Sports Concussion Data, Gender and Concussion Treatment Paths

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Concussion Studies Show Girls Are More Vulnerable

By ALAN SCHWARTZ

WEST HARTFORD, Conn., Sept. 24 — Despite the mandate that girls could no longer play in the living room, in the chair in which she tried to read but could not remember a wedding anniversary when she was playing high school basketball, knapsacked beneath her helmet, knobby elbows and dizziness and sometimes her entire body, Schubert took the ball and played football. She thought they were football players, women playing football. She thought they were football players, and she was right. The women's football team is the first to be founded in the United States, the first to be founded in the world. The study, conducted by researchers at Ohio State University, the University of Wisconsin, and the University of Connecticut, found that girls are more vulnerable to concussions than boys. The study, conducted by researchers at Ohio State University, the University of Wisconsin, and the University of Connecticut, found that girls are more vulnerable to concussions than boys. The study, conducted by researchers at Ohio State University, the University of Wisconsin, and the University of Connecticut, found that girls are more vulnerable to concussions than boys. The study, conducted by researchers at Ohio State University, the University of Wisconsin, and the University of Connecticut, found that girls are more vulnerable to concussions than boys. The study, conducted by researchers at Ohio State University, the University of Wisconsin, and the University of Connecticut, found that girls are more vulnerable to concussions than boys.
CONCUSSIONS
Is Football Too Dangerous?

Parents, kids, even schools themselves have been slow to recognize the terrible health risks posed by head injuries from high school football

BY BOB MEADOWS

His eyes glued to the football, Alex Zordich never saw the other player. Helmetless during a drill last June at a Penn State University football camp, Alex reached low to intercept the pass, and his head crashed into someone’s knee. Sprawled on the ground, the 6’3” sophomore at Cardinal Mooney High School in Youngstown, Ohio, immediately knew he had suffered a concussion—it was the same injury that had forced him to miss his entire eighth grade season. “My head was pounding, my vision was blurry,” says Alex, 16, who usually plays quarterback and whose dad, Michael, was an NFL defensive back for 12 seasons. “I just thought I better sit out for a while.”

Alex has since completely recovered, but concussions—when the brain crashes into the skull after a jarring impact—will sideline at least 67,000 of the 1.2 million high school football players this fall, including hundreds who will suffer dizziness, shurred speech and confusion. In the long term concussions can cause extended memory loss, depression and other symptoms of brain dysfunction. Even more alarming, while other serious injuries have declined in the past 10 years, the percentage of injuries that are concussions has nearly doubled, according to a July study by the Center for Injury...
High school athletes face serious concussion risks

By Janice Lloyd
USA TODAY

When high school athletes suffer concussions, as many as 40-50% return to action prematurely and set themselves up for more severe injuries, new research shows.

The study from the Center for Injury Research and Policy at Nationwide Children's Hospital in Columbus, Ohio, adds fuel to growing concerns about the long-term side effects of concussions. It also shines new light on inadequately trained personnel on the sidelines unprepared to make accurate diagnoses and informed decisions about sending players back on the field.

"We find these numbers about athletes returning to play prematurely, alarming," says Dawn Comstock, the study’s director of research.

Concussions account for almost one in 10 sports injuries, according to the Centers for Disease Control and Prevention, and for young people ages 15-24, sports are second only to motor vehicle accidents as the leading cause of brain injury. Comstock estimated that more than 130,000 concussions occurred in nine sports last year, adding that those are "conservative estimates" that do not include some sports.

About 3.8 million students competed in those sports. The most concussions occurred in football and boys' and girls' soccer.

The statistic most troubling to Comstock: 16% of football players reported returning to play the same day they lost consciousness. An athlete is advised not to return to the same day after losing consciousness in guidelines created by an international panel of experts in 2003.

Young athletes, whose brains and skulls are immature, risk death or additional concussions by going back too soon. Recurrent concussions also have led to depression and early dementia, according to studies on retired NFL players. All concussions require evaluation by a medical doctor.

In rare instances, the danger with a concussion can lead to death from second impact syndrome (SIS), a condition in which the brain swells, shutting down the brain stem and resulting in respiratory failure. In North Carolina last year, two high school football players died from SIS. Both returned to play within two days of getting a concussion. Three other football players died from brain injuries, and 14 high school football players died overall, says the Annual Survey of Football Injury Research.

The National Federation of State High School Associations has reviewed the new data from Comstock and is sending a revised concussion pamphlet to state federations before the end of the school year, says the federation's Bob Colgate.

"We’re trying to keep this a front-burner issue," Colgate says. "Kids are still getting in and playing with head injuries."

The pamphlet is directed at coaches, the people most often responsible for the welfare of athletes. Colgate says. Only 42% of high schools have athletic trainers. Kevin Guskiewicz, a former athletic trainer for the Pittsburgh Steelers, belongs to the National Athletic Trainers Association and is chair of the sports science department at the University of North Carolina.

"If we cannot put the appropriate medical personnel on the sidelines, such as certified athletic trainers, schools should consider dropping contact or high-risk sports," he says. "People have said we’re overreacting, but if you’re involved in the mismanagement of these kids and listen to their families, you quickly realize the importance of quality care."
Reducing the number of concussions in high school girls’ soccer is a daunting task

By Chelsea Janes, Published: April 24

Tori Bellucci steadied her balance, dizzy by climbing a flight of stairs at Huntington High in 2012. She couldn’t remember the next class on her schedule — one she’d had for two months — so she ducked into the bathroom to take a look at her schedule.

Math. Of course.

In the days after she suffered her third concussion on the soccer field in the fall of 2012, doubts, fears and confusion joined the aches inside Bellucci’s skull.

“It changes the way you think and feel,” Bellucci, now 18, said. “I was just like really sad, really kind of desperate type of feeling. I couldn’t do anything because of my head, so I would just be in my room with the shades drawn. I was like, ‘I don’t want to live like this anymore.’ ”

By the time her high school and club soccer careers ended in 2013, Bellucci, an All-Met, had suffered five concussions. And the effects knocked her priorities into perspective. She walked away from the game she loved, turning down a scholarship to play at Towson, because for her, playing soccer wasn’t worth all the hours spent in rooms with lights and screens off and her memory sputtering.

Bellucci is one of thousands of female soccer players with similar experiences. According to High School RIO (reporting information online), an injury surveillance system built by Dr. Dawn Comstock of the Colorado School of Public Health, only football and boys’ hockey players report concussions at a higher rate than girls’ soccer players. Since 2008, high school girls’ soccer players have reported an average of 14 concussions per 10,000 games played (a game is equal to one game played by one player). The figure is nearly twice the average for boys’ soccer (7.30), and only football (27) and boys’ hockey (18) have reported more concussions than girls’ soccer.

Searching for answers

As defined by the National Athletic Trainers’ Association, a concussion is a “trauma-induced alteration in mental status that may or may not involve loss of consciousness,” and results from “the
White House Healthy Kids and Safe Sports Concussion Summit – 5/29/14
Why am I here today

- “There is a very definite brain injury due to single or repeated blows on the head or jaw which cause multiple concussion hemorrhages. ... The condition can no longer be ignored by the medical profession or the public.”
  – JAMA, Oct 13, 1928

Why are we still struggling with sports-related concussion diagnosis, management, and prevention in 2015? Why has work on return to learn lagged behind work on return to play?
Epidemiology of Sports and Recreation Related Concussion

• Epidemiology = the study of the distribution and determinants of health-related states or events in specified populations and the application of this study to the control of health problems
  – Data driven decisions
  – Relies on systematic and unbiased collection, analysis, and interpretation of data
  – Concussion is NOT just a sports problem!
Concussions Publications Growing Rapidly

PubMed Keyword Search Results

- Number of Publication vs. Year

- Year: 1843 to 2014

- Publication Growth over Time
Alarming News over past 5-10 Years

- Concussion epidemic = concussion crisis
  - Dramatic underreporting
  - Significantly increasing rates
  - Persistent symptoms
- Severe outcomes
  - Second impact syndrome
  - CTE
  - Dementia
  - Depression
- Confusion
  - Helmets all the same vs. some helmets better than others?
  - Best clinical practices for managing recovery and return to play?
- Lack of knowledge
  - Lack of objective, accurate, and conclusive diagnostic tools
  - Lack of primary prevention programs
Data is Crucial

• The best decisions are evidence-based

• People like using data
  – Policy makers
  – Physicians
  – Coaches
  – Parents
  – Manufacturers and marketers
  – Etc.

• Where do we get sports data?
  – Participation numbers?
  – Injury reports?
  – Exposure reports?
  – Information on potential risk or protective factors?
Current Sources of Sports-Related TBI Epidemiologic Data

• 2013 IOM Report
  – “The National Collegiate Athletic Association Injury Surveillance System and High School RIO™ (Reporting Information Online) data systems are the only ongoing, comprehensive sources of sports-related injury data, including data on concussions, in youth athletes.” p. 6
  – “Currently most of the reported epidemiologic data on sports-related concussions in youth come from three surveillance systems…” p. 23
    • “National Electronic Injury Surveillance System – All Injury Program (NEISS-AIP)
    • NCAA Injury Surveillance System (NCAA ISS)
    • High School RIO™ (Reporting Information Online)”
High School RIO (05/06-current)

• National High School Sports-Related Injury Surveillance System (High School RIO)
  – Athletic Trainers from U.S. high schools report injuries
  – Internet-based data collection tool (RIO): 24/7 and updatable

• Definitions
  – Injury: 1) occurred as result of organized high school practice or competition, AND 2) required medical attention by a team physician, certified athletic trainer, personal physician, or emergency department/urgent care facility, AND 3) resulted in restriction of the high school athlete’s participation for ≥1 days beyond the day of injury OR any concussion, fracture, dental injury, or heat event
  – Athletic exposure (AE): one athlete participating in one competition or practice
High School RIO Data

• ATs asked to log on weekly throughout each academic year to provide data

• Exposure data
  – Practice AEs
  – Competition AEs

• Injury data
  – Athlete: height, weight, year in school, position, etc.
  – Injury: body site, diagnosis, severity, etc.
  – Injury event: mechanism, specific activity, etc.
High School RIO Dataset

• Injury data captured 05/06 through 14/15
  – >65,000 injuries
  – >35,000,000 AE
  – 2.00 injuries per 1,000 AE

• Injury by type of exposure
  – About half of all injuries occur in practice
  – Rates of injury are significantly higher in competition compared to practice
# Sports Included in High School RIO

<table>
<thead>
<tr>
<th>Boys’ Sports</th>
<th>Years Studied</th>
<th>Girls’ Sports</th>
<th>Years Studied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseball</td>
<td>10</td>
<td>Basketball</td>
<td>10</td>
</tr>
<tr>
<td>Basketball</td>
<td>10</td>
<td>Cross Country</td>
<td>3</td>
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<tr>
<td>Cross Country</td>
<td>3</td>
<td>Field Hockey</td>
<td>7</td>
</tr>
<tr>
<td>Football</td>
<td>10</td>
<td>Gymnastics*</td>
<td>4</td>
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<tr>
<td>Ice Hockey</td>
<td>7</td>
<td>Lacrosse</td>
<td>7</td>
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<tr>
<td>Lacrosse</td>
<td>7</td>
<td>Softball</td>
<td>10</td>
</tr>
<tr>
<td>Soccer</td>
<td>10</td>
<td>Soccer</td>
<td>10</td>
</tr>
<tr>
<td>Swimming</td>
<td>7</td>
<td>Swimming</td>
<td>10</td>
</tr>
<tr>
<td>Tennis</td>
<td>1</td>
<td>Tennis</td>
<td>1</td>
</tr>
<tr>
<td>Track</td>
<td>7</td>
<td>Track</td>
<td>10</td>
</tr>
<tr>
<td>Volleyball+</td>
<td>3</td>
<td>Volleyball</td>
<td>10</td>
</tr>
<tr>
<td>Wrestling</td>
<td>10</td>
<td>Cheerleading*</td>
<td>6</td>
</tr>
</tbody>
</table>

*Sports no longer under surveillance  * Co-Ed sport although predominantly female participants
# Changing Injury Patterns

<table>
<thead>
<tr>
<th>Injury rates per 1,000 AE</th>
<th>2005/06</th>
<th>2013/14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>4.36</td>
<td>3.74</td>
</tr>
<tr>
<td>Boys’ Soccer</td>
<td>2.43</td>
<td>1.62</td>
</tr>
<tr>
<td>Girls’ Soccer</td>
<td>2.36</td>
<td>2.47</td>
</tr>
<tr>
<td>Girls’ Volleyball</td>
<td>1.64</td>
<td>0.99</td>
</tr>
<tr>
<td>Boys’ Basketball</td>
<td>1.89</td>
<td>1.45</td>
</tr>
<tr>
<td>Girls’ Basketball</td>
<td>2.01</td>
<td>1.88</td>
</tr>
<tr>
<td>Boys’ Wrestling</td>
<td>2.50</td>
<td>2.48</td>
</tr>
<tr>
<td>Boys’ Baseball</td>
<td>1.19</td>
<td>1.01</td>
</tr>
<tr>
<td>Girls’ Softball</td>
<td>1.13</td>
<td>0.99</td>
</tr>
</tbody>
</table>
# Changing Injury Patterns

## Most Common Injuries

<table>
<thead>
<tr>
<th>Body Sites</th>
<th>2005/06</th>
<th>2013/14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle</td>
<td>22.7%</td>
<td>16.9%</td>
</tr>
<tr>
<td>Head/Face</td>
<td>12.3%</td>
<td>25.3%</td>
</tr>
<tr>
<td>Knee</td>
<td>14.2%</td>
<td>14.4%</td>
</tr>
<tr>
<td>Diagnoses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strain/Sprain</td>
<td>52.0%</td>
<td>41.7%</td>
</tr>
<tr>
<td>Concussion</td>
<td>9.1%</td>
<td>21.9%</td>
</tr>
<tr>
<td>Fracture</td>
<td>9.8%</td>
<td>7.6%</td>
</tr>
</tbody>
</table>
High School RIO Concussion Data

• Concussion data captured 05/06 through 14/15
  – 12,036 concussions
  – 35,581,036 AE
  – 3.38 concussions per 10,000 AE

• Detailed data captured on injured athlete, injury, and injury event
Epidemiology of Sports Concussion

• Concussion rates and patterns vary by level/intensity of play
• Concussion rates and patterns vary by sport
• Concussion rates and patterns vary by gender
• Concussion rates have increased over time
• Athlete reporting has changed over time
• Clinical management has changed over time
• Jury largely still out on pre-existing conditions
• Management strategies vary
Examples from High School RIO

- Concussion data captured 05/06 through 14/15
  - 12,036 concussions
  - 35,581,036 AE
  - 3.38 concussions per 10,000 AE

- Injury by type of exposure
  - 63.5% competition related
    - Competition rate 8.44 per 10,000 AE
    - Practice rate 1.66 per 10,000 AE
    - $RR=5.08$
## Concussion Rates in High School and Collegiate Athletes, 2009/10-2013/14

<table>
<thead>
<tr>
<th>Sport</th>
<th>Rate per 10,000 AEs HS</th>
<th>Rate per 10,000 AEs NCAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>9.4</td>
<td>6.7</td>
</tr>
<tr>
<td>Male Ice Hockey</td>
<td>7.4</td>
<td>7.9</td>
</tr>
<tr>
<td>Female Soccer</td>
<td>6.3</td>
<td>6.3</td>
</tr>
<tr>
<td>Wrestling</td>
<td>4.4</td>
<td>10.9</td>
</tr>
</tbody>
</table>
Differences in Outcomes by Age

- NCAA ISP and High School RIO data
  - 2005/06-2008/09
  - Soccer, basketball, and baseball/softball

- Concussions
  - NCAA ISP: 6.6% of all injuries, rate 3.6 per 10,000AE
  - HS RIO: 9.1% of all injuries, rate 2.2 per 10,000AE
  - RR=1.64 (95% CI: 1.47-1.79)

- Concussion outcomes
  - NCAA ISP: 54.8% RTP in 1-6 days, 1.5% MDQ
  - HS RIO: 34.6% RTP in 1-6 days, 3.1% MDQ
Epidemiology of Sports Concussion

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## Concussion Rates per 10,000 AEs: 2013/14

<table>
<thead>
<tr>
<th>Sport</th>
<th>Competition</th>
<th>Rank</th>
<th>Practice</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football</td>
<td>33.2</td>
<td>1</td>
<td>5.5</td>
<td>1</td>
</tr>
<tr>
<td>Boys’ Ice Hockey</td>
<td>23.7</td>
<td>2</td>
<td>1.7</td>
<td>7</td>
</tr>
<tr>
<td>Girls’ Soccer</td>
<td>19.9</td>
<td>3</td>
<td>2.6</td>
<td>4</td>
</tr>
<tr>
<td>Boys’ Wrestling</td>
<td>12.5</td>
<td>4</td>
<td>3.5</td>
<td>2</td>
</tr>
<tr>
<td>Boys’ Lacrosse</td>
<td>12.3</td>
<td>5</td>
<td>1.6</td>
<td>8</td>
</tr>
<tr>
<td>Girls’ Basketball</td>
<td>12.0</td>
<td>6</td>
<td>1.2</td>
<td>11</td>
</tr>
<tr>
<td>Boys’ Soccer</td>
<td>9.1</td>
<td>7</td>
<td>0.9</td>
<td>13</td>
</tr>
<tr>
<td>Girls’ Field Hockey</td>
<td>7.6</td>
<td>8</td>
<td>1.0</td>
<td>12</td>
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<tr>
<td>Girls’ Lacrosse</td>
<td>6.9</td>
<td>9</td>
<td>2.2</td>
<td>5</td>
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<tr>
<td>Girls’ Volleyball</td>
<td>5.5</td>
<td>10</td>
<td>1.7</td>
<td>6</td>
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<tr>
<td>Boys’ Basketball</td>
<td>4.0</td>
<td>11</td>
<td>1.2</td>
<td>10</td>
</tr>
<tr>
<td>Girls’ Softball</td>
<td>3.2</td>
<td>12</td>
<td>1.5</td>
<td>9</td>
</tr>
<tr>
<td>Cheerleading*</td>
<td>1.8</td>
<td>13</td>
<td>3.4</td>
<td>3</td>
</tr>
</tbody>
</table>

*Competition includes competition and performance
Gender Differences by Age Group

• In gender comparable sports females have higher rates of concussion than males
  – HS RIO and NCAA ISP data 2005/06-2008/09
    • HS: RR=1.3, p<0.001
    • NCAA: RR=1.3, p<0.001
• Females had longer RTP than males
  – HS ≥22 days: girls 12.0%, boys 7.6%
  – NCAA ≥22 days: women 6.0%, men 4.1%
• After controlling for symptom resolution time, HS girls were more likely to miss ≥22 days or be medically disqualified than boys
Epidemiology of Sports Concussion

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Change in Concussion Rates Over a Decade

Concussion Rates per 10,000 AE

- Competition
- Overall
- Practice

Year:
- 2005/06
- 2006/07
- 2007/08
- 2008/09
- 2009/10
- 2010/11
- 2011/12
- 2012/13
- 2013/14
- 2014/15

Colorado School of Public Health
What has Driven Trends?

- Huge media focus on concussions
  - Culture shift in coverage by media
  - Tons of media coverage
  - Adoption of new terminology
  - Spread of catchphrases
  - Distribution of education

- Huge educational efforts

- State level concussion legislation
  - WA 1st in 2009
  - MS last
Epidemiology of Sports Concussion

- Concussion rates and patterns vary by level/intensity of play
- Concussion rates and patterns vary by sport
- Concussion rates and patterns vary by gender
- Concussion rates have increased over time
- **Athlete reporting has changed over time**
- Clinical management has changed over time
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- Management strategies vary
### Trends in Symptoms Reported by Athletes

#### % of HS Student Athletes Presenting with Symptom

<table>
<thead>
<tr>
<th>Symptom</th>
<th>07/08</th>
<th>08/09</th>
<th>09/10</th>
<th>10/11</th>
<th>11/12</th>
<th>12/13</th>
<th>13/14</th>
<th>14/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amnesia</td>
<td>23.9</td>
<td>24.9</td>
<td>21.4</td>
<td>22.1</td>
<td>16.9</td>
<td>15.6</td>
<td>14.1</td>
<td>11.2</td>
</tr>
<tr>
<td>Concentration Difficulty</td>
<td>59.4</td>
<td>56.4</td>
<td>53.3</td>
<td>59.6</td>
<td>58.6</td>
<td>60.2</td>
<td>57.9</td>
<td>58.1</td>
</tr>
<tr>
<td>Confusion/Disorientation</td>
<td>50.2</td>
<td>46.7</td>
<td>43.4</td>
<td>45.3</td>
<td>43.4</td>
<td>44.1</td>
<td>39.3</td>
<td>37.9</td>
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<tr>
<td>Dizziness/unsteadiness</td>
<td>83.7</td>
<td>76.3</td>
<td>75.2</td>
<td>77.6</td>
<td>75.0</td>
<td>74.7</td>
<td>74.1</td>
<td>75.4</td>
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<td>Drowsiness</td>
<td>32.1</td>
<td>27.6</td>
<td>30.2</td>
<td>32.5</td>
<td>33.9</td>
<td>33.5</td>
<td>31.4</td>
<td>34.7</td>
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<td>Headache</td>
<td>94.6</td>
<td>94.2</td>
<td>94.2</td>
<td>94.6</td>
<td>95.3</td>
<td>94.5</td>
<td>94.8</td>
<td>95.4</td>
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<td>Irritability</td>
<td>8.8</td>
<td>9.6</td>
<td>10.0</td>
<td>10.5</td>
<td>11.0</td>
<td>10.6</td>
<td>12.6</td>
<td>14.1</td>
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<tr>
<td>Light Sensitivity/Visual Disturbance</td>
<td>35.1</td>
<td>38.3</td>
<td>34.1</td>
<td>38.9</td>
<td>42.4</td>
<td>46.1</td>
<td>49.7</td>
<td>52.3</td>
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<tr>
<td>LOC</td>
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<td>4.1</td>
<td>3.8</td>
<td>3.3</td>
<td>3.5</td>
<td>2.3</td>
<td>2.4</td>
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<td>Noise Sensitivity</td>
<td>12.0</td>
<td>19.5</td>
<td>16.9</td>
<td>24.4</td>
<td>25.4</td>
<td>30.8</td>
<td>32.5</td>
<td>33.7</td>
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<td>Nausea</td>
<td>35.5</td>
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<td>29.0</td>
<td>32.2</td>
<td>31.0</td>
<td>30.5</td>
<td>29.7</td>
<td>30.6</td>
</tr>
</tbody>
</table>
Epidemiology of Sports Concussion

- Concussion rates and patterns vary by level/intensity of play
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- Management strategies vary
# Symptom Resolution

% of HS Student Athletes With All Symptoms Resolved

<table>
<thead>
<tr>
<th></th>
<th>07/08</th>
<th>08/09</th>
<th>09/10</th>
<th>10/11</th>
<th>11/12</th>
<th>12/13</th>
<th>13/14</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt; 1 Day</strong></td>
<td>30.5</td>
<td>24.8</td>
<td>24.5</td>
<td>18.4</td>
<td>12.9</td>
<td>13.0</td>
<td>9.3</td>
</tr>
<tr>
<td><strong>Within 1 Week</strong></td>
<td>52.7</td>
<td>54.7</td>
<td>53.4</td>
<td>54.9</td>
<td>46.3</td>
<td>44.0</td>
<td>48.9</td>
</tr>
<tr>
<td><strong>&gt;21 Days</strong></td>
<td>1.4</td>
<td>1.7</td>
<td>2.7</td>
<td>2.8</td>
<td>7.8</td>
<td>5.4</td>
<td>6.9</td>
</tr>
</tbody>
</table>
**Return to Play Time**

% of HS Student Athletes in Each Category of RTP

<table>
<thead>
<tr>
<th></th>
<th>07/08</th>
<th>08/09</th>
<th>09/10</th>
<th>10/11</th>
<th>11/12</th>
<th>12/13</th>
<th>13/14</th>
<th>14/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 day</td>
<td>7.9</td>
<td>2.6</td>
<td>1.5</td>
<td>0.8</td>
<td>1.8</td>
<td>0.6</td>
<td>0.9</td>
<td>1.7</td>
</tr>
<tr>
<td>1-2 days</td>
<td>6.7</td>
<td>6.4</td>
<td>4.0</td>
<td>2.4</td>
<td>1.9</td>
<td>0.8</td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>3-6 days</td>
<td>21.4</td>
<td>19.5</td>
<td>17.9</td>
<td>12.9</td>
<td>9.0</td>
<td>8.3</td>
<td>7.6</td>
<td>7.0</td>
</tr>
<tr>
<td>Season DQ</td>
<td>2.8</td>
<td>3.6</td>
<td>4.6</td>
<td>4.1</td>
<td>4.4</td>
<td>3.0</td>
<td>2.6</td>
<td>2.4</td>
</tr>
<tr>
<td>Career DQ</td>
<td>0.2</td>
<td>0.1</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Season ended</td>
<td>0.8</td>
<td>0.1</td>
<td>8.7</td>
<td>12.2</td>
<td>14.2</td>
<td>14.5</td>
<td>14.0</td>
<td>15.8</td>
</tr>
<tr>
<td>Athlete quit</td>
<td>0.4</td>
<td>1.4</td>
<td>1.2</td>
<td>1.4</td>
<td>1.9</td>
<td>1.9</td>
<td>2.7</td>
<td>1.9</td>
</tr>
</tbody>
</table>

*Colorado School of Public Health*
Epidemiology of Sports Concussion

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Outcomes of Sports Concussion

• What influences outcomes?
• Jury largely still out on many pre-existing conditions due to inconsistent results although evidence is mounting for some
  – History of prior concussion
  – Migraine history/Family migraine history
  – ADD/ADHD
  – Mood disorders
  – Etc.
Risk Factor: Medical History?


- **Methods**
  - Cohort study (n=596) administering ImPACT at baseline, 3 days and 8 days post concussion in athletes with 0, 1, 2, and ≥3 prior concussions. Repeated-measures analyses of covariance (age=covariate).

- **Results**
  - Concussed athletes with ≥3 prior concussions were still impaired 8 days post concussion on verbal memory (p<0.001), reaction time (p<0.001), and migraine-cognitive-fatigue symptoms (p<0.001).
  - Concussed athletes with history of ≥3 prior concussions take longer to recover than athletes with 1 or no previous concussion.

- **Methods**
  - Qualitative review of concussion literature with a focus on prognostic factors and specific groups including children and females was conducted using PubMed, MEDLINE, and SportsDiscus databases.

- **Results**
  - Number and severity of symptoms and prior concussion history are associated with prolonged recovery and/or increased risk of complications.
  - Children generally take longer to recover from concussions.
  - Currently there are insufficient data on the influence of genetics and gender on outcomes following concussion.
Risk Factor: Medical History?


• **Methods**
  – Cohort study of 296 student athletes with SRC with 1 day post injury symptoms of migraine (52), headache (176), and no headache (68) who were evaluated at time of injury and 1, 2, 3, 5, 7, and 90 days post event.

• **Results**
  – Student athletes with posttraumatic migraine experienced greater symptom severity scores than those with headache or no headache at time of injury and through day 7 post injury.
  – There were no group differences on balance performance or cognitive testing over time.
  – Females were 2.13 times more likely to report posttraumatic migraine
  – Posttraumatic migraine characteristics are related to prolonged symptom recovery after SRC.
Risk Factor: Medical History?

**ADHD**

  - Large retrospective study (6,529 athletes 13 – 19 years of age completed preseason health survey) found boys and girls with ADHD were significantly more likely to report a history of concussion.

  - 6,636 young athletes underwent baseline ImPACT testing (90 self-reported LD only, 262 self-reported ADHD only, 55 both). Pairwise matched comparison found athletes with ADHD and/or LD have lower baseline ImPACT neurocognitive scores compared with athletes without ADHD and LD.
Risk Factor: Medical History?


• Methods
  – Retrospective case control study of ImPACT scores of 70 high school athletes with self-reported ADHD and randomly selected age-matched controls.

• Results.
  – Although high school athletes with ADHD had a longer average time to recovery (16.5 days) compared to controls (13.5 days) the difference was not statistically significant.
  – The number of previous concussions did not have any effect on rate of recovery in the ADHD or control group.
Risk Factor: Medical History?


- **Methods**
  - Concussion clinic retrospective case-control study in athletes 9-18yrs.
  - 40 cases with PCS (persistent symptoms 3 months post SRC) age and sex matched to 80 controls (symptoms resolved within 3 weeks of SRC).

- **Results**
  - Logistic regression analysis: strong predictors of PCS included **concussion history** (OR 1.8, 95% CI 1.1-2.8, p=0.016), **pre-injury mood disorders** (OR 17.9, 95% CI 2.9-113.0, p=0.002), **family history of mood disorders** (OR 3.1, 95% CI 1.1-8.5, p=0.026), and delayed symptom onset (OR 20.7, 95% CI 3.2-132.0, p<0.001).
  - Other factors that increased likelihood of PCS included significant life stressors, other **psychiatric illness**, and **migraine**.
  - Race, insurance status, BMI, sport helmet use, medication use, and type of symptom endorsement were not predictive of PCS.
Risk Factor: Medical History?


**Methods**
- Position statement based on literature review and best practice standards.

**Results**
- A history of concussion is associated with a higher risk of sustaining another concussion.
- A greater number, severity and duration of symptoms after a concussion are predictors of a prolonged recovery.
- Youth athletes may have a more prolonged recovery and are more susceptible to a concussion accompanied by a catastrophic injury.
- Preinjury mood disorders, learning disorders, attention-deficit disorders (ADD/ADHD) and migraine headaches complicate diagnosis and management of a concussion.
Epidemiology of Sports Concussion

• Appear to be associated with worse outcomes but are they actually risk factors for concussion?
  – History of prior concussion
  – Migraine history/Family migraine history
  – ADD/ADHD
  – Mood disorders
  – Etc.

• Do individuals with these issues actually sustain concussions at higher rates than individuals without these issues?
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Management

- Physical rest vs. physical therapy
- Cognitive rest vs. rehab
- Medications/Supplements/Nutrition?
- Hyperbaric therapy?
- Academic accommodations
- Mental health care
Prevention is Always Better than Treatment

• Primary prevention
  – Prevent concussion injuries from occurring in the first place
• Secondary prevention
  – Identify, diagnose, and report concussion injuries early and manage them appropriately to return the athlete to pre-injury health as quickly as possible
• Tertiary prevention
  – Prevent or minimize long-term negative effects of concussion and reduce risk of re-injury
The goal for all of us is to keep our kids as safe as possible while they participate in sports and recreational activities so they can play more and spend less time sidelined with injury!
“… and it did a world of good which never became manifest”
Charles Dickens, A Tale of Two Cities