



**What is the role of protective equipment in sport-related concussion prevention?:
A review and synthesis of the literature**

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1 Introduction

Sport-related concussions (SRC) are a growing health concern for athletes who participate in a wide range of contact and non-contact sports. The potential short-term and long-term implications of these injuries on an athlete's well-being and sport participation have led sport and research communities to work on identifying ways to prevent such injuries (Emery et al., 2016). The use of protective equipment, which is known to prevent a wide range of sport-related injuries, is one strategy often discussed for SRC prevention (Emery et al., 2016; Kriz & Roberts, 2021). Understanding the current evidence around equipment use and SRC prevention is important for all sport participants as it may help them make decisions around equipment policies and equipment use in their sport.

2 Purpose and objectives

This review's purpose is to summarize research that explores the role of protective equipment in SRC prevention. This review's findings will provide sport organizations, coaches and athletes with information to help them make educated decisions about using protective equipment in their sport. Specifically, this review aims to determine how helmets, mouthguards and headgear influence an athlete's SRC risk.

3 Search strategy

To explore research focused on protective equipment's role in reducing SRC risk, we searched 4 databases (PubMed, DOAJ, Elsevier Science Direct and Google Scholar). We searched them between January and March 2021 and again in March 2024, using the terms "mouthguard" or "helmet" or "headgear" or "protective equipment" and "concussion" and "sport" and "risk reduction" or "prevention." We limited searches to peer-reviewed articles, published in English from 2016 to 2024. In total between the two searches, we identified 25 articles to include in this review.

4 Summary of findings

4.1 Helmets

Helmets have been found to decrease the risk of severe head trauma in several summer and winter sports, including, but not limited to, cycling, skiing and snowboarding (Alfrey et al., 2021; Ennis et al., 2018; Halstead et al., 2020). Helmets work by absorbing the forces from an impact (for example, from a fall), which reduces the number of forces applied directly to the head (Schneider et al., 2016). That said, helmets can't prevent the brain from moving around or "sloshing" within the skull (Kriz & Roberts, 2021; Schneider et al., 2016). Several studies have explored the relationship between helmet use and reducing SRC risk (for example, Alfrey et al.,

2021). However, the findings from individual studies are mixed. That is, some studies have shown mild protective effects while others have shown no protective effects (Kriz & Roberts, 2021; Schneider et al., 2016; Schneider et al., 2019; Waltzman & Sarmiento, 2019). For example, Connor and colleagues (2019) found that helmets reduced the severity of head injuries and decreased the occurrence of skull fractures in equestrian athletes. However, they suggested that since SRC incidence in helmeted riders was still high, that the use of helmets didn't effectively prevent SRC (Connor et al., 2019). These findings were further supported by Alfrey and colleagues (2021), who found that helmets reduced severe head trauma for cyclists, but didn't prevent SRC. More research is required to fully understand the role of helmets in SRC prevention for a wide range of summer and winter sports.

While the effectiveness of helmets for reducing SRC remains unclear, researchers have suggested that a helmet's fit may influence the severity and duration of an athlete's SRC symptoms (Emery et al., 2017). For example, Greenhill and colleagues (2016) noted that youth football players who wore improperly fitted helmets were at an increased risk of suffering from more severe and longer-lasting symptoms than youth wearing properly fitted helmets. These findings were further supported by Gamble et al., (2020), who found a possible relationship between helmet fit and concussion risk in Canadian youth ice hockey players. It's important to note that helmet fit can change throughout the season (Greenhill et al., 2016). For example, hairstyle changes (for example, a haircut) can alter how an athlete's helmet fits¹ (Greenhill et al., 2016). With that in mind, sports organizations and coaches may consider encouraging parents and athletes to check athletes' helmet fit regularly. To support parents and athletes with assessing helmet fit, an organization may consider referring them to tools, such as the [summer](#) and [winter](#) helmet-fitting tools, developed by Parachute Canada.

It is essential that research continues to progress to explore how additional helmet characteristics may influence SRC risk. For example, Kolstad and colleagues (2023) examined how helmet age influenced SRC risk, as many older helmets have less padding and safety features when compared to newer models. In their study, Kolstad and colleagues (2023) noted no significant differences between helmet age and SRC risk. With that said, they emphasized the need for more research exploring this relationship and the relationship between other helmet features, such as facemask types and SRC risk. As research continues to emerge, it will be necessary for sport policies to adapt to align with the latest evidence and best practices. Additionally, sports organizations should continue educational efforts around protective equipment, as many athletes do not understand the role of helmets in SRC (Hardwicke et al., 2022). This education may focus on the pros and cons of current helmets and new technologies emerging for protective equipment, like helmets (Hardwicke et al., 2022)

4.2 Headgear

¹ For an example of how changing hairstyle can alter helmet fit, see SIRC's video about the role of protective equipment in SRC.

Headgear is a softshell headcover often seen in sports like rugby and soccer (Emery et al., 2017; Kriz & Roberts, 2021; Schneider et al., 2016). Headgear protects athletes from superficial injuries like cuts and bruises, which often occur in rugby scrums (Schneider et al., 2016). However, like with helmets, the evidence is inconclusive regarding the effectiveness of headgear in preventing SRC (Emery et al., 2017; Ennis et al., 2018; Kriz & Roberts, 2021; Waltzman & Sarmiento, 2019). While some studies have shown protective effects, others have found no association between the use of headgear and reduced SRC risk (Emery et al., 2017; Knight et al., 2021; Schneider et al., 2016; Schneider et al., 2020). Most recently, a systematic review performed by Attar and colleagues (2023) did not support the use of headgear for SRC prevention. However, it is important to recognize that the literature on this topic is somewhat sparse and thus more studies are needed in order to fully understand the role of headgear in SRC.

Of note is that several studies have found an increased risk of concussion in headgear users (Chalmers et al., 2012; Menger et al., 2016; McIntosh et al., 2009). Researchers have suggested that this is the case, because players mistakenly believe that the headgear will prevent injury and thus play more aggressively. For example, in the one study, Menger and colleagues (2016) found that athletes who thought their headgear prevented SRC were around 4 times more likely to exhibit aggressive playing behaviours than athletes who wore headgear but didn't believe the headgear prevented SRC. These findings are concerning because they suggest that athletes may be putting themselves and others at an increased risk of injury when they don't understand the role of their equipment (Menger et al., 2016; Register-Mihalik et al., 2017). Like with helmets, this highlights the importance of organizations educating athletes about the roles and limitations of their equipment.

4.3 Mouthguards

Mouthguards have been found to reduce orofacial injuries, which includes damage to teeth and gums, in a wide range of sports, including ice hockey, basketball and rugby (Ahmed & Fine, 2020; Chisholm et al., 2020; Emery et al., 2017; Halstead et al., 2018; Petterson et al., 2020; Waltzman & Sarmiento, 2019). When it comes to SRC, researchers have suggested 2 mechanisms by which mouthguards may reduce an athlete's risk of injury. First, biting down on a mouthguard may increase neck muscle activation (Chisholm et al., 2020; Green, 2017). During an impact, this increased activation may result in less head acceleration and a decreased risk of SRC (Chisholm et al., 2020; Green, 2017). Second, wearing a mouthguard changes jaw position so that there is more space between where the jaw connects to the rest of the skull (Chisholm et al., 2020; Knapik et al., 2019; Petterson et al., 2020). In an impact where the jaw is involved, this may reduce the number of forces transmitted from the jaw to the skull, which may minimize SRC risk (Chisholm et al., 2020; Knapik et al., 2019). That said, more research is needed to further understand the mechanisms by which mouthguards may influence SRC risk.

Like with helmets and headgear, the findings in the literature are mixed when it comes to the protective effects of mouthguards (Emery et al., 2017; Halstead et al., 2018; Knapik et al., 2019;

Petterson et al., 2020; Waltzman & Sarmiento, 2019). However, recently a Canadian study found that youth hockey players who wore mouthguards had lower odds of sustaining an SRC than those who didn't wear mouthguards (Chisholm et al., 2020). This was further supported by Kolstad and colleagues (2023), who found that both custom and boil and bite mouthguards had protective effects when it comes to SRC in youth athletes. Interestingly, some researchers suggest that the type of mouthguard an athlete wears may impacted their SRC risk. In one study, researchers found that off-the-shelf mouthguards (that is, boil and bite mouthguards) had a more significant protective effect against SRC compared to custom-made mouthguards (Chisholm et al., 2020). Several other studies have explored the relationship between mouthguard type and SRC risk with conflicting results (Schneider et al., 2016; Kolstad et al., 2023). As such future research should strive to understand the relationship between mouthguard type and use and SRC risk. In the meantime, sports, like ice hockey, should consider implementing policies that support the use of mouthguards (Eliason et al., 2023).

5 Conclusion

This review provides sport organizations and sport participants with information that can help them make educated decisions about the use of protective equipment in their sport. For this review, we specifically explored the role of helmets, headgear and mouthguards in SRC prevention.

Overall, there are mixed findings when it comes to the protective benefits of helmets, headgear and mouthguards for SRC. With that said, each piece of equipment offers well established protection from other injuries. Helmets can protect against severe head trauma. Likewise, a properly fitted helmet may reduce the severity and duration of an athlete's SRC symptoms. Furthermore, headgear and mouthguards have protective effects on reducing cuts and bruises and injuries to teeth and gums, respectively.

While protective equipment may not reduce SRC risk, the importance can't be overstated of athletes wearing the recommended protective equipment for their sport. Organizations should continue to promote the use of protective equipment. Organizations may also consider working to educate athletes on the roles and limitations of their equipment to ensure that athletes understand the level of protection provided and act accordingly.

Takeaway points

- Helmets and mouthguards reduce the risk of severe head trauma and orofacial injury, respectively.
 - Findings are mixed when it comes to the effectiveness of helmets, headgear and mouthguards in reducing SRC risk.
 - Athletes should be educated about their equipment's roles and limitations as well as the importance of wearing equipment that fits properly.
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6 References

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