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## A Scoping Review to Address the Culture of Concussion in Youth and High School Sports\*

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### Abstract

**BACKGROUND:** In 2013, the National Academy of Sciences emphasized the need to develop, implement, and evaluate effective large-scale educational strategies to improve the culture of concussion in youth and high school sports. In support of this recommendation, in this article we summarize research on factors that contribute to the culture of concussion.

**METHODS:** We conducted the literature search using 7 electronic databases. We used a scoping review method to identify studies that addressed knowledge, attitudes, behaviors, use of educational resources, and interventions related to concussion among young athletes, coaches, and parents.

**RESULTS:** Of the 33 articles identified, most focused on concussion education (N = 15), followed by knowledge (N = 13), behaviors (N = 13), and attitudes (N = 5). Three studies addressed multiple study populations.

**CONCLUSIONS:** The rapid spread of concussion education and awareness efforts has outpaced research on effective strategies to improve knowledge, attitudes, and behaviors that contribute to the culture of concussion. Further research is critical to inform the development and implementation of large-scale educational efforts. This research should incorporate rigorous study

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Human Subjects Approval Statement

Compilation of this review did not involve research with human subjects.

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designs; be inclusive of diverse ages, socioeconomic status, and racial/ethnic groups; and examine opportunities to improve behavioral outcomes around concussion prevention, reporting, and management.

## Keywords

concussion; traumatic brain injury; youth sports; high school sports; athlete risk

The last decade has shown tremendous growth in the amount of research, media coverage, and educational and policy interventions designed to address sports concussion. This growth is best exemplified as all 50 United States and the District of Columbia introducing sports concussion laws (sometimes referred to as Return to Play [RTP] laws).<sup>1</sup> During this same time, sports and national organizations made concussion a focus of their outreach efforts. Similarly, numerous medical and health organizations drafted concussionin-sports position statements and guidelines.<sup>2–5</sup>

To help advance research on the topic, in 2013, the National Academy of Sciences (NAS) published “Sports-Related Concussions in Youth: Improving the Science, Changing the Culture,” emphasizing that coordinated efforts among federal agencies, and various public and private groups, are critical to improve concussion prevention, recognition, and response. The NAS recommended the development, implementation, and evaluation of effective large-scale strategies to improve knowledge, attitudes, and behaviors that contribute to the culture of concussion.<sup>6</sup> The term “culture of concussion” is used in this article to describe the ways in which key audiences think and behave related to concussion. Changing the culture of concussion includes encouraging reporting of concussion, complying with appropriate concussion management plans, and other related shifts in social norms, attitudes, and behaviors around concussion to improve the health and safety of young athletes. Improving the culture of concussion requires extensive review of effective strategies for motivating behavior change. To the best of our knowledge, there are no other published literature reviews on concussion knowledge, attitudes, behaviors, education, and interventions among the 3 study populations: young athletes, parents, and coaches. Parents and coaches play key roles in preventing, recognizing, and responding to concussion in youth and high school sports. In this article, we review literature on concussion knowledge, attitudes, and behaviors that contribute to the culture of concussion. Based on these findings, we discuss priority opportunities for research to inform the development and implementation of large-scale efforts, as recommended by the NAS, to keep athletes safe from concussion.

## METHODS

The methods for this scoping review were guided by standard review methods and those described by Arksey and O’Malley.<sup>7</sup> A scoping review focuses on summarizing research findings to identify research gaps in the literature. Scoping reviews are designed to capture all relevant literature, regardless of the study design. This approach uses a 5-stage process: identifying the research question; identifying relevant studies; selecting the studies; charting the data; and collating, summarizing, and reporting the results.<sup>7</sup> Additionally, we adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

statement for reporting systematic reviews, as applicable.<sup>8</sup> PRISMA is a process used to assess health interventions.

### Stage 1: Identifying the Research Question

This scoping review addresses 2 research questions: (1) What is known from the existing literature about concussion knowledge, attitudes, and behaviors among the following young athletes (ages 5–18), parents, and coaches? and (2) What is known from the existing literature about the effect of concussion education on improving concussion knowledge, attitudes, and behaviors among young athletes (ages 5–18), parents, and coaches?

For this study, we defined attitudes as positive or negative evaluations of concussion. Attitudes can strongly influence behaviors.<sup>9</sup> For example, among youth and high school athletes, this study explored young athletes' existing knowledge related to concussion, their personal evaluations of concussion as an injury, and the relationship between these factors and young athletes' concussion reporting behaviors. Studies reported in the education section specifically focused on the effects of experiences with concussion education (eg, participation in formal curricula, initiatives, or programs) on related knowledge, attitudes, and behaviors. If measuring the effect of education was not an outcome measure of the study, the study was reported in the knowledge, attitudes, or behaviors section.

### Stage 2: Identifying Relevant Studies

A medical librarian conducted the literature search using 7 electronic databases: CINAHL, EBSCO, ERIC, Google Scholar, Grey Literature Report, PsychINFO, and PubMed. Separate searches were conducted by population using 4 search term categories (Table 1). The specific search terms were:

- *Coach* terms included the population descriptors for coaches and children/youth and health conditions.
- *Parent* terms included the population descriptors for parents, health conditions, and sports indicators.
- *Children/youth* terms included the population descriptors for children/youth, health conditions, sports indicators, and concept terms of interest.

### Stage 3: Selecting Studies

Once studies were identified, 2 independent reviewers examined each article's title and abstract to determine whether the article met the inclusion criteria: (1) published in a peer-reviewed journal between January 2007 and January 2015; (2) written in English and included study participants from the United States; and (3) addressed knowledge, attitudes, behaviors, or educational interventions related to concussion in young athletes (ages 5–18 years). If the reviewers disagreed, a third reviewer made the determination. The full text was then reviewed to confirm eligibility.

During the full-text review, 2 reviewers abstracted data from the article using a uniform abstraction template. At this stage, reviewers re-evaluated the studies against the inclusion

and exclusion criteria to determine relevance. At least 1 reviewer examined reference lists of accepted articles to identify any studies that were not retrieved through the literature search.

Publications related to treatment, recovery, or ongoing care of a child or youth who experienced a traumatic brain injury (TBI) or concussion were excluded. Publications concerning child abuse, case studies, reviews of state concussion laws, and expert opinion pieces were also excluded.

#### **Stages 4 and 5: Charting the Data and Collating, Summarizing, and Reporting Results**

Microsoft Excel was used to record the following data extracted from the selected studies: author, title, journal, study population, study design, data collection year, and results related to knowledge, attitudes, behaviors, and educational interventions

The data extraction fields were adapted from a literature search that Kerr et al<sup>10</sup> conducted about factors associated with disclosure of concussion symptoms in young athletes. We apply the same process to explore factors beyond reporting and disclosure of concussion symptoms among the audiences. A qualitative descriptive approach was used to summarize findings by group.

## **RESULTS**

### **Study Characteristics**

The literature search was conducted twice: The first search ran from January 2007 until July 2014, and the second search ran from July 2014 to January 2015 to update the literature. The first search identified 112 publications (Figure 1), with an additional 13 publications identified through other sources, such as the review of references from accepted studies, resulting in 125 studies. Fiftyone studies were excluded because of study type or irrelevance to the research questions or study population. Thus, 74 full-text studies were reviewed and 49 articles were then excluded because they focused on audiences outside of this article's scope, resulting in 25 articles. In the second search, 266 records were identified, with 238 records excluded. Twenty of 28 articles were excluded; ultimately, 8 new articles from the updated search were included. Overall, 33 articles were included in the scoping review from January 2007 to January 2015. Many studies focused on multiple outcomes. Most studies focused on concussion education (N = 15), followed by knowledge (N = 13), behaviors (N = 13), and attitudes (N = 5). Three articles addressed multiple study populations. Tables 2–4 present a summary of key findings about each populations' concussion-related knowledge, attitudes, behaviors, and education.

### **Young Athletes**

**Knowledge.**—Five studies addressed young athletes' concussion knowledge. Although most young athletes had heard about concussion,<sup>11</sup> gaps in knowledge regarding identifying concussion symptoms remain.<sup>12</sup> Specifically, young athletes may be unable to identify whether their symptoms are caused by a concussion<sup>13</sup> or by another condition, such as dehydration, a cold or flu, or with other general symptoms like a ringing in the ears and fatigue.<sup>12</sup> The most commonly identified concussion symptoms in a cross-sectional survey

of high school football players were headache, dizziness, and confusion, whereas harder to identify symptoms were personality changes, trouble sleeping, being more emotional, and nervousness or anxiety.<sup>14</sup> A survey of youth football players ages 8–14 found that a minority of athletes were able to recognize symptoms of concussion such as confusion (23%), nausea (42%), and sleep disturbances (57%).<sup>15</sup>

Studies that assessed the effect of concussion knowledge on young athlete's concussion reporting behaviors had mixed results. A 2013 cross-sectional survey of 167 high school athletes across 6 sports found that the participants who knew more about concussion were more likely to report a concussion during practice.<sup>13</sup> In contrast, findings from a focus group study with 50 high school athletes, conducted the same year, demonstrated that although most were knowledgeable about the dangers of concussion, the majority of the athletes reported that they would either continue playing and see how they felt or take a short break and return to play (RTP). None of the participants said they would stop playing entirely if they experienced concussion symptoms.<sup>12</sup>

**Attitudes.**—Two studies addressed young athletes' concussion attitudes. Bloodgood et al surveyed 252 athletes ages 13–18 regarding whether they viewed concussion as a “critical issue.” In general, most athletes (70%) agreed that concussions are a “critical issue.”<sup>11</sup> Younger athletes (ages 13–15) were significantly more likely to believe that concussions are a “critical issue” (54%) compared with older athletes (ages 16–18;34%).<sup>11</sup> In addition, when asked if their friends would “think they were dumb for caring about concussions,” younger athletes (21%) were significantly more likely than older athletes (11%) to disagree with the statement.<sup>11</sup>

Chrisman et al<sup>12</sup> found that young athletes who received negative messages from their coach and/or were insulted by their coach for reporting an injury felt pressured to keep playing despite concussion symptoms. Conversely, young athletes who received positive messages from their coach and were praised for symptom reporting were more likely to report their concussion symptoms.

**Behaviors.**—Ten studies addressed young athletes' concussion behaviors, and most studies focused on concussion reporting and adherence to RTP protocols. These studies suggest that young athletes do not regularly report their symptoms to trained personnel.<sup>12,13,16,17</sup> Cohort studies with middle and high school students by Rivara et al<sup>16</sup> and O’Kane et al<sup>17</sup> demonstrated that 58.6% of middle school athletes and 69% of high school athletes reported playing with concussion symptoms. One study compared the number of female soccer players ages 11–14 in Washington State who reported playing with concussion symptoms before and after the passage of the state's concussion legislation. The study found that after the law was passed, 56% of soccer players reported playing with symptoms compared with 70% before the concussion legislation.<sup>18</sup>

Barriers to reporting a possible concussion among young athletes were identified. The most commonly identified barriers included not thinking a concussion was serious, concern about losing their position in the game, losing game time, losing future career opportunities, looking weak, and disappointing or being influenced by teammates and/or coaches.<sup>12,13</sup> In 1

study, the worst possible scenario young athletes reported was having to leave a game due to a concussion and their team subsequently losing—fearing they would be blamed for the loss.<sup>12</sup> In addition, one study found that 72.9% of athletes reported that they would always tell their coach or trainer about concussion symptoms during a game, but during a championship game scenario, only 51.7% of athletes reported that they would always tell their coach or athletic trainer.<sup>19</sup> Similarly, a cross-sectional survey of 496 athletes ages 13–18 found that only half of athletes (50.9%) reported that they would always report a concussion to a coach or athletic trainer if it meant they would have to miss a practice or two.<sup>20</sup> Further, a survey of youth football players found that 62% of athletes did not disagree completely with the statement: “If I am hit in the head and have a headache, it is OK to continue to play, as long as I don’t lose consciousness.”<sup>15</sup>

A prospective cohort study by Hwang et al<sup>21</sup> examined adherence to discharge instructions among pediatric patients discharged from an emergency department following a concussion. Of these patients, researchers found that more than one third (39%) reported returning to play on the same day of their injury.<sup>21</sup> Among patients who returned to play or to other regular activities 2 weeks following their concussion, many reported still having symptoms (35%), and many (58%) returned to play without medical clearance.<sup>21</sup> In a randomized control study of high school athletes, Yard et al<sup>22</sup> similarly found that between 15% to 40% of athletes RTP too soon.

**Education.**—Five studies addressed young athletes’ education related to concussion. Participation in concussion education may increase athletes reporting of symptoms.<sup>19,23</sup> A survey of high school athletes by Bramley et al<sup>19</sup> indicated that participants who received concussion education from any source were more likely to report concussion symptoms (72%) to a coach or athletic trainer compared with athletes with no education (36%). A cross-sectional study of high school football players found that 60% of athletes received formal education about concussion in a class or online, and 54% had discussed concussion with their parents, and 25% reported that they never received any form of education about concussion.<sup>14</sup>

A cross-sectional study of high school athletes compared recognition of concussion signs and symptoms before and after athletes viewing an educational video about concussion. The study found that 77% of athletes correctly identified concussion signs and symptoms at baseline, and 90% recognized concussion signs and symptoms after the intervention.<sup>24</sup> Bagley et al<sup>25</sup> compared knowledge of concussion recognition and appropriate response before and after athletes participated in the Sports Legacy Institute Community Educators (SLICE) concussion education program, a workshop delivered by health professionals with information about concussion that features interactive discussion and case studies about athletes. A prospective cohort study of young athletes who participated in the SLICE curriculum reported improved knowledge of concussion recognition and response following participation in concussion presentations and discussions (ie, 34% passed the pretest compared with 80% passing the posttest).<sup>25</sup>

## Youth and High School Sports Coaches

**Knowledge.**—Four studies addressed youth and high school sports coaches' concussion knowledge. A descriptive epidemiology study found that most high school coaches agreed that an athlete who has a concussion cannot RTP the same day of the injury.<sup>26</sup> In regard to concussion identification, Naftel et al<sup>27</sup> surveyed 402 middle and high school coaches and found that 86% of coaches could correctly identify concussion signs and symptoms and that most knew that concussions are not always accompanied by loss of consciousness.<sup>27</sup> Still, studies suggest that coaches may have difficulty identifying some symptoms, such as vision problems, sensitivity to light and noise, problems with sleep, and nausea<sup>28,29</sup> as signs of concussion.

**Attitudes.**—One study addressed youth and high school sports coaches' concussion attitudes. Faure et al<sup>28</sup> found that almost all high school coaches (94%) viewed concussion as a serious injury and that overall coaches felt it was their responsibility to recognize a possible concussion and remove an athlete from play.

**Behaviors**—One study addressed youth and high school sports coaches' behaviors related to concussion. The importance of a game may influence a coach's intention to remove an athlete with a concussion from play.<sup>30</sup> Researchers asked a group of 314 coaches whether they would remove a young athlete from play with concussion symptoms in different scenarios. When the importance of the game or event was not included in the scenario, 92% of coaches reported they would remove the young athlete from play. When the scenario included a championship game, up to 83% of coaches reported they would not allow a concussed athlete to participate in the game.<sup>30</sup>

**Education.**—Nine studies addressed youth and high school sports coaches' concussion education. The number of coaches receiving education on concussion has risen dramatically over the last few years as part of state, league, or school concussion in sports policy implementation, including training requirements mandated by some sports organizations.<sup>31</sup> A survey of 96 high school coaches in the southeast found that almost all (96%) had participated in either a seminar or Web-based concussion education program.<sup>32</sup> Coaches who receive coaching education are more likely to correctly recognize concussion signs and symptoms<sup>29</sup> and to feel comfortable deciding whether an athlete needs to be evaluated for a possible concussion.<sup>33</sup>

The US Centers for Disease Control and Prevention's (CDC) HEADS UP campaign includes resources that educate coaches about concussion prevention, recognition, and response. Youth and high school coaches who participated in surveys and were exposed to HEADS UP self-reported improved knowledge of concussion identification and management, viewing concussions more seriously, and increased use of prevention strategies and effort in educating others about concussion.<sup>34,35</sup>

Shenouda et al<sup>36</sup> surveyed coaches in Washington 1 year after the passage of concussion in sports legislation in the state and found that although coaches' knowledge of concussion was high, gaps in practice regarding the prevention of concussion existed. A 2014 study by Rivara et al<sup>17</sup> also in Washington State, found that most methods of coach concussion



education were not associated with coach awareness of concussions among their athletes. Additionally, the study found that underreporting of concussion remains high despite mandated coaching education.

Glang et al<sup>37</sup> evaluated the effectiveness of ACTive, an e-learning program for coaches about concussion prevention and management practices. A randomized controlled trial with 75 youth sports coaches demonstrated that coaches in the intervention group had large overall gains on all 5 of the posttest measures (knowledge of concussion symptoms, general knowledge about concussion, self-efficacy regarding recommended actions after a concussion, intention to take appropriate action after concussion, and attitudes about concussion) compared with the coaches in the control condition.

## Parents

**Knowledge.**—Four studies addressed parents' concussion knowledge. Stevens et al<sup>38</sup> surveyed 105 parents whose children were discharged from the emergency department with concussion. Findings indicated that approximately 63% of children developed post-concussive signs and symptoms, yet only 30% of parents initially stated that their children exhibited postconcussive signs and symptoms. When parents were asked about individual symptoms, approximately 47% of parents who initially reported an asymptomatic child identified 1 or more symptoms in their child.<sup>38</sup> Similarly, Hajek et al<sup>39</sup> found that while parents and children reported similar postconcussion symptoms, on average children reported more symptoms than their parents. When parents were asked to identify signs and symptoms of concussion, most could identify concussion symptoms, but 44% missed emotional outbursts and 28% missed difficulty sleeping.<sup>40</sup> Further, a survey of 235 parents found that when parents were asked if there are circumstances when an athlete could RTP immediately after a concussion, 61% replied yes while 99% agreed that a health care provider should check a student with concussion before they RTP.<sup>41</sup>

**Attitudes.**—Two studies addressed parents' concussion attitudes. Bloodgood et al<sup>11</sup> reports that 84% of parents agree that concussions are a “critical issue.” Parents of youth ages 10–13 are most aware of concussion, most likely to believe concussions are a “critical issue,” and most likely to seek information about concussion.<sup>11</sup> Among all parents, significantly more mothers (68%) than fathers (34%) strongly agree that concussions are a “critical issue.” Terminology may also be an influential factor in how parents' think about concussion. Parents tend to perceive “concussions” as milder and “TBI” as a more severe injury.<sup>42</sup>

**Behaviors.**—Two studies addressed parents' behaviors related to concussion. Parents play a significant role in influencing their child's behaviors regarding concussion and safety in sports, such as a young athlete's behavior related to reporting a concussion.<sup>23</sup> In a study of ski and snowboarding parents and their children, there was a strong association between parent and child helmet-wearing behavior.<sup>43</sup>

**Education.**—One study surveyed 369 parents of about their receipt of concussion education and found that more than half reported receiving concussion information (57.7%). Most parents received concussion educational materials from pediatricians (44.9%),



followed by coaches (31.5%), and less than one third searched information independently on the Internet.<sup>40</sup>

## DISCUSSION

This scoping review suggests that along with the rise in educational efforts, the level of awareness and knowledge about concussion among athletes, coaches, and parents has grown. However, a paradigm shift is needed from a focus on knowledge and awareness to one that supports research and development of educational efforts. These efforts should focus on behavioral outcomes around concussion prevention and reporting, improving attitudes that create a culture of concussion, and meeting the needs of targeted audiences.

Today, as many as 7.8 million athletes participate in high school sports,<sup>44</sup> and 60 million participate in organized youth sports programs.<sup>45</sup> Concussions continue to be a commonly reported injury in youth and high school sports. Although youth athletes participating in nonscholastic sports programs far outnumber those in high school-based sports, most of the literature identified in this review focused on high school-aged athletes in scholastic-based programs. Age-specific research is needed to target athletes at each age group, as perceptions of health and safety, the importance of sports competition, and the influence of coaches and parents may vary significantly between high school, middle school, and elementary schoolaged athletes. Furthermore, because it is important to influence athletes early, research about younger athletes is critical. There is also limited research about variations in knowledge, attitudes, and behaviors by race/ethnicity, rural/urban residence, and socioeconomic status.

Among both youth and high school athletes nationwide, one the most significant concerns identified was the culture of underreporting concussions. Reporting concussion symptoms is essential for an athlete to receive the proper assessment, monitoring, treatment, and healing time. As many as two thirds of young athletes in the studies reviewed did not take this critical first step.<sup>12,17</sup> Some studies examined factors that influence underreporting; however, no interventions were identified that lead to improved reporting behaviors among athletes. There is a lack of studies assessing young athletes' behaviors in relation to a specific intervention (such as a rule and/or practice changes; school, state, and league policies; coaching strategies and/or communication).

To improve the culture of concussion safety, it is time for the field to make a paradigm shift from focusing on secondary prevention (reducing the impact of concussion after it has already occurred) to primary prevention (preventing concussion before it occurs) among young athletes. Examining the role that social influences, environmental influences, and policy can play in preventing concussion is critical and currently lacking. CDC's National Center for Injury Prevention and Control has also published, "Injury Center Research Agenda 2009–2018," which includes research priorities related to sports concussion.<sup>46</sup>

## Limitations

Our findings were limited by the small number of studies that met the inclusion criteria and by the lack of studies that assessed interventions or included multiple data collection phases

to evaluate the effects of the experimental interventions. Furthermore, most of the literature focused on high schoolaged athletes. Only a handful of articles specifically addressed youth athletes. Future research could implement rigorous intervention designs to evaluate key audiences' knowledge, perceptions, and behaviors toward concussion, and investigate the research questions specific to youth athletes.

The research summaries do not use international research as knowledge and attitudes/social norms are specific to time and place, and concussion knowledge and attitudes/social norms of interest to this report are those currently held in the United States.

A limitation of scoping reviews is that they generally do not appraise the quality of evidence included in the review.<sup>7</sup> Future efforts should explore the feasibility of conducting a systematic review as a next step in understanding knowledge, attitudes, and behaviors about concussion among parents, athletes, and coaches.

## Conclusions

Despite these limitations, this report summarizes existing literature regarding key audiences' knowledge, perceptions, and behaviors toward concussion. It also begins to address culture as a significant factor that impacts knowledge, perceptions, and behaviors. This report identifies future directions for research and opportunities to build on existing literature to ultimately change the culture around concussions.

More research examining behavioral outcomes of effective interventions and approaches are needed to improve the culture of concussion. Research should incorporate rigorous study designs, include younger athletes and those in nonscholastic settings, include groups from different socio-economic and racial/ethnic backgrounds, assess behaviors in the context of interventions, and examine intervention opportunities to improve behaviors around concussion prevention, reporting, and management. Further research is critical to inform the development and implementation of large-scale educational efforts.

In practice, there are several opportunities for parents, coaches, and young athletes to take steps to improve the culture of concussion. For example, coaches are well positioned to cultivate an expectation among young athletes on their teams to report a concussion. They should ask their young athletes to be upfront in discussing their concerns about reporting a concussion. Both parents and coaches should emphasize to young athletes that reporting concussion symptoms is essential in all situations. Athletes should learn concussion signs and symptoms and look out for the well-being of their teammates.

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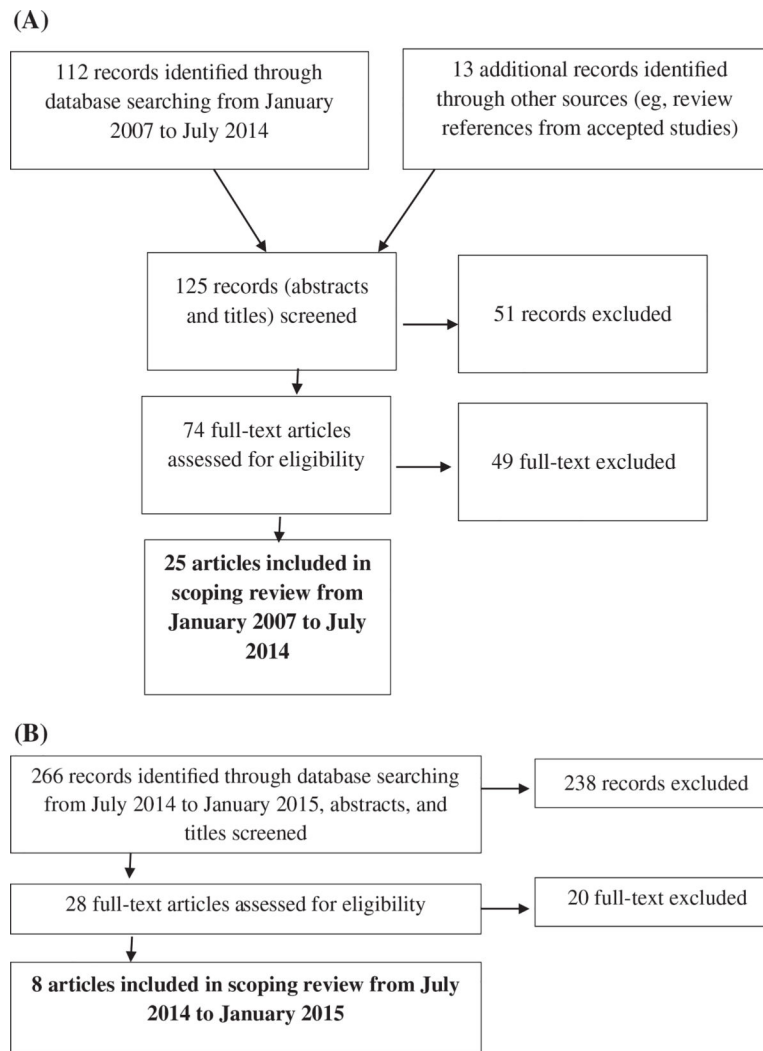
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### IMPLICATIONS FOR SCHOOL HEALTH

Concussion knowledge, attitude, and behavior research provides an important context for identifying opportunities to protect young athletes from concussion in all settings, especially school settings, where physical activity and participation in sports comprise an important part of the curricula. Concussions have clear implications for school health, as concussions symptoms can affect how a young person thinks, acts, learns and feels. School professionals can improve the culture of concussion by supporting students who return to school after a concussion by encouraging students to report symptoms, take time to heal, and by providing needed support when students return to learn. School professionals play a critical role in supporting this process as students should be cleared to return to school after concussion before they RTP.





**Figure 1.**  
Flow of Study Selection. (a) Initial Search; (b) Updated Search

Table 1.

Search Terms

Population Descriptors				
Coaches	Parents	Children/Youth	Health Conditions	Sport Indicators
<ul style="list-style-type: none"><li>• Coach(es)</li><li>• Athletic-trainer(s)</li><li>• League(s)</li></ul>	<ul style="list-style-type: none"><li>• Parent(s)</li><li>• Family</li><li>• Families</li><li>• Mother(s)</li><li>• Father(s)</li><li>• Grandparent(s)</li><li>• Nonparent caregiver(s)</li></ul>	<ul style="list-style-type: none"><li>• Youth</li><li>• Adolescent</li><li>• Teen(s)/teenager</li><li>• Child/children</li><li>• High school student(s)</li><li>• Elementary school student(s)</li></ul>	<ul style="list-style-type: none"><li>• Traumatic brain injury</li><li>• Brain injury</li><li>• Head injury</li><li>• Concussion</li><li>• Craniocerebral trauma</li></ul>	<ul style="list-style-type: none"><li>• Sport-related</li><li>• Sport(s)</li><li>• Athletics</li><li>• Recreational activities</li></ul>
				<ul style="list-style-type: none"><li>• Attitude(s)</li><li>• Aware(ness)</li><li>• Behavior/behavior change</li><li>• Belief(s)</li><li>• Education</li><li>• Knowledge</li><li>• Learning</li><li>• Practice patterns</li></ul>

**Table 2.**  
 Characteristics of Studies Examining Young Athletes' Concussion-related Knowledge, Attitudes, Behaviors, and Educational Interventions

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
Bagley et al (2012)	Effectiveness of the SLICE Program for youth concussion education	636 athlete; 9–18year; (MA)	Study quizzed athletes about concussion knowledge before and after participating in the SLICE program (prospective cohort)	Not reported	Not reported	Not reported	Not reported	SLICE curriculum improved athletes' knowledge about concussion recognition and response (pretest 34% vs posttest 80%).
Bloodgood et al (2013)	Exploration of awareness, knowledge, and perceptions of traumatic brain injury among American youth athletes and their parents	252 youth athletes grouped by age (13–15, 16–18), 100 parents grouped by child's age (5–9, 10–13, 14–18) (US)	Surveys assessed youth athletes' and parents' knowledge, attitudes, and information-seeking behavior on concussion (cross-sectional)	Not reported	4 out of 5 youth athletes ages 13–18 had heard about concussion.	7C% of youth athletes indicated they agreed or strongly agreed that concussions are a "critical issue."	Not reported	Not reported
Bramley et al (2012)	High school soccer players with concussion education are more likely to notify their coach of a suspected concussion	60 high school soccer athletes (OH, PA)	Survey assessed athletes' previous concussion education and RTP decisions using 3 different scenarios (cross-sectional)	2003–2010	Not reported	Not reported	72% of athletes with previous concussion training vs 36% of athletes without previous training said they would notify their coach/trainer of concussion symptoms.	Participants with concussion education (72%) were more likely to report concussion symptoms to a coach/trainer than athletes with no concussion education (36%).
Chrisman et al (2013)	Qualitative study of barriers to concussive symptom reporting in high school athletics	50 high school athletes from 3 football teams, 2 male soccer teams, and 4 female soccer teams (Seattle, WA)	Discussions to identify barriers to reporting concussive symptoms in high school athletics (focus groups)	Not reported	Young athletes may believe that concussion symptoms are other general symptoms like a ringing	Young athletes who received positive messages from their coach and were praised for symptom reporting	6 of 9 groups reported they would continue to play, and 3 of 9 groups reported they would take a quick break and then RTP.	Not reported

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
					in the ears and fatigue.	were more likely to report concussion symptoms.		
Coumoyer et al (2014)	Concussion knowledge in high school football players	334 high school football players (FL)	Survey assessed knowledge of concussion after new concussion education legislation was passed (cross- sectional)	Not reported	Athletes most commonly identified symptoms related to concussion were: headache (97%), dizziness (93%), and confusion (9C%), 81% of athletes identified LCC as a symptomq and 53% identified nausea and vomiting.	Not reported	Not reported	54% of athletes had discussed concussion with their parents. 60% of athletes reported that they received formal education about concussion in class or online. 25% reported that they never received any form of education about concussion. No relationship was found between the method of education and athletes' abilities to identify concussion symptoms and long-term consequences.
Hunt TN (2015)	Video educational intervention improves reporting of concussion and symptom recognition	68 high school athletes (SC)	Survey assessed impact of concussion education video on increasing reporting of concussion symptoms (cross-sectional)	Not reported	Not reported	Not reported	Not reported	The intervention group recognized 77% of concussion signs and symptoms before the intervention and 90% concussion signs and symptoms after the intervention. Control group

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
Hwang et al (2014)	Are pediatric concussion patients compliant with discharge instructions?	150 patients (ages 8–17) discharged from the emergency department with a concussion diagnosis	Baseline and follow-up surveys assessed patients RTP behaviors (prospective cohort)	2011–2012	Not reported	Not reported	At 2 weeks, 44% of patients RTP or normal activities, 35% were symptomatic, and 58% did not receive medical clearance.	79% of concussion signs and symptoms at baseline and 83% post intervention.
Kurowski et al (2014)	Factors that influence concussion knowledge and self-reported attitudes in high school athletes	496 high school athletes	Survey assessed athletes' knowledge and reporting behaviors related to concussion (cross-sectional)	Not reported	Not reported	Not reported	4C% reported that they would always immediately tell a coach or athletic trainer if they had a headache, foggy or dizziness after a hit to the head.	Not reported
McAllister-Deitrick et al (2014)	Sport-related concussion knowledge among youth football players	81 youth football players ages 8–14	Survey assessed concussion knowledge	Not reported	A small number of athletes could recognize some symptoms of concussion such as confusion (23%), nausea (42%), and sleep disturbances (57%)	Not reported	62% agreed with the statement "if I am hit in the head and have a headache, it is OK to continue to play, as long as I don't lose consciousness."	Not reported
O'Kane et al (2014)	Concussion among female middle-school soccer players	351 elite female soccer players (ages 11–14) from 33 youth soccer teams (WA)	Analysis of concussion incidence, rate, symptom description, and whether players sought medical attention or played with	2003–2012	Not reported	Not reported	Most players played with symptoms (58.6%), with 44.1 % seeking medical attention.	Not reported

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
O' Kane et al (2014)	Evaluation of the Zachery Lystedt Law among female youth soccer players	351 elite female soccer players (ages 11–14) from 33 youth soccer teams (WA)	Study assessed the risk of playing with symptoms, evaluation by a healthcare provider, and receiving a concussion diagnosis before and after the Lystedt law passed (prospective cohort)	2003–2012	Not reported	Not reported	After passage of the law 56% reported playing with symptoms compared with 7C% before (no statistical significance).	Not reported
Register-Mihalik et al (2013)	Knowledge, attitude, and concuss on-reporting behaviors among high school athletes: a preliminary study	167 high school athletes	Assessment of athletes' knowledge, attitudes, and beliefs regarding concussion (cross-sectional)	2008–2010	Athletes' increased knowledge of concussion was associated with increased prevalence of reporting concussion events occurring in practice and the reporting prevalence of bell-ringer-only events overall.	The most common reasons athletes did not report a concussion event were they did not think it was serious enough (70.2%), did not want to be removed from play (36.5%), did not want to let down teammates (27.0%), did not want to let down coaches (23.0%), did not know it was a concussion (14.9%), and did not want to be removed from practice (13.5%).	Of the 584 bell-ringer events that athletes recalled, only 12.3%, the respondent indicated the event was reported to a coach or a medical professional.	Not reported



Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
Register-Mihalik et al (2013)	Using theory to understand high school aged athletes' intentions to report sport-related concussion: implications for concussion education initiatives	167 high school athletes age 15.7 ± 1.4 from 25 high schools	Assessment of contributors' intention to report concussion symptoms (cross-sectional)	Not reported	Not reported	Not reported	89 participants recalled at least 1 concussive event. Of those, 17% indicated they reported all recalled concussive events to a coach or medical professional.	Participation in concussion education may increase reporting of symptoms.
Rivara et al (2014)	The effect of coach education on reporting of concussions among high school athletes after passage of a concussion law	778 high school football and female soccer athletes (WA)	Assessment of concussion incidences, the proportion of concussed athletes who played with symptoms, and the association of coach education with awareness of athletes with symptoms (cohort study)	2012	Not reported	Not reported	69% of athletes reported playing with symptoms.	Not reported
Yard et al (2009)	Compliance with return to play guidelines following concussion in US high school athletes, 2005–2008	100 nationally representative US high schools (US)	Retrospectively graded injury reports for concussed athletes submitted by certified athletic trainers (ATCs; prospective cohort)	2005–2008	Not reported	Not reported	Almost half of all high school athletes failed to comply with American Academy of Neurology (AAN) RTP guidelines. Males returned to play sooner after sustaining the same severity concussion as females. 22% of males returned the same day following a grade II concussion vs C% of females	Not reported

Table 3.

Characteristics of Studies Examining Coaches' Concussion-Related Knowledge, Attitudes, Behaviors, and Educational Interventions

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
Bramley et al (2012)	Do youth hockey coaches allow players with a known concussion to participate in a game?	314 youth hockey coaches	Survey with case scenarios about concussion (cross-sectional)	Not reported	Not reported	Not reported	When the importance of the game or the event was not included in the scenario, 92% of coaches reported they would remove the young athlete from play. When the scenario included a championship game, up to 83% of coaches reported they would not allow a concussed athlete to participate in the game	Not reported
Chrisman et al (2014)	Implementation of concussion legislation and extent of concussion education for athletes, parents, and coaches in Washington State	270 public high school football, female soccer, and male soccer coaches (WA)	Survey assessed variation in concussion education and knowledge, related to the concussion law passed in WA, and measured the effects in urban vs rural locations (survey)	2012–2013	Not reported	Not reported	Not reported	Concussion education for coaches and parents was similar between sports, and concussion education for all parties was similar in urban and rural locations
Covassin et al (2012)	Educating coaches about concussion in sports: evaluation of the CDC's "Heads Up: Concussion in Youth Sports" initiative	340 youth sport coaches (US)	Survey assessed coaches' awareness of sports-related concussion and the usefulness of CDC's	Not reported	Not reported	Not reported	Not reported	77% of coaches reported being better able to identify a concussion in athletes, and 50% reported learning

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
Esquivel et al (2013)	Concussion management, education, and return-to-play policies in high schools: a survey of athletic directors, athletic trainers, and coaches	235 high schools (MI)	"Heads Up: Concussion in Youth Sports" initiative and materials (survey)	Not reported	Coaches, athletic directors, and athletic trainers agreed that an athlete who suffered a concussion cannot RTP the same day of injury	Not reported	Not reported	something new about concussion after reviewing the materials
			Survey of concussion education and baseline cognitive testing (survey)					Not reported
Faure et al (2011)	An examination of Idaho high school football coaches' general understanding of concussion.	77 high school head football coaches (ID)	Coaches' knowledge and previous training assessed with questionnaire and interviews (survey)	2005–2006	97.3% of coaches knew that a concussion is not always accompanied by a loss of consciousness	76.7% of coaches did not feel they had been adequately trained in this area. 94.2% of coaches said the risk of concussion in football did concern them 86.3% of coaches felt they had a responsibility to be able to recognize signs and symptoms of concussion and to know when it is safe for an athlete to RTP.	Not reported	Not reported
Giang et al (2010)	Online training in sports concussion for youth sports coaches	75 sports coaches of young athletes (ages 10–18) (US)	Questionnaire evaluated AC Tive, an interactive e-learning program designed to train coaches	Not reported	Not reported	Not reported	Not reported	Intervention group had gains across knowledge of concussion symptoms, general concussion

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
Naftel et al (2014)	Knowledge and management of sports concussions among coaches and certified athletic trainers in Alabama	402 coaches and 55 ATCs (AL)	Survey of concussion knowledge, Zurich Consensus statement, and concussion management (Internet survey)	Not reported	Coaches and ATCs had difficult?/ recognizing subtle symptoms, such as trouble sleeping, personality changes, and dizziness	Not reported		knowledge, misconceptions about concussion, self-efficacy regarding perceived self-confidence about taking appropriate action
Rivara et al (2014)	The effect of coach education on reporting of concussions among high school athletes after passage of a concussion law	775 high school football and female soccer athletes (VVA)	Assessment of concussion incidences, the proportion of concussed athletes who played with symptoms, and the association of coach education with awareness of athletes with symptoms (cohort study)	2012	Not reported	Not reported		Of athletes with a concussion, 40% reported that their coach did not know they had a concussion. There were no differences in coach awareness by the number of educational modalities or awareness of the Lystedt Law
Sarmiento et al (2014)	A 10-year review of the Centers for Disease Control and Prevention's Heads Up initiatives: bringing concussion awareness to the forefront	US	Discussion of CDC's Heads Up campaign for concussion education (focus groups, survey)	Not reported	Not reported	Not reported	Not reported	Summary of results of HEADS UP campaign
Shenouda et al (2012)	The effects of concussion legislation 1 year later—What have	391 parents, coaches, volunteers, club officers, and referees (WA)	Assessment of identification and management	2010	Not reported	Not reported	Not reported	93% agreed that all concussions are serious, 75% believed they

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
Valovich et al (2007)	we learned: a descriptive pilot survey of youth soccer player associates	156youth sports coaches	of concussion symptoms and RTP guidelines according to the Lystedt laws (survey) Survey assessed concussion knowledge	Not reported	Coaches have difficulty identifying some symptoms of concussion	Not reported	Not reported	had adequate access to information related to head injury Coaches who receive coaching education are more likely to correctly recognize concussion signs and symptoms
Williams et al (2012)	High school coaches' perceptions of physicians' role in the assessment and management of sports-related concussive injury	101 high school coaches (SEUS)	Survey assessed high school coaches' concussion awareness, number of concussions seen in the past year, referral to physicians, and RTP guidelines (cross-sectional)	Not reported	Not reported	Not reported	Not reported	95.8% of high school coaches received formal concussion awareness training

ATC, certified athletic trainer; RTP, return to play; CDC, Centers for Disease Control and Prevention.

**Table 4.**  
 Characteristics of Studies Examining Parents' Concussion-Related Knowledge, Attitudes, Behaviors, and Educational Interventions

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
Bloodgood et al (2013)	Exploration of awareness, knowledge, and perceptions of traumatic brain injury among American youth athletes and their parents	252 youth athletes grouped by age (13–15, 16–18), 100 parents grouped by child's age (5–9, 10, 13, 14–18) (US)	Surveys assessed youth athletes' and parents' knowledge, attitudes, and information-seeking behavior about concussion (cross-sectional)	Not reported		70% of youth athletes and 84% of parents indicated they would agree or strongly agree that concussions are a "critical issue." More mothers than fathers (68% vs 34%) said they would strongly agree that concussions are a critical issue.	Not reported	
Gordon et al (2010)	Concussion or mild traumatic brain injury: parents appreciate the nuances of nosology	1734 parent; at the ED	Brief questionnaire about the diagnostic terms "concussion," "minor traumatic brain injury," and "mild traumatic brain injury" (survey)	Not reported	Not reported	Parents perceived "concussions" as milder and "TBI" as a more severe injury.	Not reported	Not reported
Hajek et al (2011)	Agreement between parents and children on ratings of postconcussive symptoms following mild traumatic brain injury	186 youth with mild TBI and 99 youth with orthopedic injuries (ages 8–15) evaluated in ED (OH)	Postconcussive symptoms were assessed using the Health and Behavior Inventory and the Postconcussive Symptom Interview. Symptom ratings were assessed by children and their parents (part of a larger longitudinal study)	Not reported	Parents may be less aware of their child's fluctuating symptoms following mild TBI compared with OI, or children with mild TBI may lack awareness of their symptoms. Correlations tended to be higher on cognitive symptoms compared with somatic	Not reported	Not reported	Not reported



Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
LaBond et al (2014)	Sports-related head injuries in students' knowledge, attitudes, and perceptions	235 parents (Midwest school district)	Survey assessed knowledge and attitudes about sports-related head injuries (descriptive research study)	Not reported	When asked if there were circumstances when an athlete could return to play immediately after a concussion, 61% replied yes. 99% agreed that a physician should check a student with concussion before they return to play. 72% strongly agreed that parents should know the signs and symptoms of concussion. 63% reported that they can recognize concussion in their child, and 10% reported that they could determine when their child was ready to play.	Not reported	Not reported	Not reported
Mannings et al (2014)	Knowledge assessment of sports-related concussion among parents of children aged 5 years to 15 years enrolled in recreational tackle football	369 parents of athletes ages 5–15	Survey assessed parental knowledge of concussion signs and symptoms	2011	65% of parents were unable to identify that concussion is a mild TBI and can be achieved by something other than a blow to the head (42%). Most parents could identify	Not reported	Not reported	53% reported receiving information about concussion and its symptoms (57%). 28% reported receiving written

Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
Provance et al (2012)	Implications of parental influence on child/adolescent helmet use in snow sports	206 children ages 6-17 and their parents (CO)	Survey assessed factors that influenced youth to not wear a helmet while skiing/snowboarding (cross-sectional)	2006-2008	Not reported	87.7% of children who always wore a helmet said that safety was one of their reasons for wearing a helmet.	A child was 9.55 times more likely to wear a helmet if his or her parent also wore a helmet than if the child's parent did not wear a helmet.	Not reported
Register-Mihalik et al (2013)	Using theory to understand high school aged athletes' intentions to report sport-related concussion: implications for concussion education initiatives	167 high school athletes age 15.7 $\pm$ 1.4 from 25 high schools	Assessment of contributors' intention to report concussion symptoms (cross-sectional)	Not reported	Not reported	Not reported	89 participants recalled at least 1 concussive event. Of those, 17% indicated they reported all recalled concussive events to a coach or (radical) professional.	Not reported
Stevens et al (2010)	Parental recognition of postconcussive symptoms in children	105 parents of children ages 5-17 who were discharged from the pediatric ED with TBI (Midwest US)	Survey delivered to parents 2-5 days post injury about the identification of TBI symptoms (prospective)	2009	62.9% of children who had concussions developed post concussive symptoms, but most parents (69.5%) initially reported that their child did not exhibit post concussive signs or symptoms. When parents were asked about individual symptoms, 46.6% of parents who had reported an	Not reported	Not reported	Not reported

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Author (Publication Year)	Title	Study Population (Location)	Study Design	Data Collection Year	Knowledge	Attitudes	Behaviors	Education
					asymptomatic child, recognized 1 or more symptoms in their child.			

ED, emergency department; OI, orthopedic injury; TBI, traumatic brain injury.