Sport-related concussion (SRC) education: A review and synthesis of the literature

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Last updated: January 2024

Introduction

Sport-related concussions (SRC) represent a growing health concern for many athletes (Black et al., 2020; Ramsay & Dahinten, 2020), as these injuries can negatively impact an athlete's health and well-being (Kim et al., 2018; Pennock et al., 2020). With this in mind, it's essential to identify strategies that may improve the primary and secondary prevention of SRC (Russell et al., 2017). Improving SRC education is an often-discussed strategy for improving athlete safety, increasing SRC awareness, reducing injury occurrence and decreasing the negative impacts when SRCs happen (Russell et al., 2017).

To be most effective, educational initiatives should be based on the most up-to-date evidence and made widely available for all sport members and health care professionals. That availability is key because all members of the sport community and health care professionals contribute to improving the primary and secondary prevention of SRC (Pennock et al., 2020; Russell et al., 2017). While SRC education has improved in recent years, there's a need to continue evaluating, updating and enhancing initiatives for SRC education. By improving SRC education, knowledge and behaviours, we may create safer sport environments, which will allow athletes to continue to enjoy the many benefits of sport.

Purpose and objectives

This review's purpose is to summarize the research exploring SRC education, knowledge and behaviors. By summarizing this research, our goal is to highlight the importance of improving SRC education for all individuals involved in sport (for example, coaches, parents and guardians, and officials). Specifically, the objectives of the review are to highlight:

- the effectiveness of education on improving knowledge and behaviors;
- the importance of SRC education for all members involved in sport;
- strategies for improving educational initiatives in the future.

Search strategy

To explore the literature focused on SRC education, in June 2021, we searched three databases (PubMed, Web of Science and Google Scholar) using the terms "concussion" AND “sport” AND “education” OR “prevention” AND “behaviours” OR "attitudes” OR “knowledge.” We identified additional articles by manually searching through reference lists of key articles included in this review. We included studies in the review if they were peer-reviewed and published in English between 2015 and 2021. In total, we identified 24 articles to include in this review. In November 2023, we updated this review by conducting a search identical to the one executed in June 2021, focusing on articles published between 2021 and 2023. An additional 17 articles were included in this review.

Summary of findings

1.1 The effectiveness of educational initiatives

1.1.1 Knowledge

Research shows that exposure to SRC education is often associated with improvements in SRC knowledge in a wide range of individuals, including parents, coaches, athletes and officials (Black et al., 2020; Conaghan et al., 2020; Enniss et al., 2018; Kolberg et al., 2021; Labiste et al., 2021; Macartney et al., 2019; Ramsay & Dahinten, 2020; Salmon et al., 2023; Yeo et al., 2020). For example, McCartney and colleagues (2019) found that youth soccer players (ages 10 to 14 years), who were exposed to the Parachute Concussion Awareness for Players curriculum, showed significant increases in their SRC knowledge. In particular, after completing the Parachute curriculum players reported higher knowledge around SRC symptom recognition (Macartney et al., 2019). This is important because athletes must recognize the signs of an SRC (Macartney et al., 2019). After all, parents or guardians and coaches won't always notice an injury happened (Macartney et al., 2019).

It's important to recognize that while educational initiatives can improve short-term SRC knowledge, these initiatives may not have lasting effects (Mrazik et al., 2015; Ramsay & Dahinten, 2020). In many cases, knowledge has been found to return to baseline or pre-intervention levels over time (Mrazik et al., 2015; Ramsay & Dahinten, 2020). Given the likelihood of a return to those levels, organizations may consider providing educational initiatives throughout the season to ensure that SRC knowledge is maintained (Cusimano et al., 2018).

1.1.2 Behaviours and attitudes

Several studies have explored the relationship between SRC knowledge, behaviours and attitudes. When examined together, these studies suggest that while educational initiatives may improve SRC knowledge (Cash et al., 2021), these changes in knowledge don't necessarily result in changes in behaviours or attitudes around SRC (Black et al., 2020; Bernstein et al., 2019; Conaghan et al., 2020; Cusimano et al., 2018; Kim et al., 2020; Ramsay & Dahinten, 2020; Waterworth et al., 2020). However, it's important to note that the findings of individual studies are mixed. That means some studies showed improvements to SRC behaviours and attitudes post-education while others saw no changes (Conaghan et al., 2020).

One study that emphasizes the disconnect between SRC knowledge and behaviours was performed by Mrazik and colleagues (2015). In that study, researchers found that 95% of Canadian youth hockey players reported that they knew they should stop playing if they suspected an SRC. However, when asked what they would do, only 78% of athletes said they would stop playing and report their injuries. Most concerning was that of the athletes who previously had an SRC, only 43% stopped playing and followed proper SRC protocols. This study highlights the need for educational initiatives to go beyond knowledge to target behaviours as well.

Another important point to consider is the focus of research on assessing the impact of education on individuals' *intentions* to report SRC. Notably, some studies do not demonstrate improvements in intentions to report an SRC following educational initiatives. For instance, in a comparative study that looked at three different education tools (meaning, current NCAA handout, educational video, and non-treatment control video), Adame et al. (2023) observed no difference between the tools when it came to changing athletes' immediate intention to remove themselves from play or to promptly report their SRC. Conversely, in studies indicating enhanced intentions, caution is warranted in drawing conclusions, as heightened intentions do not necessarily correlate directly with reporting behaviors (Daneshvar et al., 2021; Daneshvar et al., 2021; Kroshus et al., 2023). Consequently, further research investigating the link between intentions to report a SRC and subsequent SRC reporting behaviors is essential to help gain a comprehensive understanding of the dynamics involved in concussion reporting.

Because SRC reporting remains low, there's a particular need to improve SRC reporting behaviours in athletes (Pennock et al., 2020; Sarmiento et al., 2017). SRC underreporting is concerning because it means that athletes may not get the care they need post-injury (Sarmiento et al., 2017). Furthermore, athletes who continue to play after an SRC place themselves at risk of suffering from secondary impact syndrome and a prolonged SRC recovery (Russell et al., 2017). To improve behaviours around SRC, it's important to create interventions that target the factors contributing to athletes' underreporting of SRC, for example, not wanting to let their team or coach down (Pennock et al., 2020; Kim et al., 2018; Sarmiento et al., 2017).

Additionally, to improve SRC reporting behaviours, coaches and sport leaders should work to create environments where athletes feel supported and comfortable coming forward with information about SRC (Kim et al., 2018; Yeo et al., 2020). For instance, in Callahan and colleagues' (2021) study, the authors found that exposure to SRC education was significantly associated with more favorable perceived social norms surrounding SRC care seeking. This finding underscores the critical significance of promoting a culture that encourages athletes to seek support for SRC, especially in situations where the prevailing sport culture may not facilitate such care-seeking behaviors. Moreover, coaches play a critical role in influencing reporting behaviours (Sarmiento et al., 2017). For example, in their review, Sarmiento and colleagues (2017) noted that athletes are more likely to report an SRC when their coaches encourage and celebrate reporting. With this in mind, coaches may consider having more frequent and open conversations about SRC with their athletes. Coaches and organizations may also consider promoting interventions designed to foster social support amongst teammates (Caron et al., 2018) as peers can influence each other's health behaviours (Hickling et al., 2020). Improving social support amongst teammates may help increase reporting behaviours (Caron et al., 2018) and help athletes cope with their recovery (Kita et al., 2020).

1.2 Education for all

This review's previous section focused primarily on the importance of education for athletes. However, improving SRC education is critical for all stakeholders involved in sport, as all individuals play a role in enhancing SRC management and prevention. In this section, we'll

highlight the importance of improving SRC education for all sport members and supporters, including healthcare professionals, policymakers, parents and guardians, sport organizations, coaches and officials.

1.2.1 Health care professionals

Medical professionals, such as pediatricians and emergency room physicians, play an important role in detecting and managing an SRC (Bazarian et al., 2020; Mathieu et al., 2018). To ensure that these professionals can accurately diagnose and appropriately manage an SRC, it's important that they're knowledgeable of SRC and that they are aware of the most current recommendations and best practices (Mathieu et al., 2018). Providing health professionals with SRC education can increase their short and long-term concussion knowledge as was demonstrated in a study performed by Berz et al., 2022. Additionally, healthcare professionals with extensive SRC knowledge and strong self-efficacy may be more inclined to adopt and follow SRC guidelines, which is key for sustaining the well-being and health of athletes (Sarmiento et al., 2021).

Unfortunately, many medical practitioners are not exposed to concussion education. In a study focusing on medical students in Scotland, the authors found that only 15% of the participants had received prior education on SRC during their schooling, while a substantial 92.5% expressed an interest in acquiring SRC education. In a study from the US, the results show that the majority of medical students would be able to define concussion however, most reported never having a lecture dedication to concussion (Donaworth et al., 2016). This underscores a clear need for increased SRC education within medical schools. However, in a Canadian study, it has been shown that concussion education among medical students has improved. In fact, in their study, the authors found that 85% of the medical schools provided concussion-specific education (compared to 29% in their 2012 study) and the number of hours dedicated to learning about concussion was 2.65 hours (compared to 0.57 in their 2012 study; Mathieu et al., 2018). This data is encouraging, but more efforts are needed as it is essential for these future healthcare professionals to possess the necessary knowledge to provide optimal care for patients affected by SRC.

Additionally, healthcare professionals play a critical role in educating individuals about SRC (Bazarian et al., 2020). In fact, healthcare professionals were the preferred and most common source of SRC education for parents and coaches in a recent Canadian study (Black et al., 2020). Accordingly, these professionals must share accurate information that will allow athletes and their supporters (that is, parents, guardians and coaches) to take the appropriate steps towards recovery. Healthcare professionals may also work to educate athletes about risk reduction strategies (Bazarian et al., 2020). For example, they may explain the potential benefits of neck strength training and the importance of wearing properly fitted equipment (Bazarian et al., 2020).

1.2.2 Policymakers and sport organizations

Policymakers and sport organizations (including sport governing bodies and sport administrators) play an essential role in improving SRC awareness, education, management and prevention (Russell et al., 2017). As such, it's critical that members within this group are familiar with the current evidence and best practices. That way they can use this information to develop, revise and promote effective rule changes, legislation and educational initiatives (Kim et al., 2018).

When creating policies, policymakers and sport organizations may consider specifying the content, type and quality of the educational tools that should be shared (Black et al., 2020). Researchers have noted that policies that provide clarity about the recommended tools may have a more significant impact on improving education (Black et al., 2020; Kim et al., 2018).

1.2.3 Coaches and parents

A registered healthcare practitioner such as a team physician isn't present at many sporting events. Thus, the responsibility for SRC detection and immediate management (that is, removal from play) often falls to the coaches and parents (Black et al., 2020; Kim et al., 2018; Pennock et al., 2020). Accordingly, parents, guardians and coaches should be educated about SRC signs and symptoms, and the importance of seeking medical care for athletes with a suspected injury (Black et al., 2020; Kim et al., 2018). Furthermore, educational initiatives should focus on the return-to-sport protocols when the initiatives are targeted at parents, guardians and coaches, because they all play central roles in facilitating a safe re-entry into sport (Black et al., 2020).

Educating parents, guardians and coaches may have benefits for athletes' SRC knowledge as well (Black et al., 2020; Chrisman et al., 2021; Kroshus et al., 2023; Yeo et al., 2020). For example, Black and colleagues (2020) noted that Canadian parents who are exposed to SRC education are more likely to educate their children about SRC than those who aren't exposed to educational initiatives. Similarly, a review by Conaghan and colleagues (2020) noted that coaches who were exposed to more educational initiatives were more likely to discuss SRC with their athletes. Chrisman and colleagues (2021) found similar results using a web-based SRC education platform for collegiate coaches. Indeed, coaches had 2.5 greater odds of expecting to discuss SRC with their team following completion of the SRC education platform. Improving communication between coaches and athletes not only about SRC, but also the importance of proper tackling techniques or around helmet fit may also contribute to SRC prevention (Yeo et al., 2020).

1.2.4 Officials

By calling for pauses in play to allow for injury assessments, officials play an important role in SRC recognition and initial management (King & Coughlan, 2021; Kroshus et al. 2017, Yeo et al., 2020). However, only 24% of the referees involved in Kin & Coughlan’s (2021) study reported receiving SRC education. Moreover, 85% of the referees felt that they could play an important role in SRC recognition, but only 41% felt adequately equipped with knowledge (King & Coughlan, 2021). In rugby, officials can give players who have a suspected SRC a Blue

Card.[1] The Blue Card requires an athlete to stop playing and begin the appropriate return-to-sport process. To ensure that officials have the knowledge and confidence to recognize an SRC, it's important to continue to provide them with SRC education (Kroshus et al., 2017; Yeo et al., 2020). Additionally, it's vital to educate others about the role that officials play in creating a safe sport environment, as officials are more likely to call for an injury assessment when they feel supported (Kroshus et al., 2017).

1.3 Strategies for improving educational initiatives

Future research is required to fully understand how to optimize educational initiatives to improve SRC knowledge, behaviours and attitudes (Kim et al., 2018). However, researchers have suggested several strategies that may be used to enhance educational initiatives in the future. These strategies include engaging with learners regularly, using diverse learning tools, and tailoring those tools to the target audience.

1.3.1 Engage with learners regularly

As aforementioned in this review, knowledge gained from educational initiatives often dissipates over time (Mrazik, Dennison, Brooks, Yeates, Babul & Naidu, 2015; Ramsay & Dahinten, 2020). To help individuals maintain their SRC knowledge, it may be beneficial for educational initiatives to occur at multiple time points throughout a season (Hunt et al., 2018; Kim et al., 2018; Kroshus et al., 2019; Ramsay et al., 2020). On-going education may be particularly important when the educational tools are delivered through online platforms, as these forms of dissemination often have shorter lasting effects (Cusimano et al., 2018).

Additionally, disseminating SRC information on a regular basis may be beneficial as it allows for information to be shared in smaller doses (Caron et al., 2018; Kroshus et al., 2019). This can reduce information overload, which often makes educational initiatives feel overwhelming (Caron et al., 2018). Furthermore, delivering education on a more regular basis allows for content to be continuously refined and updated to ensure that it reflects the most recent research and best practices (Yeo et al., 2020), and meets the changing needs of the target audiences (Caron et al., 2018).

1.3.2 Use a diverse range of learning tools

To reach individuals with a diverse range of learning styles, it can be beneficial for educational initiatives to integrate a range of learning strategies (Cusimano et al., 2018; Hunt et al., 2018; Kim et al., 2018; Pennock et al., 2020; Weber Rawlins & McLeod, 2023). For example, organizations may consider disseminating information using a mixture of infographics, videos, handouts and social media (Kim et al., 2018).

A study performed by Cusimano and colleagues (2018) exemplified the benefits of using multiple learning modalities. In that study, researchers noted that individuals who used 3 or more Canadian concussion resources (including apps, learning modules and videos) showed

[1] For more information about the Blue Card, visit Rugby Ontario's website.

more significant improvements in their SRC knowledge compared to those who used just 1 resource (Cusimano et al., 2018).

Of note, researchers have suggested that compared to more passive forms of dissemination, interactive learning tools such as workshops may have a more significant and perhaps more long-lasting impact on knowledge, behaviours and attitudes (Kim et al., 2018). Interactive tools may be particularly effective when they're delivered on a more ongoing basis (Kim et al., 2018). Kroshus and colleagues (2019) highlight the crucial role of simplicity in educational interventions and emphasize the need for minimal resource utilization to enhance feasibility. In light of this, those spearheading educational initiatives should explore a diverse array of learning tools, incorporating interactive options that are user-friendly and demand minimal resources.

1.3.3 Ensure tools are audience specific

To be most effective, a learning tool's content and style should be designed with the needs and preferences of the target audience in mind (Cusimano et al., 2017; Hunt et al., 2018; Kim et al., 2018). This may mean that an organization needs to create different tools for different audiences. For example, if the learning tool is intended for First Nation communities, the content should be guided by First Nations culture and ideally include input from First Nations leaders to be more effective (Hunt et al., 2018).

Additionally, it's important to consider how the target audience will interact with the learning tool. For example, if the intention is for the learning tool to be used by a team before practice, it's important that the intervention isn't too long to avoid interfering with training times (Conaghan et al., 2020; Enniss et al., 2018). Lastly, learning tools should focus on addressing gaps in audience-specific knowledge. For example, learning tools targeted at parents and coaches may work to clarify SRC signs and symptoms as well as the proper return-to-sport protocols (Black et al., 2020, Feiss et al., 2020; Ramsay & Dahinten, 2020).

Conclusion

This review provides sport members with information about the importance of SRC education. For this review, we specifically explored the effectiveness of educational initiatives on changing knowledge and behaviours, the importance of continuing to provide education to all sport members and strategies for improving SRC educational initiatives in the future.

Overall, research suggests that educational initiatives improve SRC knowledge in a wide range of sport members. However, these knowledge gains may not last over a long period of time. As such, it may be beneficial to deliver SRC education on an ongoing basis throughout the season. Of note is that changes in knowledge don't necessarily translate into changes in behaviours and attitudes around SRC, for example, reporting behaviours. More research is needed to understand how to improve reporting behaviours in athletes. Nonetheless, researchers have suggested that creating environments where athletes feel supported and comfortable coming forward with SRC information may be an essential first step.

While SRC knowledge has improved in recent years, there's still a need to enhance education for all sport members. When creating educational tools to target different audiences, it's important to consider each target audience's unique needs and preferences. Additionally, to ensure that educational tools meet the needs of all individuals within the target audience, it can be beneficial to provide a diverse range of learning tools. When possible, it may help to include interactive tools, as these may have more long-lasting effects on an individual's SRC knowledge.

Takeaway points
• Educational initiatives can improve SRC knowledge for a wide range of sport participants and supporters. • Changes in SRC knowledge don't necessarily lead to changes in SRC attitudes and behaviours (e.g., reporting). • SRC education is required for all sport members and healthcare professionals. • Educational initiatives may be improved by using a diverse range of learning tools that are tailored to the needs of the target audience.

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