

EVIDENCE BRIEF

Interventions to Prevent Concussions



December, 2020

Key Messages

- Concussions are the most common form of head injury and represent a significant burden of injury to Ontarians. In 2018, the former Ministry of Health and Long-Term Care (MOHLTC) in Ontario included concussions as a topic of consideration in their injury prevention guidelines.
- To inform a program of public health intervention, we reviewed the literature on interventions to prevent concussion across ages and injury mechanisms.
- There is strong evidence supporting the effectiveness of body checking policies in youth ice hockey and for multi-component education programs in youth sports.
- There is mixed evidence regarding the effectiveness of protective equipment in concussion prevention in sporting and non-sporting contexts. Mouth guards do not appear to prevent concussions, but prevent other facial injuries in sports. Helmets prevent head injuries in sports and motorcycling; however, future research should assess concussion as an independent outcome.

Issue and Research Question

Concussions are the most common form of head injury and can be caused by either direct impact or forceful motion of the head or other part of the body that results in rapid movement of the brain within the skull.¹

In Ontario, emergency department visits for concussions has increased significantly over time, from 63.7 visits per 100,000 in 2003, to 242.5 per 100,000 in 2018.² This may reflect a true increase in incidence, an increase in awareness and reporting, or a combination of the two. In either case, this increase identifies an opportunity for prevention.

Much of the current action on concussions in Canada pertains to concussion awareness and identification, post-concussion management and guidelines for returning to school, work and sports. This, then, identifies a gap for public health organizations to focus on concussion prevention. In 2018, the former Ministry of Health and Long-Term Care (MOHLTC) in Ontario included concussions as a topic of consideration in their injury prevention guidelines.³ This requirement outlined the need to assess the evidence on concussion prevention strategies to inform these programs of public health.

As a result, we conducted a rapid review of the literature in order to answer the following research question: What are effective interventions for concussion prevention?

Methods

A rapid review of published literature was conducted to synthesize research evidence on the effectiveness of concussion prevention strategies in reducing concussion risk, across all ages. To identify relevant evidence, systematic searches were conducted on November 1st, 2019 and for the above research question. Public Health Ontario (PHO) Library Services conducted a search in Medline, Embase, CINAHL, and PsycINFO and SPORTDiscus using relevant vocabulary and subject headings. All database results were integrated and duplicates were removed. The search strategy is available upon request.

English-language peer-reviewed review level papers were eligible for inclusion if they: examined the effectiveness of concussion prevention strategies in reducing concussion risk and were published in the last ten years. Papers that did not have concussion outcomes, scored weak on the quality appraisal included interventions focused on treatment rather than prevention of concussions were excluded. Narrative overviews that lacked reproducible search methods were also excluded.

One reviewer screened all of the titles and abstracts, with a second reviewer screening a random selection of titles and abstracts. Full-text versions of all papers for inclusion were reviewed by two reviewers. For all relevant papers, one PHO staff extracted relevant data and summarized content.

Quality appraisal was conducted for each included review using the HealthEvidence.org Quality Assessment Tool for Review Articles.⁴ Two reviewers made independent assessments for each of the ten quality criteria. Any discrepancies were resolved by discussion. The findings below provide an overview of the study results. Findings are organized by intervention type.

Main Findings

The peer-reviewed literature search identified 1578 articles, of which 9 met inclusion criteria.⁵⁻¹³ One included review was a review of reviews,⁶ four were systematic reviews and meta-analyses,^{6,8,10,13} three were systematic reviews,^{7,9,11} and one was a scoping review.¹³

Eight reviews examined evidence related to the effectiveness of protective equipment in preventing concussions,^{5-8,10-13} five examined rule changes/modifications^{5-7,9,13} four examined education programs,^{6,7,12,13} and one examined exercises to increase musculature of the neck.⁷

Using the [Healthevidence.org](https://www.healthevidence.org) Quality Assessment Tool for Review Articles,⁴ relevant reviews were rated as strong,^{5-7,9-12} moderate,^{8,13} or weak on methodological quality, and weak reviews were excluded (n = 2). Included reviews showed some consistent weaknesses: lacking a comprehensive search and not assessing the methodological quality of included reviews. Quality scoring for each included review is available upon request.

Protective Equipment

Mouth Guards

Currently, there is no scientific evidence to suggest that mouth guards are an effective mechanism to prevent concussion in sport. Mouth guards; however, are protective equipment devices that have been shown to be effective in reducing the risk of dental injury in sport.

Four reviews examined the effectiveness of mouth guards for preventing concussion.^{6,10,11,13} Knapik conducted a meta-analysis to examine the effectiveness of mouth guards for preventing sports-related concussions.⁷ Among the five included primary studies they found a non-significant increase in concussion risk with the use of mouth guards (summary relative risk (RR) [nonusers/users]= 1.25, 95% confidence interval (CI): 0.90, 1.74) and concluded that mouth guards did not appear to reduce the risk of concussions in sporting activities.¹⁰ Emery et al. also conducted a meta-analysis of five primary studies and reported an incidence rate ratio (IRR) of 0.8 (95%CI: 0.6, 1.1), suggesting a non-significant reduction in concussion risk associated with the use of mouthguards.⁶ The authors concluded that the evidence for mouth guard use in preventing concussions in sports (e.g., basketball, ice hockey, rugby) was mixed, but that there may be an overall protective effect.⁶ Ratka conducted a systematic review of three studies examining if mouth guards reduce the risk of concussions in rugby.¹¹ Their results were inconclusive; they reported that there was limited evidence to support the use of mouth guards to reduce concussion incidence in rugby.¹¹ Lastly, Waltzman conducted a scoping review to summarize the current research on concussion prevention strategies in youth sports.¹³ They concluded (based on evidence of one primary study) that there was no evidence to suggest mouth guards prevent concussion among football players.¹³

Helmets

Currently, there is substantial scientific evidence to suggest that helmet use is an effective mechanism to prevent head injury in sport and in motorcycling.

Three reviews examined the effectiveness of helmets in reducing the risk of concussion.^{5,6,8} Høyve conducted a meta-analysis to examine the effects of bicycle helmets on serious head injuries among cyclists involved in motor vehicle collisions.⁸ The authors concluded that the use of bicycle helmets reduced traumatic brain injuries by 53% (95%CI: -64%, -36%).⁸ Donnan et al. conducted a review of reviews examining the effectiveness of helmets in reducing brain injuries.⁵ The authors concluded that helmets effectively reduce the risk of traumatic brain injuries from participation in cycling, skiing, snowboarding, ice hockey and motorcycling.⁵ Similarly, the systematic review and meta-analysis by Emery et al. found that helmet use during skiing and snowboarding reduced the risk of traumatic brain injuries, including concussion.⁶

Other Protective Equipment

Currently, the scientific literature on the effectiveness of protective equipment such as headgear and facial protection is mixed. The majority of systematic review and meta-analysis level literature show that head gear and facial protection do not reduce the risk of concussion in sport.

Five reviews examined the effectiveness of other types of protective equipment, such as facial protection or the use of a combination of protective equipment.^{5-7,12,13} The systematic review and meta-analysis by Schneider et al. estimated the relative risk of concussion for individuals wearing protective equipment (i.e., headgear, full face shields) compared to wearing standard or no equipment and they reported no significant effect of the equipment intervention (RR=0.82, 95%CI: 0.56, 1.20).¹² The review of reviews by Donnan et al. examined the effectiveness of wearing facial protection during ice hockey.⁵ They found that wearing full facial protection, compared to partial protection, reduced the severity of concussions.⁵ Emery et al. evaluated the effectiveness of headgear in reducing the risk of concussions in rugby and soccer.⁶ The evidence for rugby was inconsistent; two studies reported a protective effect of headgear on concussion risk among professional rugby players (IRR=0.57) and (IRR=0.43), while the remaining three studies reported no effect. The two studies that examined the effectiveness of headgear in soccer demonstrated positive, but non-significant effects.⁶ One additional primary study identified in the scoping review by Waltzman et al. found that the proportion of adolescent soccer players who reported signs of a concussion over the course of a season was higher among those who did not wear protective headgear, compared to those who did (52.8% vs. 26.9%).¹³ Lastly, the systematic review by Ennis et al., (2018) concluded that the evidence supported the use of head protective equipment (including helmets, headgear and face shields) in both pediatric and adult amateur athletes.⁷

Rule Changes/Modifications

The scientific literature is consistent in demonstrating the effectiveness of body checking policy on the reduction in concussion risk in youth ice hockey players.

Four reviews examined the effectiveness of rule changes and/or modifications to prevent sport-related concussions.^{6,7,9,13} All of the studies within these reviews focused on rules related to body-checking in hockey. Emery et al. conducted a meta-analysis examining the effectiveness of policy and rule changes that prohibit body checking in youth ice hockey. They found that disallowing body checking in youth ice hockey resulted in a 70% reduction (IRR= 0.30, 95%CI: 0.22, 0.41) in the risk of concussion.⁶ They concluded that rules and/or policies that prohibit body checking were effective in reducing the risk of concussion among youth ice hockey players.⁶ Similar conclusions were made by the other three reviews that examined rule changes/modifications.^{7,9,13}

Education

The scientific literature on the effectiveness of education programs to reduce the risk of concussion demonstrates that a multi-component approach to education programming is effective at reducing the risk of concussion adolescents (11-15 years). These programs include hands-on training on proper equipment fitting, tackling technique and strategies for reducing player-to-player contact; however, an important component of the program is the involvement of a player safety coach.

The four reviews that examined any educational interventions^{5,7,12,13} focused on the results of the same two studies by Kerr et al.^{14,15} These studies were consulted directly as they were the only educational interventions described in the reviews.

The first study by Kerr et al. examined concussion incidence in three youth football groups, ages 5-15. One group participated in the Heads Up Football program (HUF), which consists of education and hands-on training on proper equipment fitting, tackling technique and strategies for reducing player-to-player contact. The program also includes an individual who receives additional HUF training and is responsible for ensuring team coaches adhere to the safety protocol; these individuals are referred to as player safety coaches (PSC). The second intervention group participated both in the HUF program, as well as adhered to the Pop Warner (PW) 2012 guidelines. These guidelines restrict the types and amounts of contact allowed during practices in order to prevent injuries, including concussions. The final group acted as a control group and was characterized by not participating in HUF, following PW guidelines or having a PSC. Incident concussions were then compared between the three groups over one football season. A statistically-significant reduced incidence of concussions was observed in the 11-15 year old HUF+PW group in practices only, compared to those in the control group (RR=0.18, 95%CI: 0.04, 0.85). Those in the HUF-only group did not have a significantly lower rate of concussions in any age group in either games or practices.¹⁴ The group who experienced the lowest rate of concussions was given a multi-component intervention. It is; therefore, impossible to identify which component was effective or

if the two interventions in tandem were responsible for the reduction in risk. Additionally, as the effect was only observed among 11-15 year-olds in practices, but not games, the potential benefits of the combined HUF and PW program may have limited generalizability.

The second primary study by Kerr et al.¹⁵ specifically assessed the effect of the PSC component of the HUF program. The study included six high school football teams, all of which completed the HUF education component; three of which also had a PSC (as described above). The authors found that the rate of concussions was significantly lower among the PSC group in practices but not in games, compared to the education-only group (RR=0.12, 95%CI: 0.01, 0.94). The PSC group experienced one concussion in a game and one in practice over the entire season, with the education-only group experiencing seven and eight concussions in games and practices, respectively. The rate ratio for the PSC compared to the education-only group in games was similar (RR=0.14, 95%CI: 0.02, 1.11), but not statistically significant.¹⁵ Both of these estimates should be interpreted with caution; however, as the frequency of concussions experienced in both groups were similar low which may limit the statistical power to produce a precise estimate.

Discussion and Conclusions

This review identified several interventions that have demonstrated success in preventing concussions, as well as some that require more research.

There is strong evidence supporting the effectiveness of body checking policies in youth ice hockey for preventing concussions, as well as the effectiveness of multi-component education programs in youth sports. These highlight the opportunity for regulatory and educational interventions in youth sports to prevent concussions.

There is mixed evidence regarding the effectiveness of protective equipment in concussion prevention in sporting and non-sporting contexts. Mouth guards do not appear to prevent concussions, but prevent other facial injuries in sports. Helmets are shown to prevent head injuries in sports and motorcycling; however, future research should assess concussion as an independent outcome, rather than evaluating the effect of helmets on a general head injury outcome variable that may include various types and severities of head injury.

Implications for Practice

The identification of effective interventions can support the development of a program of public health for concussion, in line with the MOHLTC 2018 Injury Prevention guidelines. These efforts, along with working with local community groups and other stakeholders, can reduce the population burden of concussions in Ontario.

Additionally, identifying the gap in conclusive evidence supporting other interventions can guide future research. Efforts to fill these knowledge gaps and continuously support concussion prevention are needed.

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Specifications and Limitations of Evidence Brief

The purpose of this Evidence Brief is to investigate a research question in a timely manner to help inform decision making. The Evidence Brief presents key findings, based on a systematic search of the best available evidence near the time of publication, as well as systematic screening and extraction of the data from that evidence. It does not report the same level of detail as a full systematic review. Every attempt has been made to incorporate the highest level of evidence on the topic. There may be relevant individual studies that are not included; however, it is important to consider at the time of use of this brief whether individual studies would alter the conclusions drawn from the document.

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Citation

Ontario Agency for Health Protection and Promotion (Public Health Ontario), Medeiros A, Berenbaum E, Richmond SA. Interventions to prevent concussions. Toronto, ON: Queen's Printer for Ontario; 2020.

ISBN 978-1-4868-4846-1

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