VANDERBILT UNIVERSITY MEDICAL CENTER

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Rule Changes – Do They Actually Work to Prevent Injury?

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IRONMAN
WORLD CHAMPIONSHIP
MEDICAL SYMPOSIUM

Safe Sport & Rules

- Rules provide structure and allow all contestants equal opportunities to perform, excel, and challenge each other
- Rule creation, implementation, and ongoing modification is important to establish conditions for participants to remain unharmed and injury free
- Individual and societal level health concerns
- Participants need to understand the purpose of rules as well as their personal obligations with respect to observing them

Injury Prevention is a Team Sport

Emery CA et al. CJSM, 2006.

Safety cannot be delegated, it is a shared responsibility of…

- Parents
- Coaches
- Youth athletes
- Safety advocates
- Sports leagues
- Schools
- Health professionals

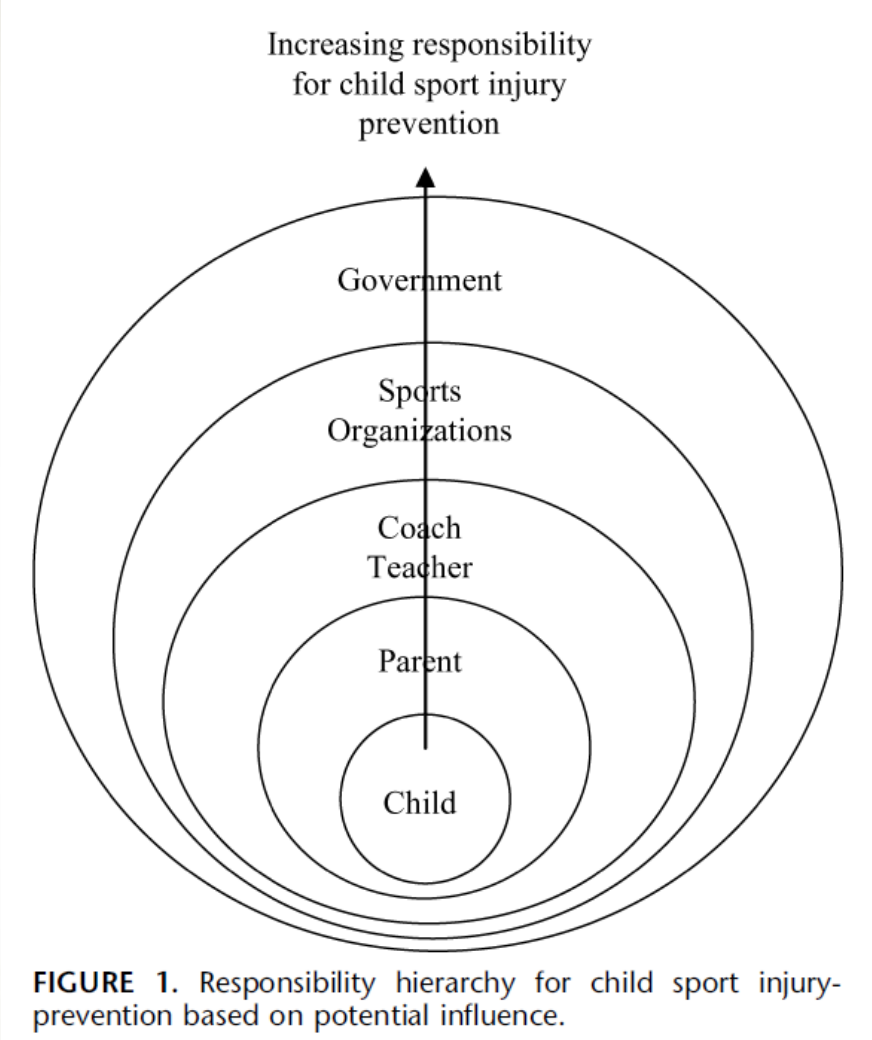


FIGURE 1. Responsibility hierarchy for child sport injury-prevention based on potential influence.

Youth Athletes & the Responsibility of Prevention

- Level of child development
  - Perceptual / Cognitive
    - Identify fewer hazards and do so more slowly
      - Age ≤ 10 (pedestrian data)
    - Overestimate physical abilities
    - Lack of understanding for consequences
    - Sense of invulnerability
  - Low level of perceived risk + over-estimation of ability = signif increase in risk of injury (age 11-14 → OR 3.77-7.92)
    - Kontos AP. J Ped Psych, 2004.

We Can Make a Difference

- Injury often predictable and preventable
  - Not just “accidents”
- As many as half the injuries sustained by youth while playing sports are likely preventable

Key Sports Safety Prevention Strategies

- Adherence to rules & limit illegal play
  - 6.4% of overall injuries in 9 HS sports were related to rules transgressions
    - Collins CL et al. Inj Prev, 2008. (RIO)
  - Since 2002 alone, the NFL has made over 50 rules changes re: health & safety
- Teaching proper fundamentals & technique
- Protective equipment
- Conditioning programs
- Educational & awareness campaigns

Collins CL et al. Inj Prev, 2008.

When the Rules of the Game are Broken

Enhanced enforcement of sports' rules and targeted education about the dangers of illegal activity for players, coaches, and referees/officials can reduce sports-related injuries.

Fehr et al. CJSM, 2024.

Rule Enforcement: Basketball Head Contact

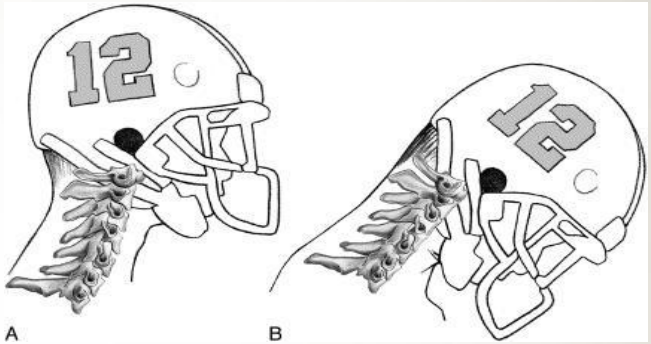
- Concussion common in school-aged basketball (Female typically 2x)
- Contact to head illegal
- 90% direct (player to player)
  - limb/trunk
  - 55% moderate, 37% mild, 9% severe
- 10% indirect (player to environment)
  - 95% Ball to face, 5% head to floor
- Only 19% called a foul (8-12% in lower classifications)
- Majority occurred within key
- Boy
  - Rebounding (offense & defense)
  - 20 head contacts/game
- Girl
  - Rebounding (defense) & driving/attacking rim (offense)
  - 18 head contacts/game
- 29 reported total concussions
- Call to action: Stricter enforcement and improved training for refs

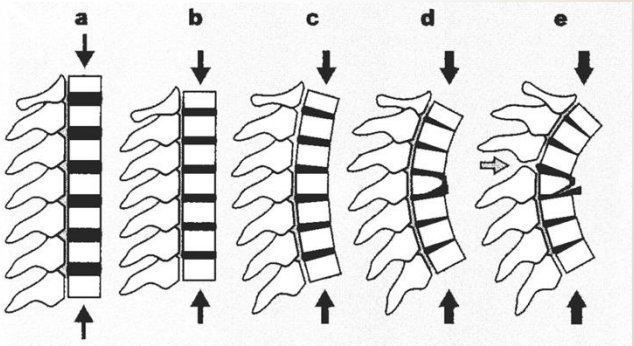
Rule Changes

SPORT SPECIFIC STRATEGIES

Football: Catastrophic Spine Injuries

- Most likely scenario:
  - Axial loading aka “spearing”
  - Game; Making tackle (69%)
  - Playing defense (71%)
    - DB (35%), special teams (~12%)
- Increased 116% from 1959-1963 to 1971-1975
- Spear tackling outlawed 1976 (34 cases)
- Rate of cervical injuries decreased 70%
- NCAA (2005) and NFHS (2007) strengthened spear-tackling rule & penalties
  - “Intentional” removed from definition
  - Further expansion regarding illegal helmet contact

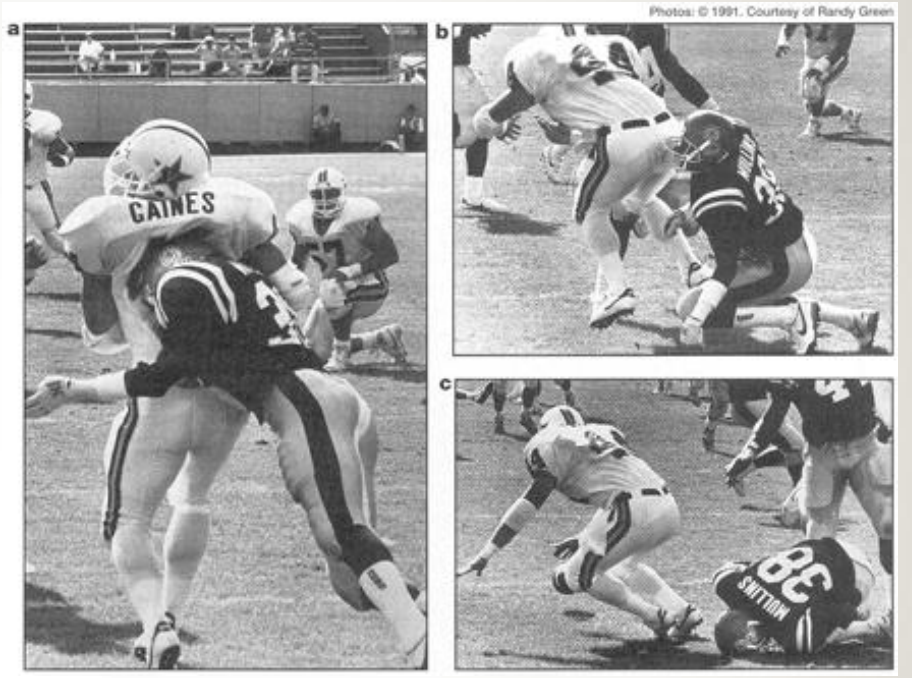


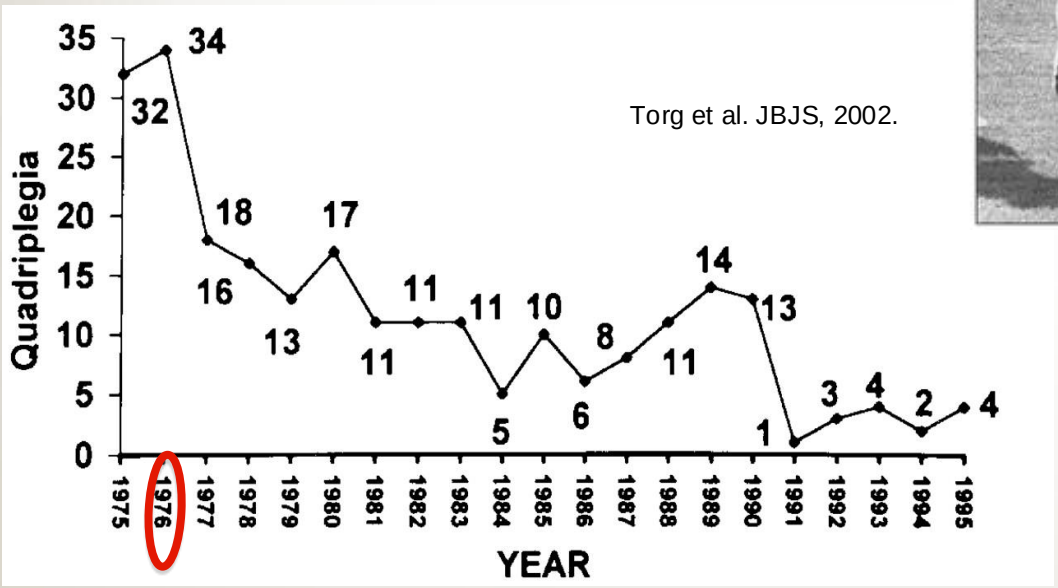


Kucera et al. NCCSIR, 2021.
Heck et al. JATA, 2004.
Cantu et al. Neurosurgery, 2003.
Torg et al. JBJS, 2002.
Torg et al. AJSM, 1975.

Spear Tackling

- Keys to further prevention
  - Renewed educational efforts
    - Ie. Teaching proper tackling techniques
  - Rule enforcement





Torg et al. JBJS, 2002.

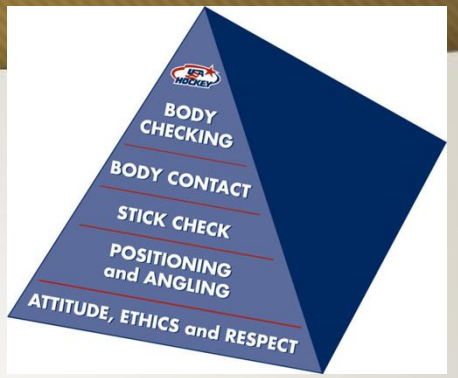
Obana et al. OJSM, 2021. (LOE 3)

Football: Targeting

- Concussions occur at higher rates in HS football compared with all other HS sports
- NFHS implemented rules defining illegal contact against a defenseless player above the shoulders (2014)
- National Electronic Injury Surveillance System (NEISS) data for HS football players 14 to 18 years old (2009-2019)
- A total of 4,983 (national estimate = 154,221) HS football concussions diagnosed in US ED's
  - 58.8% during competition & 41.2% during practice
  - Between 2009 and 2013…
    - the rate of concussions increased 10.7%
    - the rate of helmet-to-helmet concussions increased 17.6%
  - Between 2015 and 2019…
    - the rate of concussions decreased 6.2%
    - the rate of helmet-to-helmet concussions decreased 5.6%
  - There were no significant changes between other mechanisms of concussion before and after the 2014 rule implementation.

Ice Hockey: Body Checking

- Leading cause of injury
  - All injuries (RR 2.45); Concussion (OR 1.71)
    - Emery CA et al. Inj Prev, 2010.
- IRR: Checking vs Non-Checking League
  - Any injury (3.07), severe injury (3.30), any concussion (3.75), severe concussion (3.61)
    - Emery CA et al. JAMA, 2010. (LOE 2)
- Checking: Experience vs Novice
  - Emery CA et al. CMAJ, 2011. (LOE 2)
  - Overall injury/concussion rates similar for 1st time check pee-wee & 1st time check bantam
    - Learning to body check at a younger age does not reduce a player's odds of injury
      - Prolongs the athlete's exposure to risk



Body Checking Update

- Body Checking prohibited for players under age 13 & females
  - Hockey Canada 2013
  - USA Hockey 2022
    - USA Hockey strongly encourages competitive contact to occur in all age classifications as part of the skill progression that teaches body checking.
- Policy disallowing body checking was associated with 46% lower rate of game-related concussions (>4K Canadian players over 5 years)
  - Eliason et al. CJSM, 2023.
- Per 1000 player-hours, players (ages 13-14) in leagues without body checking had 4.3 fewer injuries and $1577 (Canadian) less total healthcare system costs
  - Currie et al. Int J Env Res Pub Health, 2021.

Ice Hockey: Fair Play Rules

- Target aggressive play & illegal hits
- Roberts et al. Arch Ped Adolesc Med, 1996.
  - 3-day, 31-game Junior Gold tournament (273 male, HS)
  - Points awarded or revoked based on sportsmanship & excessive penalties
  - Fourfold reduction in penalties & injuries
- Kriz et al. AJSM, 2019. (LOE 3)
  - Rhode Island HS boys' ice hockey implemented varying suspensions for players accumulating excessive penalty infraction minutes
  - Significant reduction in all injuries, concussion and combined concussion+upper body injury

Football: Kickoff Return

- Disproportionate number of catastrophic cervical and brain injuries during special team plays
  - Highest average rate concussion per play in NFL occurred on kickoffs (0.69/100 plays)
- Rule Change: NFL and NCAA moved the kickoff line 5 yards forward (2011)
- Definitive data on catastrophic injuries lacking

Football: Kickoff Return

- 7.51 fewer concussions (95% CI, −12.88 to −2.14) occurred for every 1000 kickoff plays after vs before the rule change. (NCAA Ivy League)
  - Wiebe et al. JAMA, 2018.
- Touchbacks and fair catches increased, but there was not a corresponding decrease in concussions as anticipated. (NCAA PAC-12)
  - Whelan et al. OJSM, 2023. (LOE 3)
- Reduced overall injuries but not head injuries (NFL)
  - Ruestow et al. J Occup Environ Hyg, 2015.

Football: Less Full Contact Practice

- Concussion & head impact exposure among college football players are disproportionately higher…
  - In preseason than regular season
  - In practices and not games
    - McCrea et al. JAMA Neurol, 2021. (LOE 2)
- Strategy without major modification to game play

Football: Less Full Contact Practice

- Concussion rates in Wisconsin HS football practice decreased by 57% in year after a rule change limiting the amount and duration of full-contact activities
  - No change in competition concussion rate
  - Pfaller et al. AJSM, 2019. (LOE 2)
- Decreased concussion rates in Michigan HS football practice x 3 years following rule change
  - Bretzin et al. JAT, 2022. (LOE 3)

Baseball: Pitch Counts

- 1st introduced 1996; elaborated upon multiple times since
- Combat throwing-related overuse injuries
  - Injury risk in a game increased 20% for every inning pitched and 10% for every 10 pitches thrown
    - Andrews et al. JOSPT, 1998.
  - 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
    - Olsen et al. AJSM, 2006.
  - Risk of shoulder/elbow surgery
    - > 80 pitches/game -- 4 times
    - > 8 months/year -- 5 times
    - Pitched fatigued -- 36 times
      - Olsen et al. AJSM, 2006.

Baseball: Pitch Counts

- UCL injuries in nonprofessional pitchers continue to rise
  - Hodgins et al. AJSM, 2016
  - Erickson et al. AJSM, 2015.

Ray TR. CSMR, 2010.

Youth Baseball Overuse Injuries

- Proper throwing biomechanics
- Arm fatigue
  - Age-specific pitch count & rest guidelines
  - Refrain from participating in…
    - Multiple leagues
    - Year-round baseball
    - Scouting showcases
- Pitch type ?

TABLE 2. Pitch count and days of rest by age group.

Age (yr)	2006 USA Baseball Guidelines	2010 Little League Baseball Regulations
	Pitch Count Limits	
17–18	NA	105·d^{-1}
15–16	NA	95·d^{-1}
13–14	75·game^{-1}	95·d^{-1}
	125·wk^{-1}	
	1000·season^{-1}; 3000·yr^{-1}	
11–12	75·game^{-1}	85·d^{-1}
	100·wk^{-1}	
	1000·season^{-1}; 3000·yr^{-1}	
9–10	50·game^{-1}	75·d^{-1}
	75·wk^{-1}	
	1000·season^{-1}; 2000·yr^{-1}	
7–8	NA	50·d^{-1}

Adequate Days of Rest

Age (yr)	Number of Pitches Thrown	Days of Rest
7–18	21–35 pitches	1 d
	36–50 pitches	2 d
	51–65 pitches	3 d
	66+ pitches	4 d

Baseball: Pitch Counts

- Why failing short?
- Erickson et al. OJSM, 2023.
  - 89% of players had at least 1 violation of the MLB Pitch Smart guidelines
  - 84% preseason violation, 14% in-season violation
  - Pitchers who threw with greater velocity were at higher risk for violation
- Zaremski et al. CJSM, 2023.
  - Non-compliance, Loopholes & Inconsistency across states
  - “Well-intentioned prevention policies; must entertain other potential risk factors beyond voluminous pitching practices.”

Success Stories

- Pole-Vaulting
  - Prior to 2003; Highest incidence of traumatic catastrophic injury and 2nd highest number of fatalities across HS and college sports
  - 2003: NCAA, NFHS, and USA Track & Field mandated new rules
    - 68% increase in the minimum landing pad dimensions behind the vault box & all hard surfaces adjacent to the landing pad removed or padded (minimum 2 inches dense foam)
  - Annual catastrophic injuries declined 88% from pre-rule (1986-2003) compared with post-rule (2003-2020)
  - Likely saved ~ 17 lives; No fatalities over the last 13 years

Boden et al. JBJS, 2023.
Boden et al. AJSM, 2012.
Boden at al. AJSM, 2001.

Boden et al. JBJS, 2023.
NCCSIR, 2022.
Yau et al. Sports Health, 2019.
Shields et al. JAT, 2009.

Success Stories

- Cheerleading
  - Rise of injuries early 2000s (majority = pyramid & basket toss)
  - 2006-2007: NFHS & USA Cheer implemented several safety measures
    - Eliminated performing the basket toss on any hardwood court unless it was on a mat (minimum thickness 1⅜ inches) and during the halftime or postgame and in an area free of obstruction
    - No basket toss during high-risk, quick timeouts
    - Mandated 2 spotters for each individual at the 2.5-person height in a pyramid in college cheerleading.
  - 63% overall reduction in the number of catastrophic basket toss injuries
  - No collegiate basket toss injuries reported since the rule change
  - Number of basket toss injuries declined in HS from 2007 to 2010, with no injuries over the last 11 years reported

Conclusion

- Rules play a critical role in imposing structure on sport competitions, thereby creating equitable and safe conditions
- Growing literature regarding the importance and efficacy of rule implementation in reducing sports-related injuries.
  - Importance of using objective data to guide additions or modifications of existing rules
- Requires enforcement, training and education for all participants and stakeholders
- Improved player health and safety requires regular evaluation and rule changes to evolve the game and increase player protections by eliminating potentially dangerous tactics and minimize risk

Thank You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