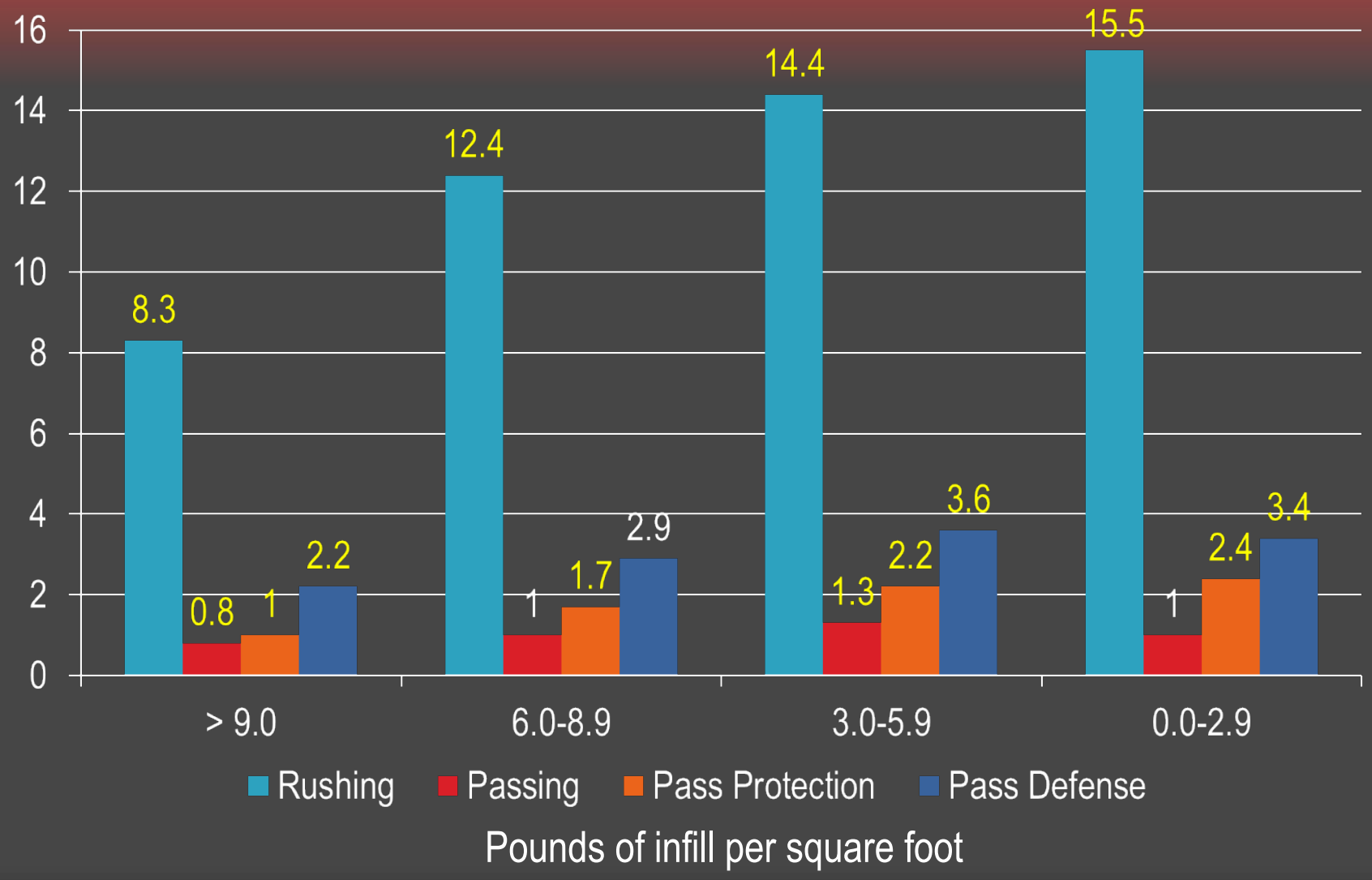
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Player Position



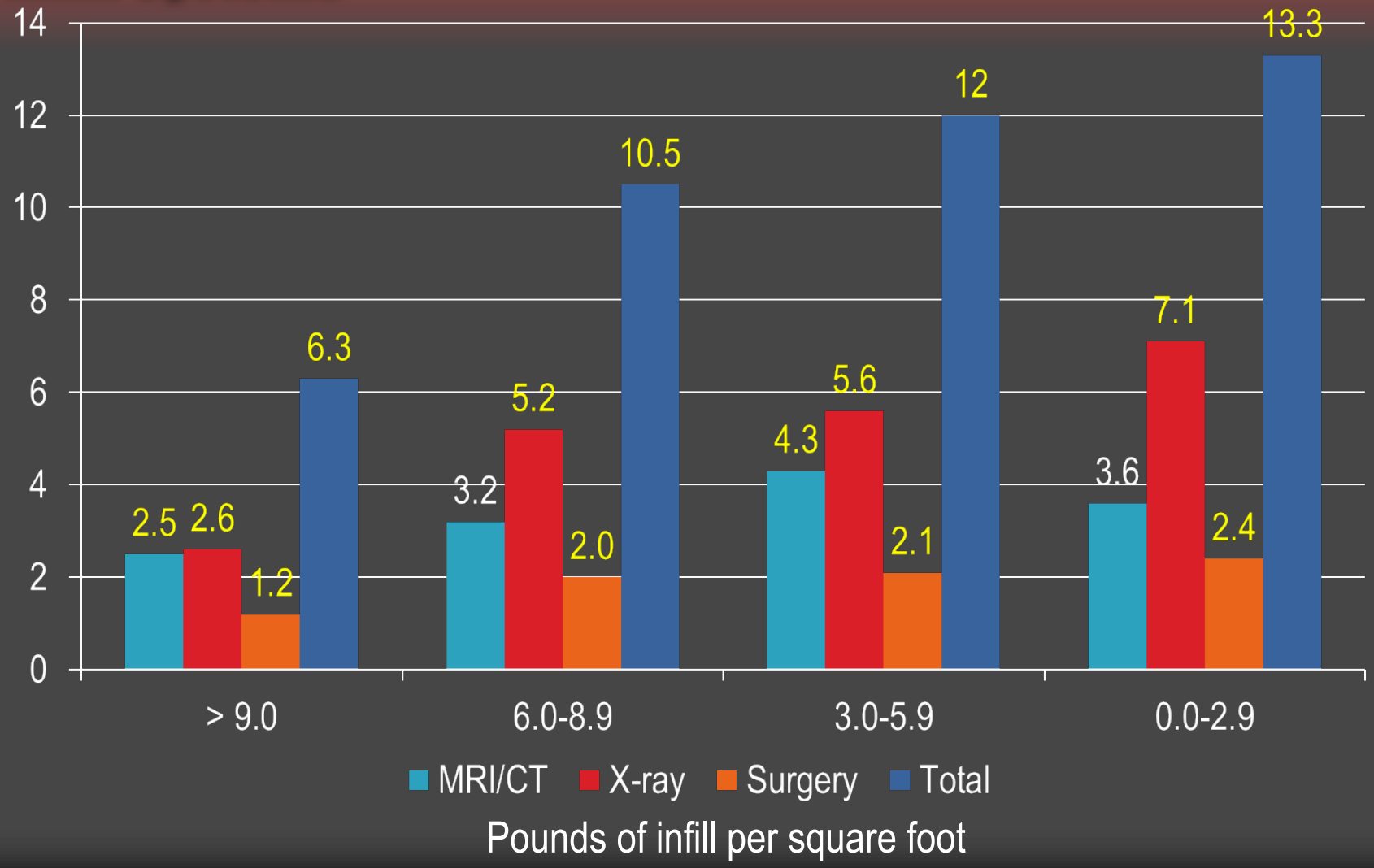
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Injury Mechanism



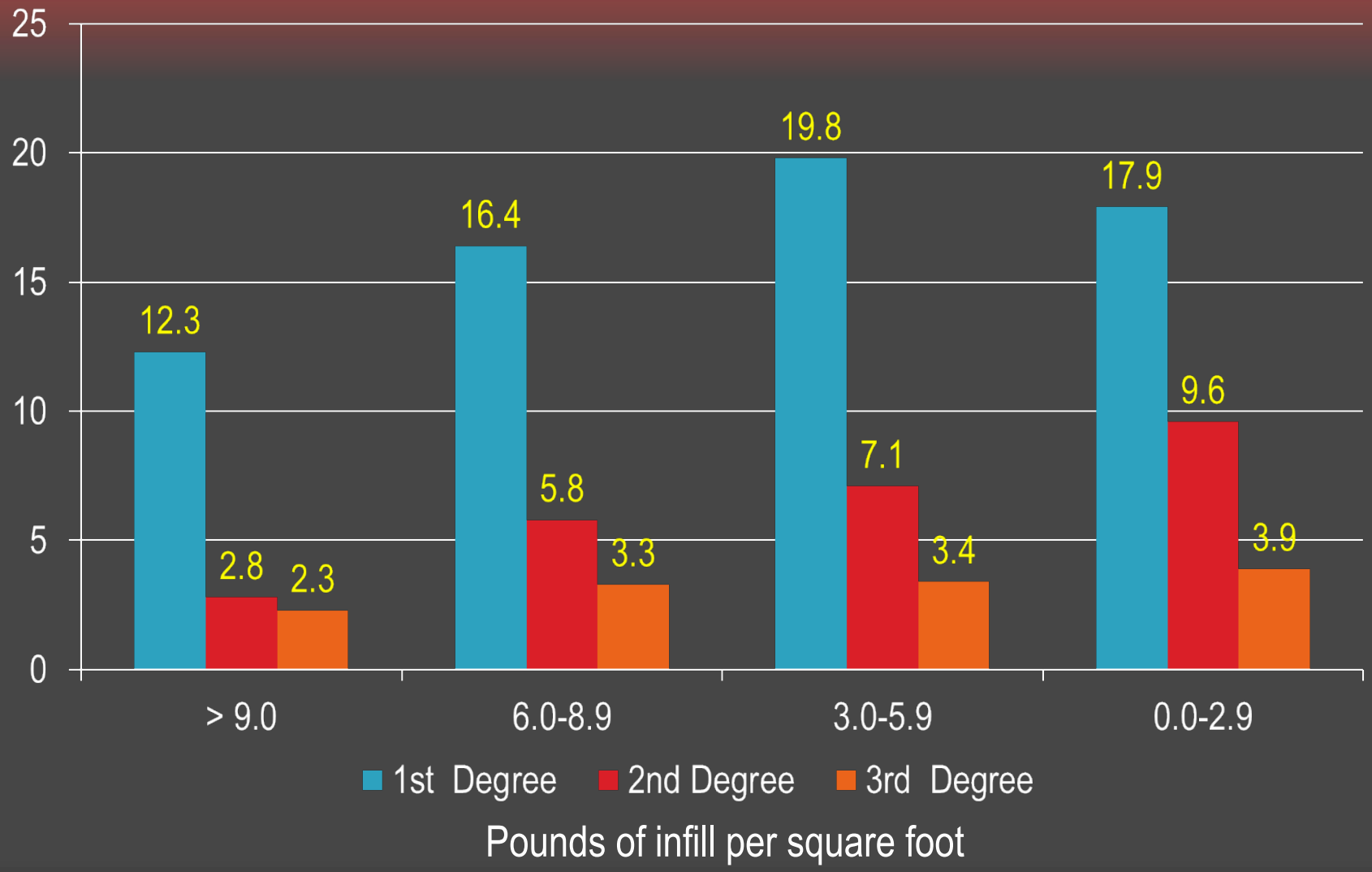
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Injury Situation



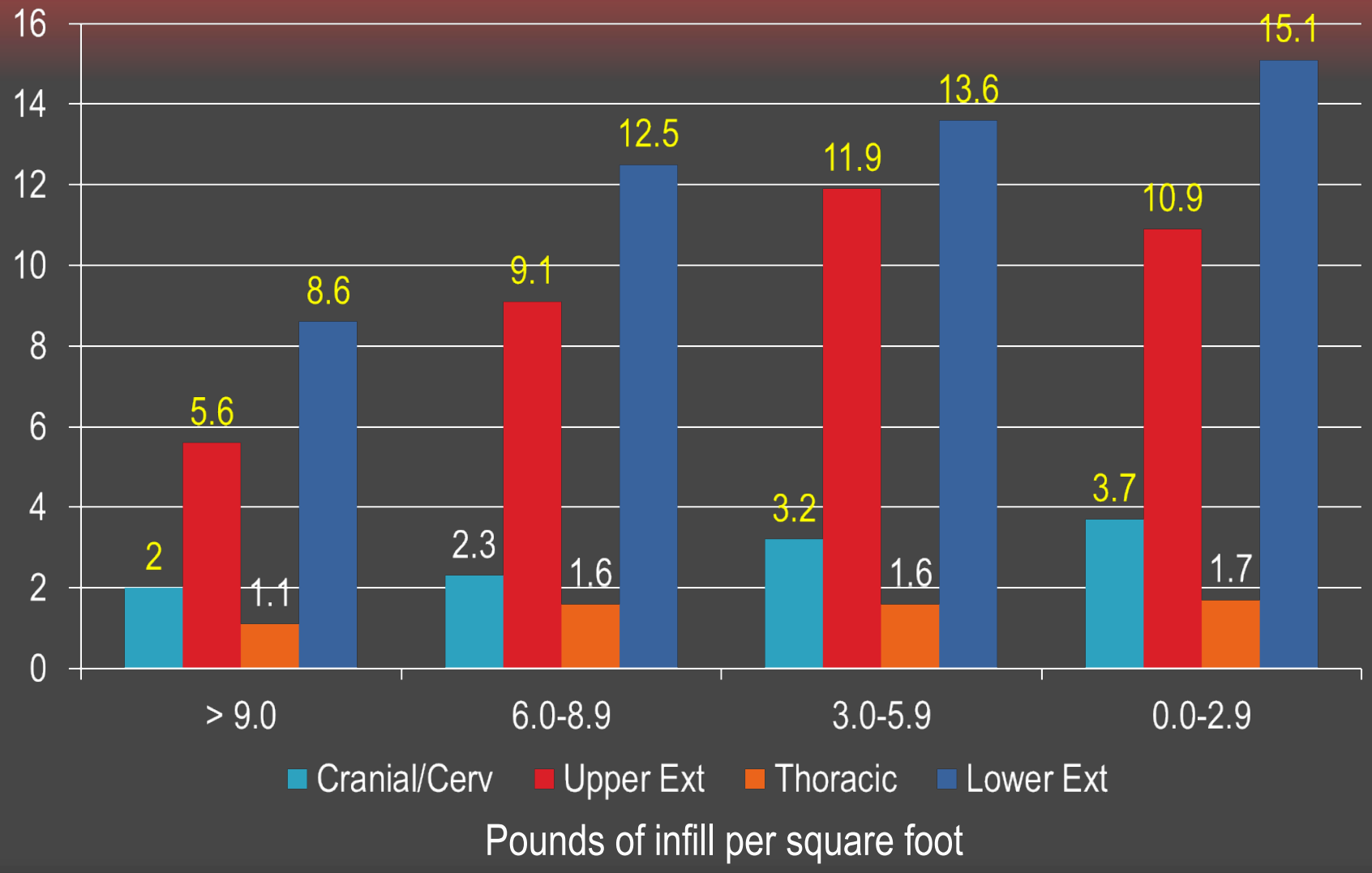
Incidence of Game-Related High School Football Imaging/Surgical Procedures between Artificial Turf Infill Systems



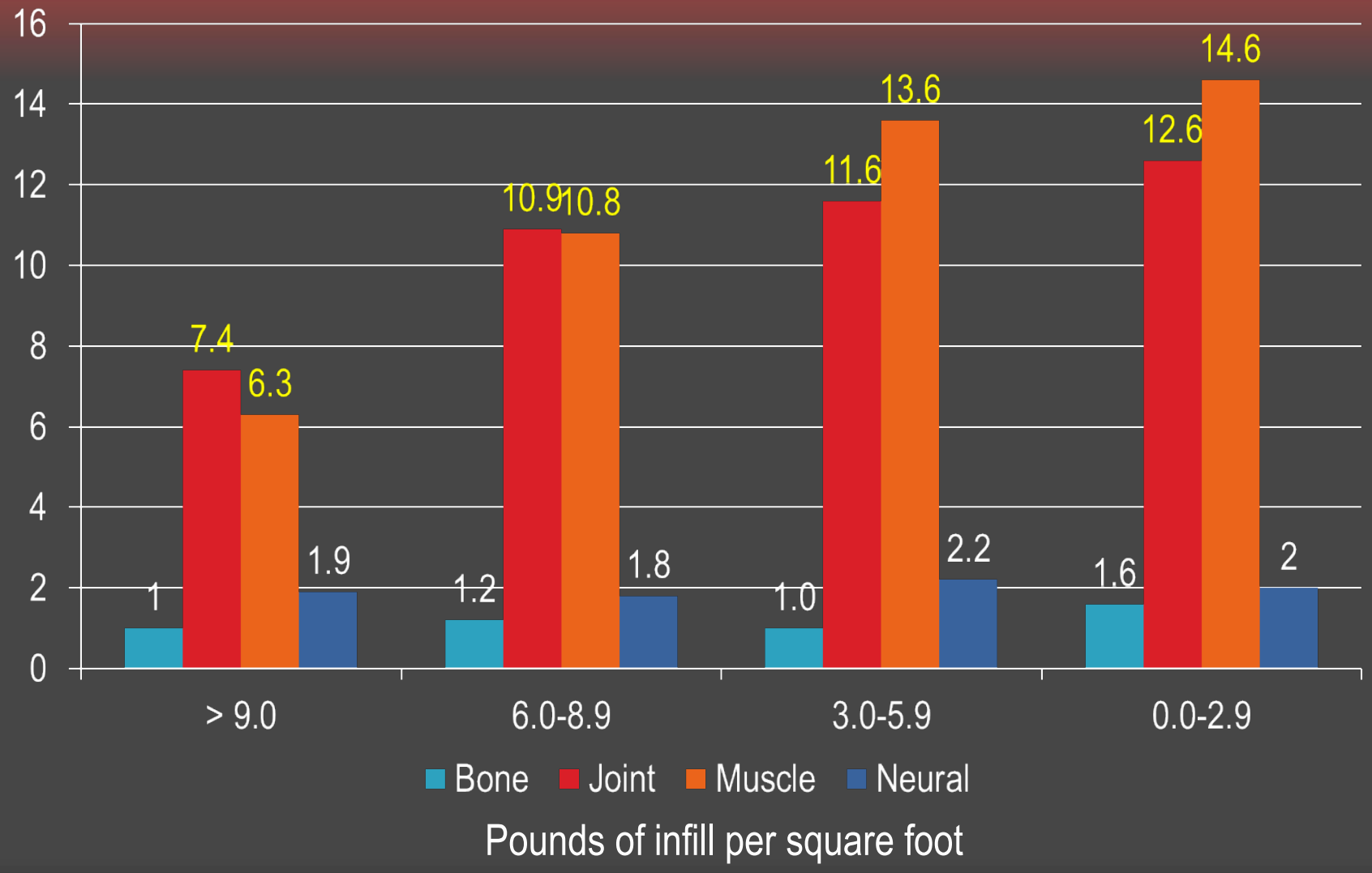
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Injury Grade



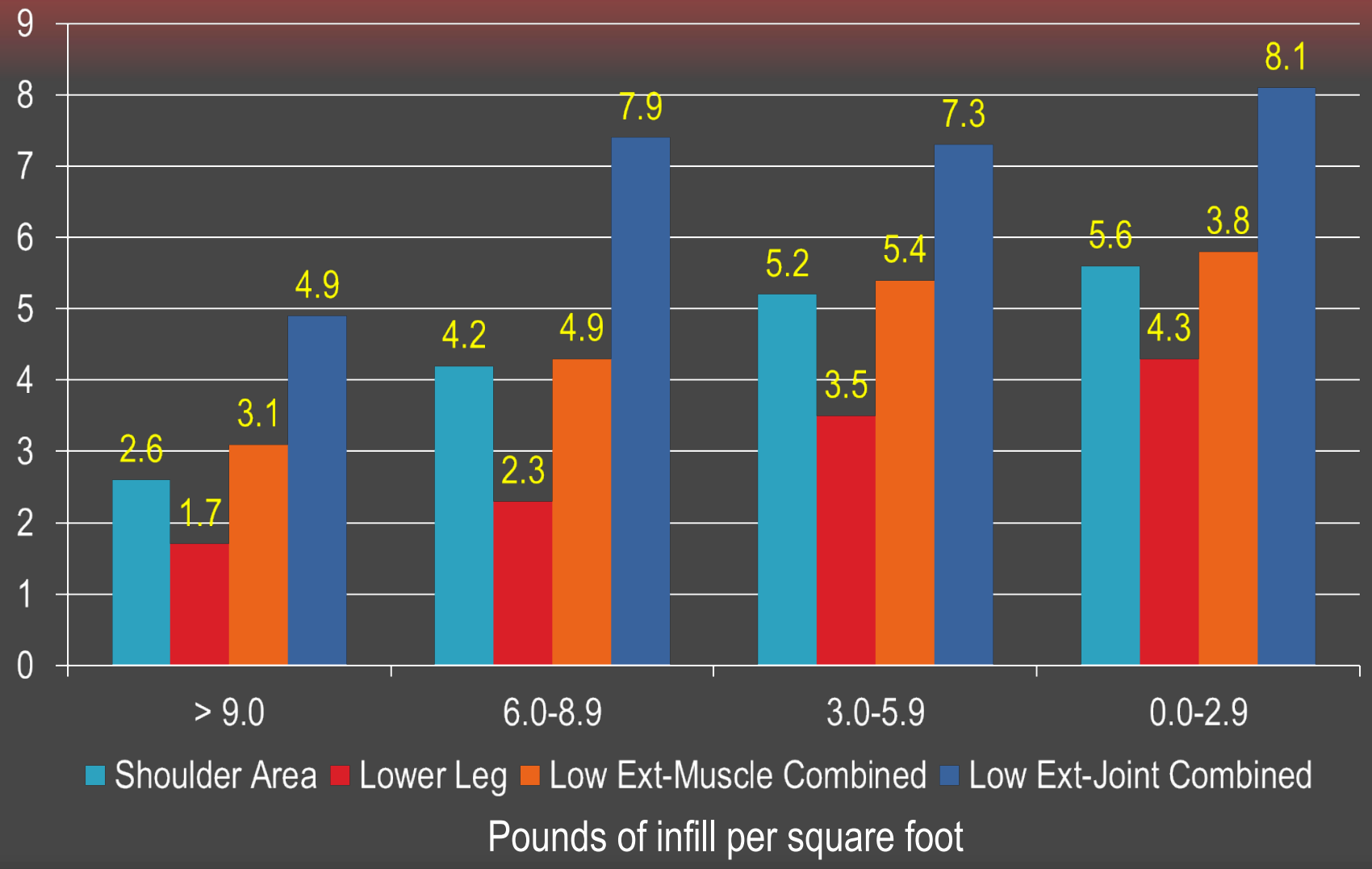
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Anatomy



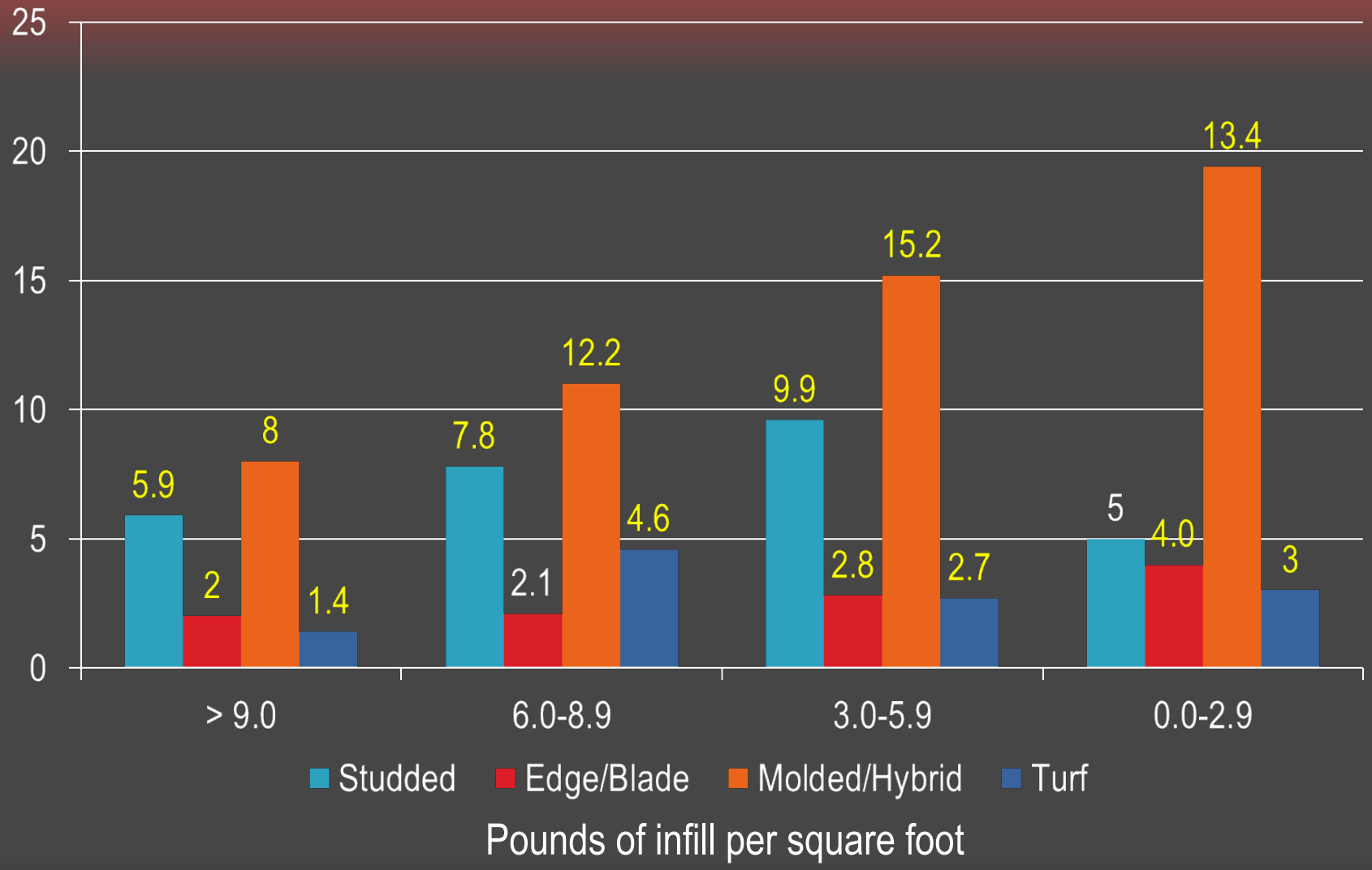
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Type of Tissue



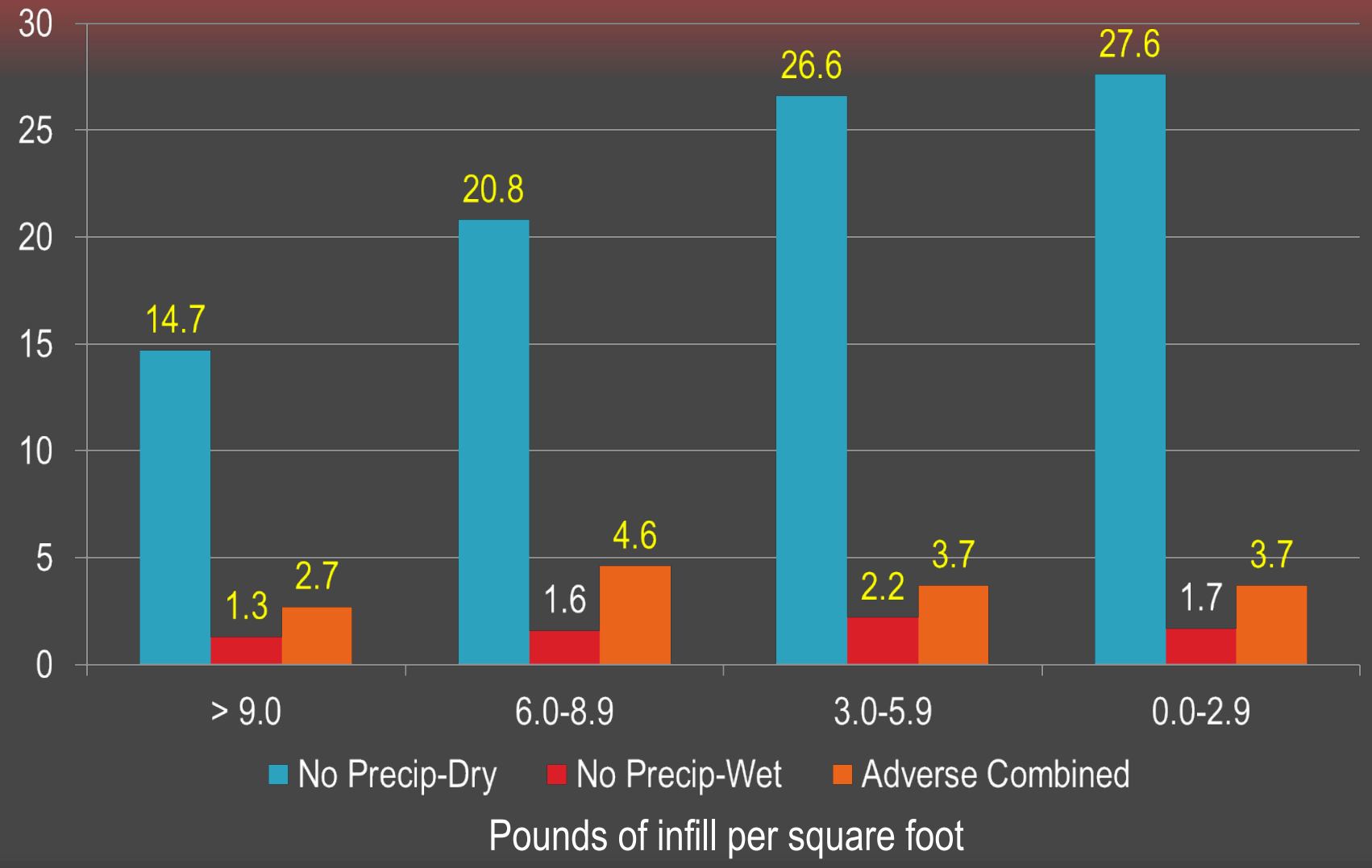
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Body Location



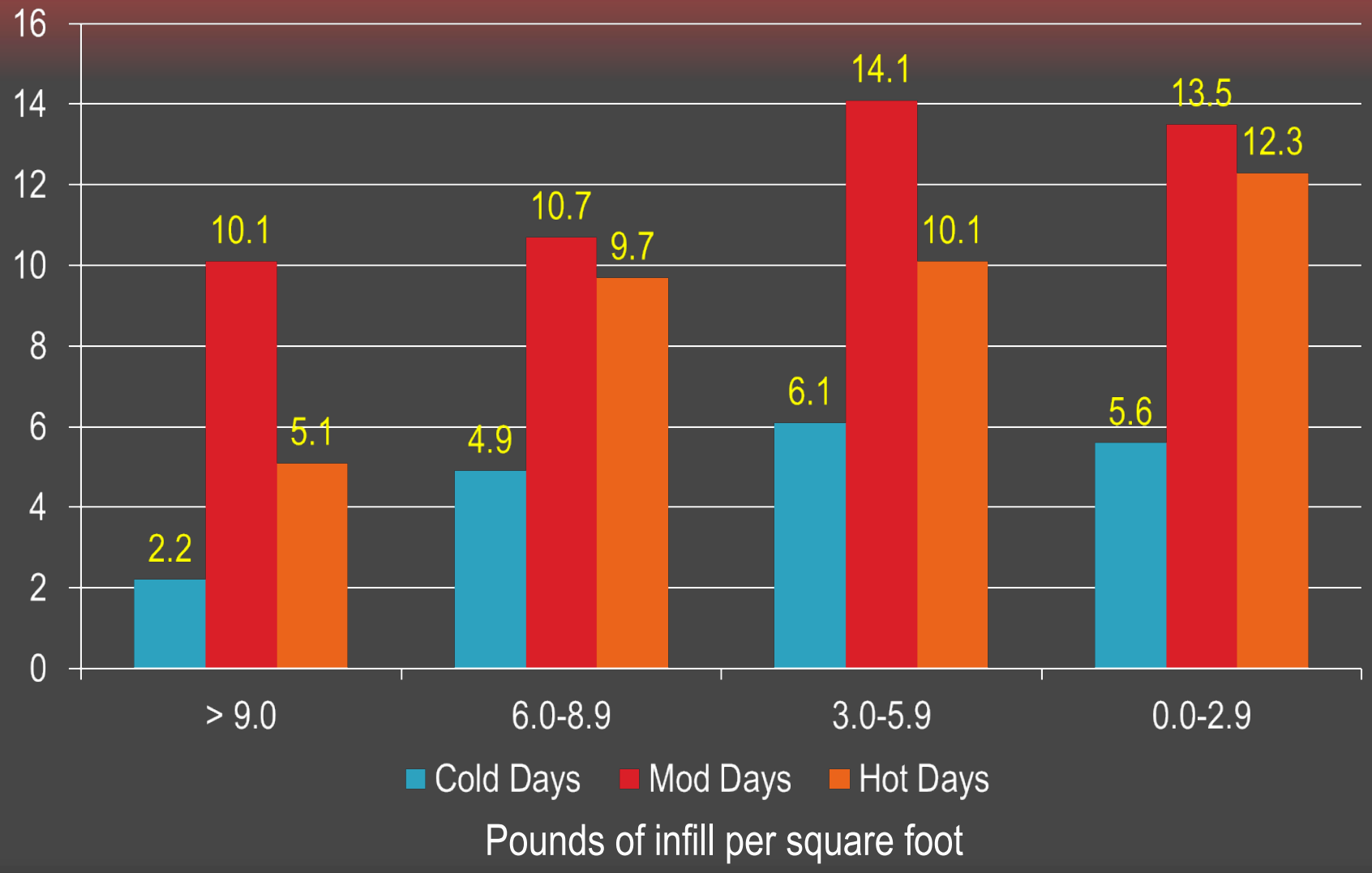
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Cleat Design



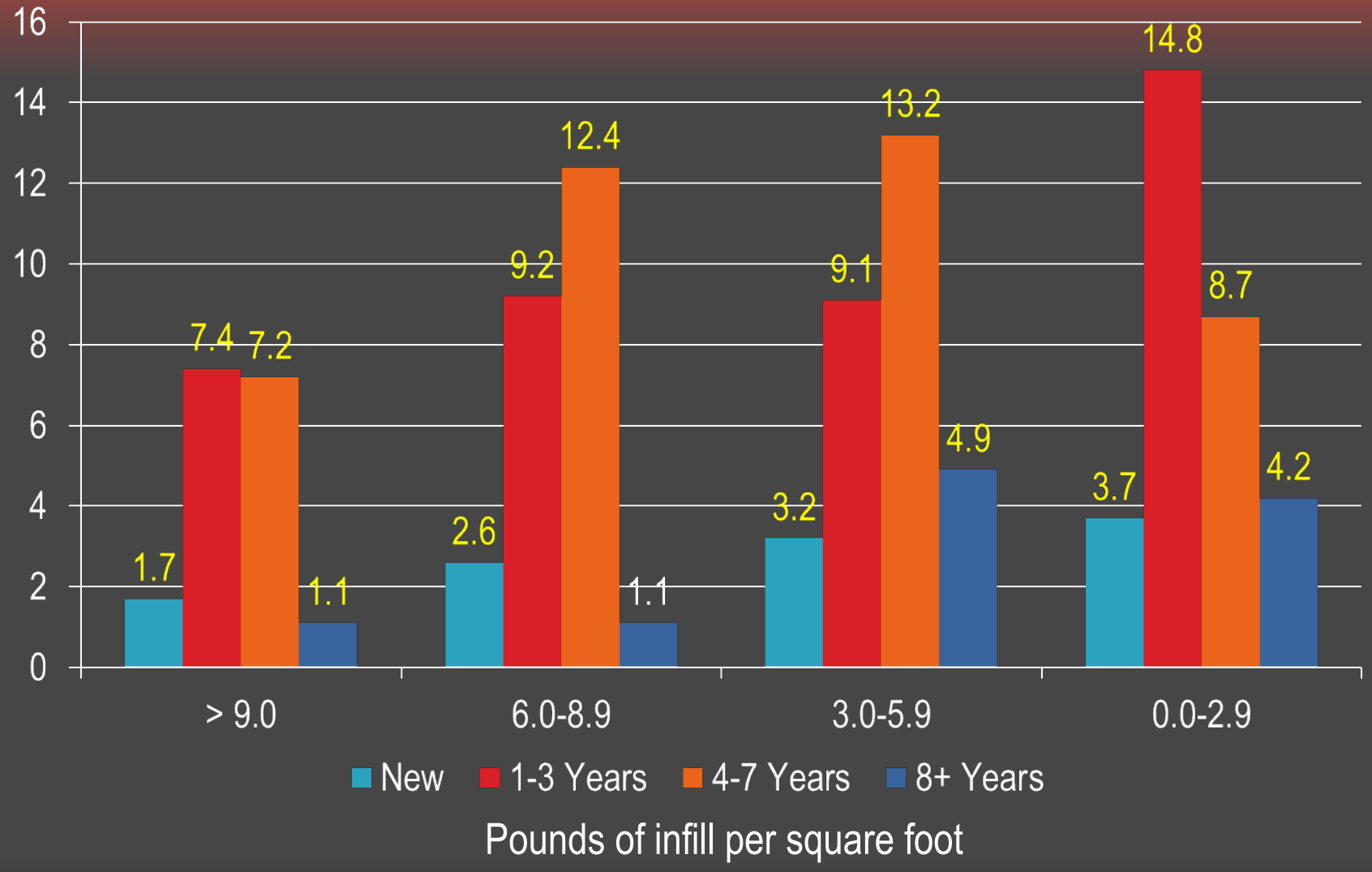
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Field Conditions



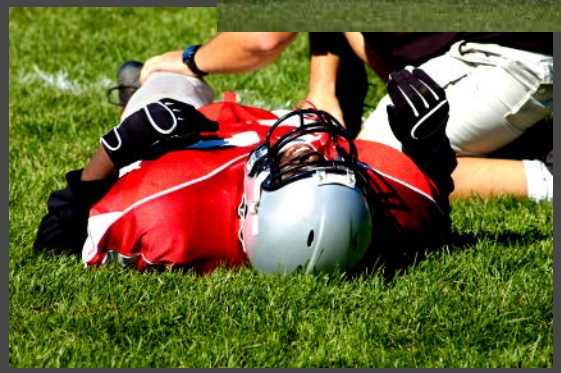
Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Temperature



Incidence of Game-Related High School Football injuries between Artificial Turf Infill Systems by Turf Age



Summary



Total Injuries

- **19 – 29%** lower incidence of injury between >9 lbs/sq.ft and all other infill weight surfaces

Substantial / Second Degree Injuries

- **35 – 55%** lower incidence of injury between >9 lbs/sq.ft and all other infill weight surfaces

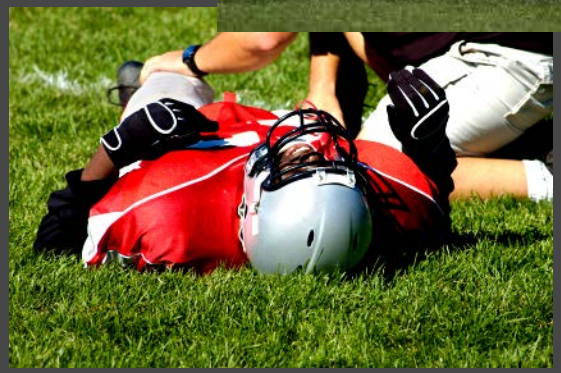
Severe / Third Degree Injuries

- **19 – 26%** lower incidence of injury between >9 lbs/sq.ft and 0-5.9 lbs/sq.ft of infill weight

Player-to-Turf / Impact with Playing Surface

- **32 – 47%** lower incidence of injury between >9 lbs/sq.ft and all other infill weight surfaces

Summary



Ligament Sprains and Tears

- **17 - 22%** lower incidence of injury between >9 lbs/sq.ft and all other infill weight surfaces

Lower Extremity Trauma

- **18 - 27%** lower incidence of injury between >9 lbs/sq.ft and all other infill weight surfaces

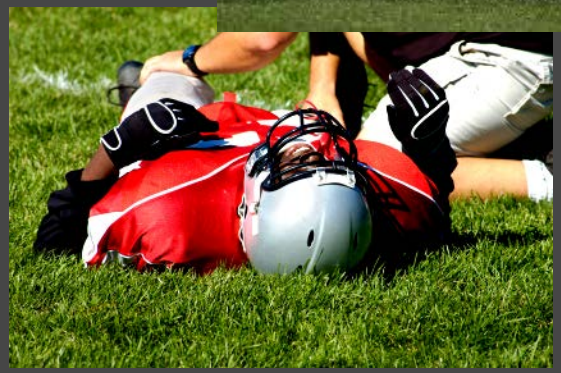
Shoe Surface During Contact Injuries

- **18 - 37%** lower incidence of injury between >9 lbs/sq.ft and all other infill weight surfaces

Adverse Weather Conditions Combined

- **16 - 26%** lower incidence of injury between >9 lbs/sq.ft and all other infill weight surfaces

Summary



Turf Age (New)

- **21 - 37%** lower incidence of injury between >9 lbs/sq.ft and all other infill weight surfaces

Turf Age (1 to 7 years)

- **19 - 23%** lower incidence of injury between >9 lbs/sq.ft and all other infill weight surfaces

Turf Age (8+ years)

- **58 - 63%** lower incidence of injury between >9 lbs/sq.ft and 0-5.9 lbs/sq.ft of infill

Total Diagnostic / Surgical Procedures Combined

- **25 - 36%** lower incidence of imaging / surgical procedures combined between >9 lbs/sq.ft and all other infill weight surfaces

Conclusion

↓ Infill Weight ↑ Injury Rate

- Recommended that football fields contain an infill weight of:

  6.0 to 9.0 lbs/sq. ft

Thank you