

Colorado School of **Public Health**

## Youth Sports-Related Concussion Prevention

R. Dawn Comstock, PhD  
Associate Professor, Epidemiology  
Colorado School of Public Health  
University of Colorado Anschutz Medical Campus

Nov 6, 2014

UNIVERSITY OF COLORADO | COLORADO STATE UNIVERSITY | UNIVERSITY OF NORTHERN COLORADO

## Today's Objectives

- Introductions
- Review current concussion knowledge
  - Diagnosis
  - Management
- Review epidemiology of sports-related concussion
  - Rates and patterns
    - *Across sports and age groups*
- Discuss concussion prevention

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## Injury Epidemiology

- Describe determinants and distributions of injury in the population of interest
- Drive evidence-based injury prevention efforts
- Evaluate the effectiveness of prevention efforts
- Monitor trends over time
  
- Workplace safety successes
- Automobile safety successes
- Home safety successes

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## Home Safety Quiz

- Think about your home
  - Smoke alarms?
  - CO detectors?
  - First aid kit?
  - Family emergency “rally point”?
  - Safe shelter spot for tornado?

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## Workplace/School Safety Quiz

- Think about your workplace/school
  - Two nearest fire escape routes?
  - First aid kit?
  - AED?
  - Tornado shelter, earthquake response plan, or flood/hurricane evacuation plan?
  - Plan for armed aggressor?

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## Sports Injury Epidemiology Research

- Proven public health methodologies can improve athlete health and safety
  - Describe rates and patterns of injury
  - Monitor trends over time
  - Compare subgroups of interest
  - Contribute to evidence-based policy discussions
  - Drive the development of interventions
  - Evaluate the effectiveness of interventions
- Change the culture regarding sports injuries
  - Not “just part of the game”
  - Not “the price you have to pay to play”

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## Youth Sports Safety Quiz

- Youth sports risks?
  - Sports with highest rates of injury?
  - Injury patterns by sport?
  - Factors that place athletes at risk or are protective?
- Youth sports safety
  - Coach?
    - *Certification, education, experience*
  - Equipment and facilities?
    - *In good repair, appropriate for sport, adequate*
  - Medical resources?
    - *Level of clinician, level of coverage, and level of coordination*
  - Emergency plan?
    - *Who makes the call (removing an athlete from play)*
    - *Who makes the call (activating EMS)*

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## Why Talk About Concussions Today?

- EVERYBODY seems to be talking about concussions!
  - Clinicians
  - Public health professionals
  - Researchers
  - Media
  - Sports policy makers/governing bodies
  - Grassroots organizations
  - Coaches
  - Parents
  - Athletes
  - Legislators

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# New York Times - 2007

"All the News That's Fit to Print"

## The New York Times

VOL. CLVII No. 54,085 TUESDAY, OCTOBER 2, 2007

### Concussion Studies Show Girls Are More Vulnerable

By ALAN SCHWARTZ

WEST HARTFORD, Conn. — While the effects can be — it changes how the brain works. White football does have the most concussions, but girls' high school athletes are more than twice as likely to be hospitalized for concussions, studies show.

It is thought that girls are more vulnerable to concussions because their brains are smaller and their necks are weaker than boys'. Girls also consistently took longer for their symptoms to resolve and to return to play.



A concussion that she says she had while playing football for her high school team in West Hartford, Conn.

### Note From Jury Foreshadows Verdict Against Knicks Coach

By LYNN ZINBERG

A jury indicated yesterday that Madison Square Garden and its coach, Jeff Van Gundy, were liable for the concussion suffered by a player last season in April.



President Vladimir V. Putin yesterday at the congress of United Russia, his country's top party.

### Write-Downs By Big Banks Spark a Rally

By ERIC DAMEL

Wall Street's banking giants started yesterday to admit their problems, which helped lift the stock market to a record high.

### Putin Looks to Premier's Office As Way to Keep Hold on Power

By C. J. CHIVERS

MOSCOW, Oct. 1 — President Vladimir V. Putin, who is to be re-elected in May, is looking to the premier's office as a way to keep hold on power.

### SECURITY FIRM HID SHOOTINGS, COMMITTEE SAYS

### STATE DEPT. CRITICIZED

Victims' Families Were Paid Off, House Panel Report Charges

By JOHN M. BRODER

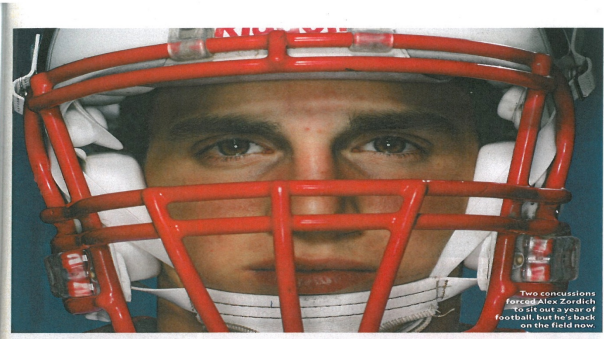
WASHINGTON, Oct. 1 — In a process of blackmailing the FBI, the State Department hid the details of a shooting in a Washington, D.C., office.

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Photographs by ANDREW BRUSSO

PEOPLE October 8, 2007 107

# People - 2007



Two concussions forced Alex Zordich to sit out a year of football, but he's back on the field now.

## 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 concus-

sion—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, slurred 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

# Time - 2009

## Life

SPORT HOME SHOPPING NERD WORLD

After Feb. 17, do not attempt to adjust your television. It won't need you anymore  
NERD WORLD, PAGE 68



### SPORT Hard Knocks. How to keep high school kids with concussions on the bench

BY SEAN GREGORY

TOO MANY KIDS ARE RETURNING to the playing field too soon after a concussion. How many? According to an alarming new study, from 2005 to 2008, 41% of concussed athletes in 100 high schools across the U.S. returned to play too soon, under guidelines set out by the American Academy of Neurology. The 11-year-old guidelines say, for example, that if an athlete's concussion symptoms, such as dizziness or nausea, last longer than 15 minutes, he should be benched until he's been symptom-free for a week. The most startling data point—uncovered by the same researchers who in 2007

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# USA Today - 2009

USA TODAY - TUESDAY, MAY 5, 2009 / 7D

## High school athletes face serious concussion risks

By Janice Lloyd  
USA TODAY

When high school athletes suffer concussions, as many as 40.3% 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 tremendously 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 will grow when she adds nine additional sports to her research this year. About 3.8 million students competed in those sports. The

highest numbers of high school concussions last year were in:

Football	55,007
Girls' soccer	29,167
Boys' soccer	20,829

Source: National Center for Injury Prevention and Control, CDC's National Traumatic Cataclysm Center, University of Pittsburgh Medical Center

The statistic most troubling to Comstock: 10% of football players reported returning to play the same day they lost consciousness. An athlete is advised not to return to play the same day after losing consciousness in guidelines created by an international panel of experts in 2004.

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 of playing 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 management of these kids and listen to their families, you quickly realize the importance of quality care."

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# ESPN - 2010


ESPN RISE HIGH SCHOOL FOOTBALL

## Athletes bare burden of reporting concussion symptoms

Trainers, coaches and players should err on the side of caution when deciding to return to play after suffering from a head injury.

David Pittman

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### What are the symptoms of a concussion?

- Headache
- Balance problems or dizziness
- Nausea or blurry vision
- Sensitivity to light or noise
- Changes in speech
- Feeling sluggish
- Feeling foggy or groggy
- Confusion or memory problems
- Confusion

### How can I prevent a concussion?

- Follow your coach's rules for safety and the rules of the sport
- Practice good sportsmanship at all times
- Use the proper sports equipment, including personal protective

### What should I do if I think I have a concussion?

- Tell your coaches and your parents. Never ignore a bump, bruise or pain to the head. Don't tell your coach if one of your teammates might have a concussion.
- Get a medical check-up. A health care professional can tell you if you have had a concussion and when you are OK to get started back to school. If you have had a concussion, your brain needs time to heal.

Source: Centers for Disease Control and Prevention

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http://rise.espn.go.com/all-sports/articles/2010/06/02-Concussions-high-school.aspx 6/3/2010

# Sports Illustrated - 2012

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TransUnion

Friday September 26, 2012 11:00AM | Updated: Friday September 26, 2012 4:30PM

## Syracuse tries to decrease risk of concussions by neck-strengthening

By Michael Cohen, Special to SI.com

Halfway through a free fall to the bottom of the Big East standings, desperation kicked in. Three consecutive losses toward the end of the 2011 season forced Syracuse coach Doug Marrone to "rip the area" in practice, as Outback Sports Hanes described it.

A week of full-sacking drills and live reps before a crucial game against Cincinnati left Hanes feeling "a little fuzzy" before kickoff, and a huge collision with a Bengals linebacker chased him money through the game. "If you remember what a Pickman card looked like with the holographic thing behind it, that's kind of what the whole surrounding of both my eyes looked like," said Hanes. "Everything neck fuzzy and really dizzy."

His suspicions of a third concussion were confirmed. Hanes' collegiate playing days were over.

After a season in which 11 Syracuse players -- more than 10 percent of the active roster -- suffered concussions, Marrone and his staff underwent an offseason of study and change. He decided that increasing the size of his players' necks might help reduce the number of incidents. More strength supporting the head could absorb the blow, he reasoned. It is a hunch spawned by the daily neck exercises he enforced during the playing days at Syracuse under Dick MacParlan in the early 1990s.

"I think a lot of us coaches who have played, we look back and say, 'Gosh, we sure have the injury issues when we played,'" said Marrone. "So for me, I was thinking of developing [the neck area] to help it."

When he read an article early this summer that linked neck strength to a decrease in concussions -- and after Syracuse made it through spring practice concussion free -- he felt confident he had what was making a stride in the right direction.

Spore's reports in the medical and weight training fields agree that Syracuse's new drills to the strength and conditioning program are the most significant. They said the program currently lacks the specific neck-strengthening tests that yield the most telling data, which experts hope to measure at the NFL combine. They want to spur a change in philosophy that utilizes more machine-based workouts and less manual resistance in order to guarantee uniform training among all athletes.

Simply in terms of increasing neck diameter, though, Syracuse's program has been a tremendous success. Each player's neck was measured before the start of spring practice and again in the summer before fall camp. William Hanes, the assistant athletic director for athletic performance, said the average growth rate across the board was roughly eight centimeters of an inch -- with some players gaining as much as an inch-and-a-half in diameter.

"I can't wear regular dress shirts anymore," said Jay Brantley, a 6-foot-3, 200-pound defensive tackle whose neck increased by roughly an inch. "I need custom-fitted now."

The collective enlargement is a result of isometric neck work, weighted neck work and flexion and extension of the neck, all with a focus of neck workouts. Four times per week, Syracuse players

Many Highlights  
After 11 players had concussions last season, Syracuse searched for answers by increasing neck size through training. Syracuse has reduced concussions. There's no evidence to support method, but it's a step in the right direction.

On Super Sunday, It All Comes Down To The Score

Transition

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http://sportsillustrated.cnn.com/2012/football/ncaa/09/28/concussions-neck-strength-syrac... 1/22/2014

# Time - 2013

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## Keeping Score

### Neck Strength Predicts Concussion Risk, Study Says

New research shows that stronger necks may lead to safer heads.

By Sean Gregory @seanregory Feb. 21, 2013 62 Comments

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For years, biomechanics researchers have suspected that girls had higher concussion rates than boys in sports like soccer and lacrosse because of gender differences in neck strength. The weaker your neck, the more likely your head will bob around on impact. And concussions are caused by the brain shaking inside the skull.



For the first time, new research backs up this conclusion. Before practices and games, athletes shouldn't just be stretching and strengthening their legs and backs. They should be working out their necks as well.

At the fourth annual Youth Sports Safety Summit in early February, Devin Comstock, associate professor of epidemiology at the Colorado School of Public Health, presented the findings. During the 2010-2011 and 2011-2012 academic years, athletic trainers collected measurements of head circumference, neck circumference, neck length, and four measurements of neck strength — extension, flexion, right lateral and left lateral — on 6,704 athletes nationwide across three sports: boys' and girls' soccer, lacrosse and basketball. These measures were taken before the start of the season; during the season, athletic trainers reported injury data — including concussion incidence — for each athlete.

**(MORE: Kids Competing Too Soon After Concussions)**  
And the results didn't favor those with tiny necks: concussed athletes had smaller mean neck circumference, a smaller mean neck circumference to head circumference ratio (in other words, a small neck paired with a large head), and smaller mean overall neck strength than athletes who did not suffer a concussion. After adjusting for gender and sport, overall neck strength remained a statistically significant predictor of concussion. For every one pound increase in neck strength, odds of concussion fell by 3%.

Comstock, and her colleagues, have submitted this research for peer review. "We focus so much on how to properly diagnose concussions," Comstock says. "That's obviously important, but preventing concussions is a much better outcome. We're not saying that you won't get a concussion if your neck is stronger. But the data shows that neck strengthening has strong potential as a key concussion prevention tool." This is a pilot study; this data is almost begging for a follow-up study in football, where repeated head trauma seems to have the most dangerous consequences. Do stronger necks correlate with less concussions in that sport?

Still, this new study is very promising. Neck strengthening exercises are easy. For example, you can use your own hands as a resistance tool — put your hands on the back of your head, and press them forward while your head pushes back. They don't require any huge investment in additional equipment; that's important for today's cash-strapped schools.

The takeaway is clear: don't neglect your neck. Your head may thank you later.

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# Boston Globe - 2014

Ban heading in youth soccer - Opinion - The Boston Globe Page 1 of 5

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### Ban heading in youth soccer

By Derrick Z. Jackson | MAY 18, 2014





# Washington Post - 2014

Reducing the number of concussions in high school girls' soccer is a daunting task - The ... Page 1 of 4

## The Washington Post

[Back to previous page](#)

### 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, dizzied by climbing a flight of stairs at Huntingtown 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.

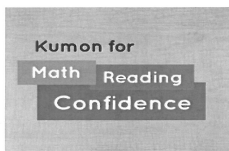
"It changes the way you think and feel," Bellucci, now 18, said. "I was just like really sad, really kind of desperate type of feeling. I couldn't do anything because of my head, so I would just be in my room with the shades drawn. I was like, 'I don't want to live like this anymore.'"

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 spattering.

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



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<http://www.washingtonpost.com/archive/local/localnews/2014/04/24/reducing-the-number-of-concussions-in-high-school-girls-soccer-is-a-daunting-task/2014/04/24/>

# NY Daily News - 2014

POLITICS

## Obama calls for more research into youth concussions

The President made the remarks at a day-long summit to emphasize the need for safety in kids' sports leagues.

THE ASSOCIATED PRESS / Thursday, May 29, 2014, 1:17 PM

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President Barack Obama delivers remarks during the White House Healthy Kids & Safe Sports Concussions Summit at the White House Thursday.

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President Barack Obama called Thursday for more robust research into youth concussions, saying there remains deep uncertainty over both the scope of the troubling issue and the long-term impacts on young people.

"We want our kids participating in sports," Obama said as he opened a day-long summit on concussions at the White House. "As parents though, we want to keep them safe and that means we have to have better information."

The summit signaled an effort by Obama to use the power of the presidency to convene a national conversation over youth concussions. The White House brought together representatives of professional sports leagues, coaches, parents, young athletes, medical professionals and others for the event.

Obama, an avid sports fan and father of two daughters involved in athletics, highlighted millions of dollars in pledges and other support from the National Football League, the National Institutes of Health and others to conduct research that could begin to provide answers and improve safety.

Among the financial commitments is a \$30 million joint research effort by the NCAA and Defense Department and an NFL commitment of \$25 million over the next three years to promote youth sports safety.

The president said additional research needs to also be combined with a broader recognition of the need to take the matter seriously.

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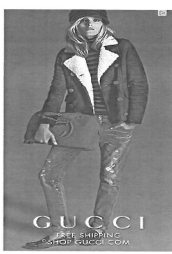
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## White House Healthy Kids and Safe Sports Concussion Summit – 5/29/14



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## Alarming News Over Past Few Years

- Concussion epidemic
  - Underreporting
  - Significantly increasing rates
  - New recognition of symptom prevalence and persistence
- Severe outcomes
  - Second impact syndrome
  - CTE
  - Dementia
  - Depression
- Lack of knowledge
  - Objective, accurate, and conclusive diagnostic tools
  - Best clinical practices for managing recovery and return to play
  - Very few primary prevention programs
- Confusion
  - Helmets all the same vs. some helmets better than others
  - Best practice re: management (meds, cocoon therapy, etc)

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## What is a Concussion?

- A complex pathophysiologic process affecting the brain, induced by traumatic biomechanical forces secondary to direct or indirect forces to the head
  - Caused by a blow or jolt to the head that disrupts the function of the brain resulting in a constellation of physical, cognitive, emotional, and/or sleep-related symptoms
  - Concussion = mTBI = brain injury

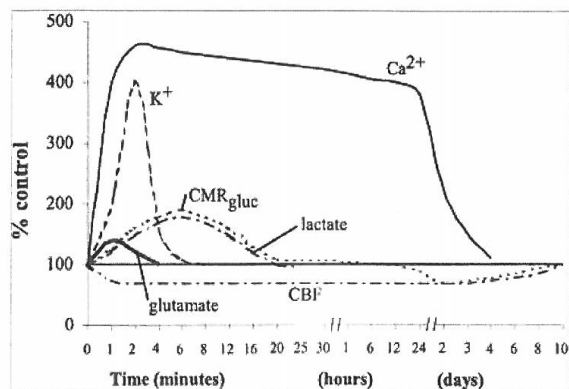
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## What is a Concussion?

- CDC NCIPC concussion video – brain movement
  - <http://www.cdc.gov/concussion/index.html>
- ESPN Sports Science video – helmet-to-helmet hits
  - <http://www.youtube.com/watch?v=fFkWTGKNLT8>
- Neurometabolic cascade associated with concussion
  - <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC155411/>
- CDC NCIPC Signs and Symptoms page
  - <http://www.cdc.gov/concussion/sports/recognize.html>
- CDC NCIPC sports and rec fact sheet
  - <http://www.cdc.gov/concussion/sports/facts.html>

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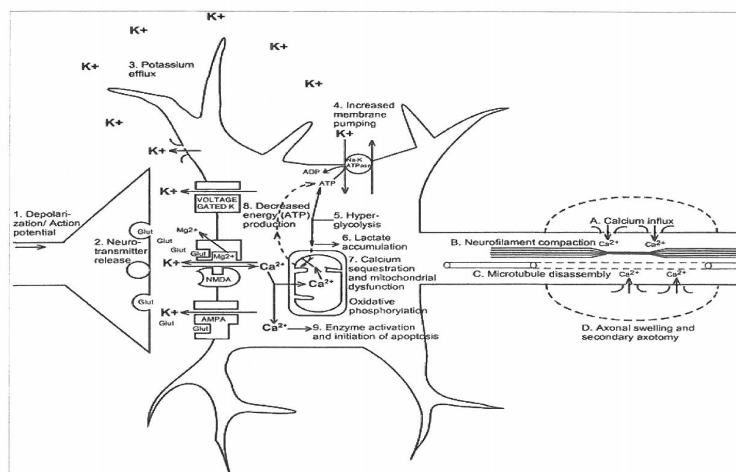
Figure 1



Neurometabolic cascade following experimental concussion.  $K^+$ , potassium;  $Ca^{2+}$ , calcium; CMRgluc, oxidative glucose metabolism; CBF, cerebral blood flow. (Reprinted with permission. Giza CC, Hovda DA. Ionic and metabolic consequences of concussion. In: Cantu RC, Cantu RI. *Neurologic Athletic and Spine Injuries*. St Louis, MO: WB Saunders Co; 2000:80–100.)

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Figure 2



Neurometabolic cascade following traumatic injury. (1) Nonspecific depolarization and initiation of action potentials. (2) Release of excitatory neurotransmitters (EAAs). (3) Massive efflux of potassium. (4) Increased activity of membrane ionic pumps to restore homeostasis. (5) Hyperglycolysis to generate more adenosine triphosphate (ATP). (6) Lactate accumulation. (7) Calcium influx and sequestration in mitochondria leading to impaired oxidative metabolism. (8) Decreased energy (ATP) production. (9) Calpain activation and initiation of apoptosis. A, Axolemmal disruption and calcium influx. B, Neurofilament compaction via phosphorylation or sidearm cleavage. C, Microtubule disassembly and accumulation of axonally transported organelles. D, Axonal swelling and eventual axotomy.  $K^+$ , potassium;  $Na^+$ , sodium; Glut, glutamate;  $Mg^{2+}$ , magnesium;  $Ca^{2+}$ , calcium; NMDA, N-methyl-D-aspartate; AMPA, d-amino-3-hydroxy-5-methyl-4-isoxazole-propionic acid.

## How is Concussion Diagnosed?

- Clinical diagnosis
  - Symptom checklist (SCAT3-Child, etc.)
  - Neuro-cognitive evaluation (ImPACT, etc.)
  - Balance test (BESS, etc.)
- Imaging is still only a research tool
  - MRI/CT are usually normal
  - Advanced neuroimaging potential for future
    - *PET – Positron Emission Tomography*
    - *DTI – Diffusion Tensor Imaging*
    - *Etc.*
- Biomarkers under development – a big unknown still

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## Concussion Signs and Symptoms?

- Physical
- Cognitive
- Emotional
- Sleep/Energy

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## Concussion Signs and Symptoms

- Physical
  - Headache
  - Blurred vision
  - Dizziness
  - Poor balance
  - Nausea/vomiting
  - Ringing in ears
  - Seeing stars
  - Vacant stare/glassy eyed
  - Numbness/tingling
  - Sensitivity to light
  - Sensitivity to noise
  - Disorientation

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## Concussion Signs and Symptoms

- Cognitive
  - Difficulty concentrating
  - Easily confused
  - Memory problems
  - Amnesia
  - Feeling slowed down
  - Feeling “in a fog”
  - Slowed responsiveness
  - Slurred speech/incoherent speech
  - Loss of consciousness

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## Concussion Signs and Symptoms

- Emotional
  - Anxiety/nervousness
  - Irritability
  - Sadness/depression
  - Lack of motivation
  - More “emotional”
  - Personality change
  - Inappropriate emotions

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## Concussion Signs and Symptoms

- Sleep/Energy
  - Fatigue
  - Drowsiness
  - Trouble falling asleep
  - Sleeping less/more than usual

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## Concussion Management

- There is no “treatment”
- Concussion management involves physical and cognitive rest until acute symptoms resolve followed by a graduated program of exertion prior to medical clearance and return to play
- No athlete should ever return to play on the day the concussion occurred!

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## Return to Play Protocol

- 1) No activity (physical and cognitive rest)
- 2) Light aerobic exercise (walking, stationary bike, etc.)
- 3) Sport-specific exercise (skating in ice hockey, etc.)
- 4) Noncontact training drills (full speed passing drills, etc.)
- 5) Full contact practice (normal practice activities)
- 6) Return to play
- Some confusion about which day is day “1” – the day of the injury or the day after the injury

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## Concussion Management

- If in doubt, sit them out
- Return to play decisions should be made by an appropriate medical provider

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## When, why, where, how?

- Concussions are not just a sports-related issue
  - Motor vehicle crashes
  - Interpersonal violence
  - Etc.
- Concussions can occur in any sports or recreation activity

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## 5 Most Common Activities Leading to ED Presentation with Concussion

- Boys under 20 years of age
  - Football
  - Bicycling
  - Playground
  - Basketball
  - Baseball
- Girls under 20 years of age
  - Playground
  - Bicycling
  - Soccer
  - Basketball
  - Horseback riding

CPSC NEISS data, US, 2001-2009

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## Sports Concussion Epidemiology

- Rates of concussion increase with athlete age, level of play, and intensity of athletic activity
- Rates vary by sport
  - Full contact/combat sports have highest rates
  - Sports where contact occurs often although largely banned by the rules have next highest rates
  - Sports where contact rarely occurs have lowest rates
- Athlete-athlete mechanism is most common

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## High School RIO (05/06-current)

- National High School Sports-Related Injury Surveillance System (High School RIO)
  - Athletic Trainers from US 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  $\geq 1$  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

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## 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/event
  - Injury: body site, diagnosis, severity
  - Injury event: mechanism, specific activity

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## Sports Included in High School RIO

Boys' Sports	Years Studied	Girls' Sports	Years Studied
Baseball	9	Basketball	9
Basketball	9	Cross Country	2
Cross Country	2	Field Hockey	6
Football	9	Gymnastics <sup>+</sup>	4
Ice Hockey	6	Lacrosse	6
Lacrosse	6	Softball	9
Soccer	9	Soccer	9
Swimming	6	Swimming	6
Track	6	Track	6
Volleyball <sup>+</sup>	3	Volleyball	9
Wrestling	9	Cheerleading <sup>*</sup>	5

<sup>+</sup>Sports no longer under surveillance

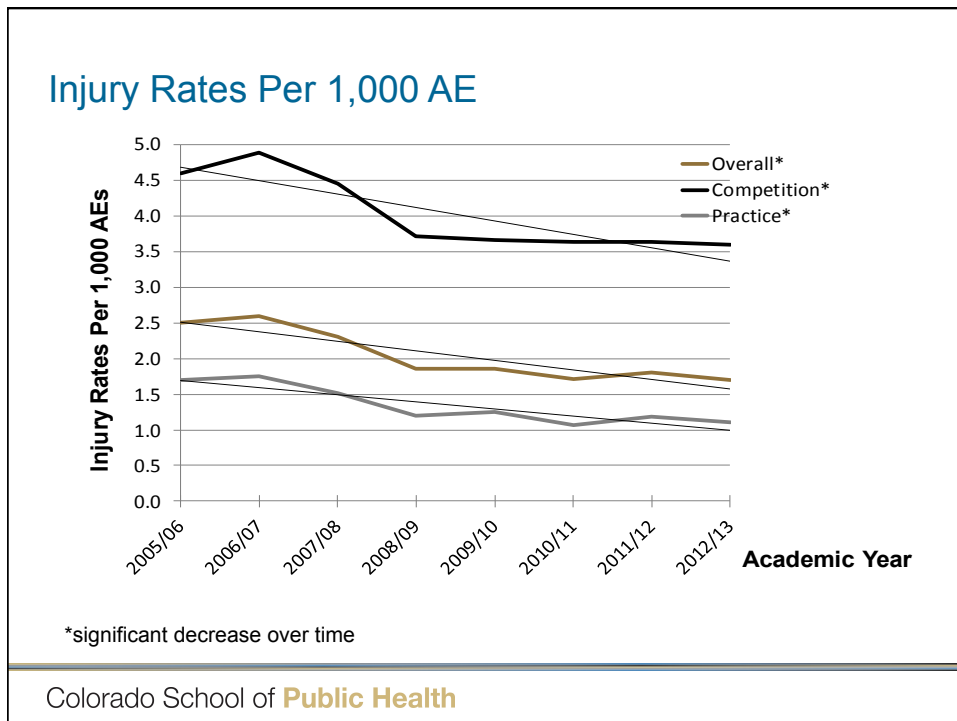
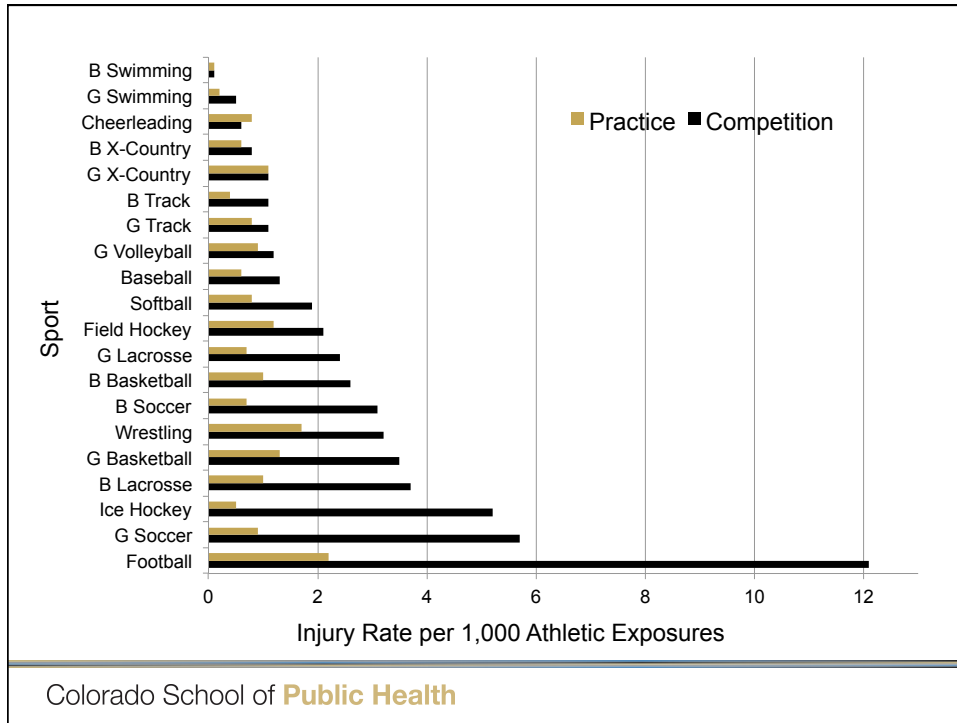
<sup>\*</sup> Co-Ed sport although predominantly female participants

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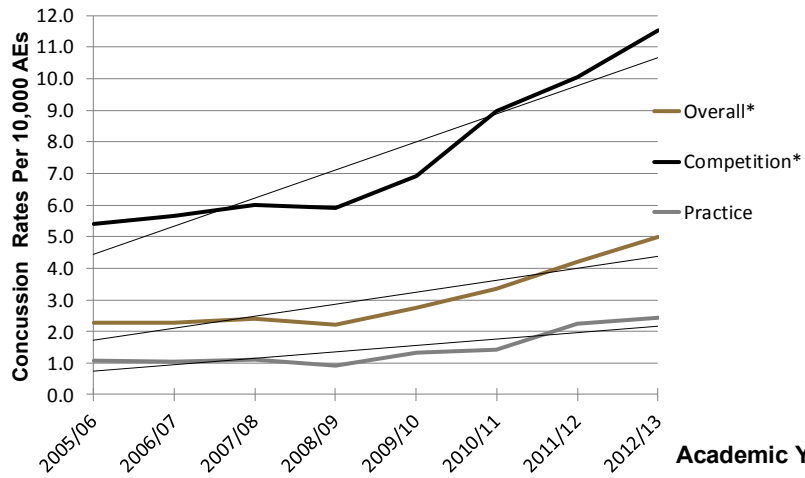
## High School RIO Dataset

- Injury data captured 05/06 through 13/14
  - 60,193 injuries
  - 30,415,179 AE
  - 1.98 injuries per 1,000 AE
- Injury by type of exposure
  - 51.5% competition related
  - Competition rate 3.98 per 1,000 AE
  - Practice rate 1.30 per 1,000 AE
  - RR=3.06 (95% CI: 3.01, 3.10)

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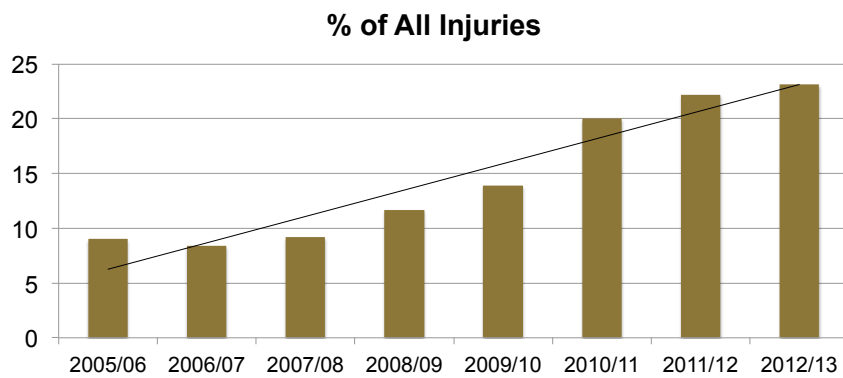
### Concussion Rates Per 10,000 AE



\*significant increase over time

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### Concussion Burden



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## Trends Over Time: Symptoms (All Sports)

### % of Student Athletes Presenting with Symptom by Year

	07/08	08/09	09/10	10/11	11/12	12/13
LOC	6.6	4.5	4.1	3.8	3.3	3.5
Amnesia	23.9	24.9	21.4	22.1	16.9	15.6
Light Sensitivity	35.1	38.3	34.1	38.9	42.4	46.1
Noise Sensitivity	12.0	19.5	16.9	24.4	25.4	30.8
Confusion/ Disorientation	50.2	46.7	43.4	45.3	43.4	44.1
Nausea	35.5	32.3	29.0	32.2	31.0	30.5
Headache	94.6	94.2	94.2	94.6	95.3	94.5

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## Trends Over Time: Re-Injury (All Sports)

### % of Student Athletes with Recurrent Concussion by Year

	07/08	08/09	09/10	10/11	11/12	12/13
New Concussion	88.6	87.7	88.6	89.7	92.1	91.0
Recurrence (this academic year)	5.6	4.9	4.3	3.1	2.3	2.0
Recurrence (prior academic year)	5.8	7.1	6.9	7.1	5.5	7.0

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## Concussions: Time for Action!

- “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
- “The NFL has reached a tentative **\$765 million settlement** over concussion-related brain injuries among its 18,000 retired players, agreeing to compensate victims, pay for medical exams and underwrite research.”
  - ESPN, Aug 29, 2013

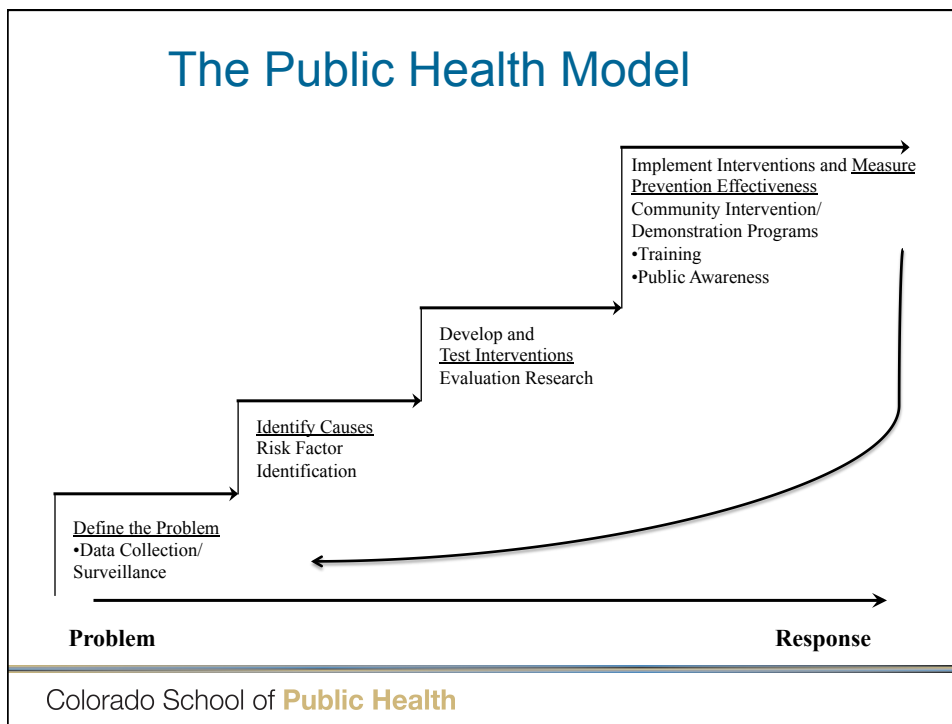
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## So, What do we do?

- Lots of resources on better diagnosis and management
- Far too little focus on prevention
  - Interventions to prevent injuries from occurring
  - Interventions to minimize the severity of injuries which can't be prevented

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## Public Health Intervention

- A set of actions with a coherent objective to promote or protect health or prevent ill health in communities or populations
- Should be
  - Needed
  - Evidence-based
  - Measurable
  - Culturally sensitive

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## Importance of Cultural Competency

- Interventions simply won't work without acceptance in the targeted population which requires cultural competency
- What is "culture"?

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## Ideas for Interventions?

- Football
- Soccer
- Baseball

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## Three Basic Approaches of Interventions

- Engineering
  - *Better protective equipment*
  - *New protective equipment*
  - *Introducing existing equipment to new sports*
- Regulation/Legislation
  - *Policy*
  - *New sports rules*
  - *Better enforcement of existing rules*
- Education/Behavior Change
  - *Data to drive evidence-based discussions*
  - *Information to assist coaches*
  - *Information to guide parental decision making*

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## Potential Intervention #1

- Should cheerleading be designated as a high school sport rather than a non-sport after school activity?
- Policy intervention

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

Sport	Competition	Rank	Practice	Rank
Football	33.2	1	5.5	1
Boys' Ice Hockey	23.7	2	1.7	7
Girls' Soccer	19.9	3	2.6	4
Boys' Wrestling	12.5	4	3.5	2
Boys' Lacrosse	12.3	5	1.6	8
Girls' Basketball	12.0	6	1.2	11
Boys' Soccer	9.1	7	0.9	13
Girls' Field Hockey	7.6	8	1.0	12
Girls' Lacrosse	6.9	9	2.2	5
Girls' Volleyball	5.5	10	1.7	6
Boys' Basketball	4.0	11	1.3	10
Girls' Softball	3.2	12	1.5	9
Cheerleading	1.8	13	3.4	3

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## How is Cheerleading Different?

- Cheerleading
  - Spend much more time (higher AE) in practice? Not really
  - Do more reps of high risk activities in practice? Maybe?
  - Learn new skills in practice? Maybe?
  - Practice in “safe” environments? Not always
- Gymnastics
  - Overall concussion rate = 15<sup>th</sup> of 20 sports
  - Practice concussion rate = 14<sup>th</sup> of 20 sports

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## Potential Intervention #2

- Should girls' lacrosse players be required to wear helmets?
- Engineering intervention

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## LAX Gender Patterns of Injury

- Among boys LAX players, 24.9% of all injuries were to the head/face
- Among girls LAX players, 26.0% of all injuries were to the head/face

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## Mechanisms of Concussion by Sport

Sport	Player-Player	Player-Surface	Player-Apparatus
Football	90.7%	6.7%	0.6%
Boys' Soccer	72.7%	10.7%	16.4%
Girls' Soccer	52.1%	20.7%	26.8%
Boys' Baseball	37.0%	6.5%	56.5%
Girls' Softball	30.5%	11.0%	58.5%
Boys' Lacrosse	79.6%	6.3%	12.7%
Girls' Lacrosse	27.7%	8.4%	61.4%

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## Potential Intervention #3

- Should soccer coaches be required to improve coaching of heading techniques?
- Educational intervention
- Policy intervention

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## Soccer Concussion Patterns

- Among boys 32.3% of all concussions occurred during heading (most common activity)
  - Of heading related concussions, 80.1% were due to athlete-athlete contact, 6.4% contact with playing surface, and 12.9% contact with ball
- Among girls 25.7% of all concussions occurred during heading (most common activity)
  - Of heading related concussions, 66.4% were due to athlete-athlete contact, 7.0% contact with playing surface, and 26.7% contact with ball

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## Better Coaching in Soccer?

- Football is a model
  - <http://usafootball.com/health-safety/how-to-tackle>
- Better coaching of soccer heading?
  - Soccer head-to-head collisions during heading
    - [http://www.youtube.com/watch?v=w6rpb2uZU\\_w](http://www.youtube.com/watch?v=w6rpb2uZU_w)
    - [http://www.youtube.com/watch?v=6HDxoEwg\\_QA](http://www.youtube.com/watch?v=6HDxoEwg_QA)
    - <http://www.youtube.com/watch?v=DqeiljFO1So>
  - Brandi Chastain coaching heading
    - [http://rockcenter.nbcnews.com/\\_news/2012/05/09/11625127-soccer-star-brandi-chastain-tells-how-young-players-can-protect-themselves](http://rockcenter.nbcnews.com/_news/2012/05/09/11625127-soccer-star-brandi-chastain-tells-how-young-players-can-protect-themselves)

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## Potential Intervention #4

- Should efforts to educate coaches, parents, and student athletes on concussion signs and symptoms and concussion management be continued or even intensified?
- Educational intervention

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## Trends Over Time: Compliance with Return to Play Guidelines (Football)

% of Student Athletes in Each Category of RTP by Year

	07/08	08/09	09/10	10/11	11/12	12/13
<1 day	11.1	3.3	0.8	0.8	1.7	0.2
1-2 days	5.4	3.8	4.9	2.2	1.8	0.7
3-6 days	20.5	21.3	17.5	12.8	8.1	9.0
Season ended	0.0	0.0	8.8	12.6	10.9	13.5
Athlete decides not to continue	0.7	2.5	1.4	1.2	2.2	2.1

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## Potential Intervention #5

- Should there be limits on the amount of contact allowed in football practices?
- Educational intervention
- Policy intervention

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

Sport	Competition	Rank	Practice	Rank
Football	33.2	1	5.5	1
Boys' Ice Hockey	23.7	2	1.7	7
Girls' Soccer	19.9	3	2.6	4
Boys' Wrestling	12.5	4	3.5	2
Boys' Lacrosse	12.3	5	1.6	8
Girls' Basketball	12.0	6	1.2	11
Boys' Soccer	9.1	7	0.9	13
Girls' Field Hockey	7.6	8	1.0	12
Girls' Lacrosse	6.9	9	2.2	5
Girls' Volleyball	5.5	10	1.7	6
Boys' Basketball	4.0	11	1.3	10
Girls' Softball	3.2	12	1.5	9
Cheerleading	1.8	13	3.4	3

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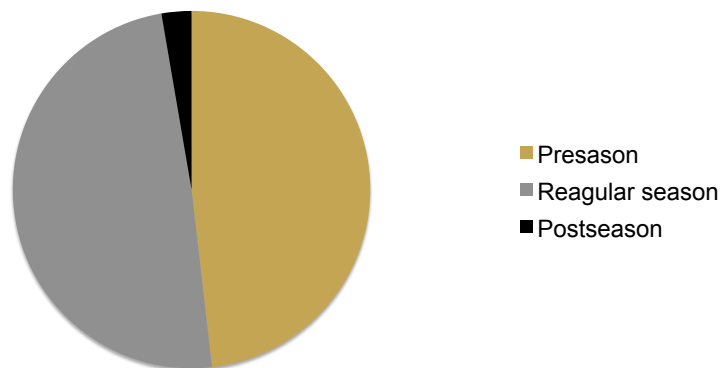
## Football Specific Concussion Mechanism by Type of Activity

Mechanism	Competition	Practice
Tackling	33.8%	32.5%
Being tackled	32.7%	28.1%
Blocking	15.6%	19.0%
Being blocked	13.3%	13.9%

Don't forget about the need for cultural competency!

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## Time in Season: When Do Football Practice Concussions Occur?



Ideas for culturally acceptable intervention(s)?

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## Preliminary Data: Caution When Interpreting

- In 2013/14 states with practice contact limits: AL, AZ, MD, TX
- High School RIO included 16 schools from those states enabling comparison to states without practice limits
- Practice concussion rates per 10,000AE were significantly lower in those four states (3.22) than other states (5.78) (RR=0.56, 95% CI: 0.40-0.77)
- No significant difference in competition concussion rates in those four states (30.81) than other states (31.97) (RR=0.96, 95% CI: 0.74-1.26)
- No significant differences in other injuries we looked at in either competition or practice
- Similar mechanisms of injury
  - player-player contact mechanism
    - *Competition: states with limits = 90.2%, other states = 89.0%*
    - *Practice: states with limits = 94.9%, other states = 85.4%*

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## Take Home Messages

- The sporting world is leading the way in improving knowledge of concussion
- The culture has shifted although we still have a way to go
- We largely understand the epidemiology of sports and recreation concussion
- We should continue efforts to improve diagnosis and management
- We must increase the focus on prevention

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## What Can Parents Do?

- Evaluate the quality of the sports program
- Evaluate the equipment and facilities
- Question coaches
- Decide what is an acceptable level of risk
- Make your kids wear appropriate gear
  - Well fitted, in good condition, used consistently
- Understand it is ok to say no to your kids

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“... and it did a world of good which never became manifest”

Charles Dickens, A Tale of Two Cities



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