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Dr. Marcus Moore
University of British Columbia

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MAKING HEADWAY ON SPORTS CONCUSSION: SPORT-SPECIFIC STRATEGIES FOR CONCUSSION PREVENTION

DR. MARCUS MOORE*

1 INTRODUCTION

Concussions in sports are a significant public health concern worldwide. Concussion is a traumatic brain injury ("TBI") resulting from biomechanical forces transmitted to the head that disrupt normal neurological function.¹ Globally, an estimated 69 million TBIs occur annually.² Concussive effects can persist as long-term syndromes (post-concussion syndrome),³ or compound themselves into life-threatening emergencies (second-impact syndrome).⁴ Chronic, even subconcussive, impacts can ultimately lead to degenerative neurological conditions (chronic traumatic encephalopathy).⁵ Troublingly, to date, there remains no medical cure for concussions.⁶ Prevention is thus paramount, as well as management, to avoid the compounding of injury or dangerous complications, as noted.

* Allard School of Law, University of British Columbia, Vancouver. The author, now a professor of sports law, regulation and governance, is permanently disabled by post-concussion syndrome from a sports concussion which ended his career as a professional ice hockey player. In terms of the selection of sports discussed, the author also played competitive soccer, and his father was a collegiate football and basketball player. The author would like to thank Dr Matthew Raj, Sarah Lush and the staff of the *Sports Law and Governance Journal*. Special thanks also to Prof. Doug Harris for guidance and UBC student Helen Yang for research assistance.

¹ David W Wright et al, 'CDC Grand Rounds: Reducing Severe Traumatic Brain Injury in the United States' (2013) 62(27) *Morbidity and Mortality Weekly Report* 549 ('CDC Grand Rounds').

² Michael C Dewan et al, 'Estimating the Global Incidence of Traumatic Brain Injury' (2019) 130(4) *Journal of Neurosurgery* 1080.

³ Samantha J McIntosh et al, 'Factors Associated With Persisting Symptoms After Concussion in Adults With Mild TBI: A Systematic Review and Meta-Analysis' (2025) 8(6) *JAMA Network Open* e2516619 ('Factors Associated With Persisting Symptoms After Concussion in Adults With Mild TBI').

⁴ Michael W Collins et al, 'A Comprehensive, Targeted Approach to the Clinical Care of Athletes Following Sport-Related Concussion' (2014) 22(2) *Knee Surgery, Sports Traumatology, Arthroscopy* 1795; Elizabeth Weinstein et al, 'Second Impact Syndrome in Football: New Imaging and Insights into a Rare and Devastating Condition' (2013) 11(3) *Journal of Neurosurgery. Pediatrics* 331 ('Second Impact Syndrome in Football').

⁵ Theodore B VanItallie, 'Traumatic Brain Injury (TBI) in Collision Sports: Possible Mechanisms of Transformation into Chronic Traumatic Encephalopathy (CTE)' (2019) 100 *Metabolism* 153943 ('Traumatic Brain Injury (TBI) in Collision Sports').

⁶ Charles H Tator, 'Concussions and Their Consequences: Current Diagnosis, Management and Prevention' (2013) 185(11) *CMAJ: Canadian Medical Association Journal* 975 ('Concussions and Their Consequences').

Sports and recreation activities, while important contributors to general health and fitness, are paradoxically also among the leading causes of concussions, particularly in young people.⁷ In Canada for example, over half of total reported concussions occur in this sphere, with the figure exceeding 80 per cent in persons aged 16–34.⁸ Measures to prevent concussions in sports are therefore central to any overall strategy of confronting the wider public health problem of concussive injury.

Society as a whole has taken note—with the recognition of a concussion “crisis” in sports.⁹ Governance organizations have acknowledged a need to act.¹⁰ But concrete prevention strategies largely need to be sport-specific, in light of the differing mechanisms and causes of concussion in different sports, as well as the particular nature, features, traditions, and culture of each sport.

This article takes up this task—offering tangible, actionable, and difference-making adjustments for four prominent sports: soccer, American football, basketball, and ice hockey.

2 SOCCER

Heading is the activity most associated with concussions in soccer. Most (78.1% of boys; 61.9% of girls) heading-related concussions occur during player collisions while attempting to head the ball, with the remainder arising from direct ball impacts or falls during heading.¹¹ And by the same token, concussion is the most common injury sustained in heading situations, accounting for more than 60 per cent of such injuries.¹² Better diagnosis and reporting of concussions could reveal these figures in fact to be a significant underestimate of heading-related concussions, as on-field video and sensor analyses suggest that heading-related activity causes approximately 90 per cent of all head-impact exposures in soccer matches.¹³ Indeed, even when heading falls short of causing concussion, it contributes to closely-related injury, as neuropathological studies of retired soccer players have found chronic traumatic encephalopathy even in players with

⁷ Kam Lun Hon, Alexander KC Leung and Alcy R Torres, ‘Concussion: A Global Perspective’ (2019) 30 *Seminars in Pediatric Neurology* 117 (‘Concussion’).

⁸ *Ibid.*

⁹ Dominic Malcolm, *The Concussion Crisis in Sport* (Routledge, 2019).

¹⁰ Marcus Moore, ‘Regulating the Concussion Crisis in Sports: Canada’s Initiative to Bring Prevention into Focus’ (2023) 23(3) *The International Sports Law Journal* 390 (‘Regulating the Concussion Crisis in Sports’).

¹¹ R Dawn Comstock et al, ‘An Evidence-Based Discussion of Heading the Ball and Concussions in High School Soccer’ (2015) 169(9) *JAMA Pediatrics* 830.

¹² Mallika Marar et al, ‘Epidemiology of Concussions Among United States High School Athletes in 20 Sports’ (2012) 40(4) *The American Journal of Sports Medicine* 747.

¹³ Jeffrey S Brooks et al, ‘Purposeful Heading Performed by Female Youth Soccer Players Leads to Strain Development in Deep Brain Structures’ (2021) 2(1) *Neurotrauma Reports* 354.

few concussions; the cumulative effect of repeated subconcussive impacts may cause long-term neurodegeneration.¹⁴

As the leading cause of concussions in soccer, the practice of heading must be a focus of a sport-specific strategy to prevent concussions in soccer. The obvious step would be to eliminate heading. Heading bans have in fact already been tried in some leagues.¹⁵ A recent study evaluating youth heading restrictions by the US Soccer Federation found a 26 per cent reduction in concussions as a portion of soccer-related injuries presenting to medical emergency departments.¹⁶ This reduction coincides with a period of increasing concussion awareness and reporting, so this figure may be an underestimate of the reduction in concussion actually occurring. Biomechanical analysis supports the recommendation to ban heading, showing how heading produces repetitive linear and rotational forces closely associated with concussive injury.¹⁷ Heading has for years been part of the artistry and traditions of soccer. That said, times change, and games with them. Heading is not indispensable to soccer. Without heading, it would still be fundamentally the same sport, and still “the world’s sport”—which much of the world knows as football, not as foot-and-head-ball. Given the significance of concussive injury, and the evidence proving the leading role of heading in causing brain injuries in soccer, the position that heading should be maintained at all costs is indefensible.

3 AMERICAN FOOTBALL

Helmet contact, including helmet-to-helmet and helmet-to-body, causes the majority of concussions in American football.¹⁸ Football helmets have a hard outer shell which tends to injure other players in contact situations. Indeed, the

¹⁴ Helen Ling et al, ‘Mixed Pathologies Including Chronic Traumatic Encephalopathy Account for Dementia in Retired Association Football (Soccer) Players’ (2017) 133(3) *Acta Neuropathologica* 337; see also Jon Patricios et al, ‘Consensus Statement on Concussion in Sport’ (2023) 57 *British Journal of Sports Medicine* 695, 705: ‘It is reasonable to consider extensive exposure to repetitive head impacts, such as that experienced by some professional athletes, as potentially associated with the development of the specific neuropathology described as CTE-NC’.

¹⁵ US Club Soccer, ‘Concussions and Head Injuries’ (Web Page, 20 March 2024) <<https://usclubsoccer.org/headinjuries/>>.

¹⁶ Deanna Killackey, ‘Header Restriction Policy in Youth Soccer Shows Promising Impact on Concussion Rates’, *AAOS 2025 Annual Meeting Press Kit* (online, 10 March 2025) <<https://aaos-annualmeeting-presskit.org/2025/research-news/header-restriction-policy-in-youth-soccer-shows-promising-impact-on-concussion-rates/>>.

¹⁷ Gregory J Tierney, Jonathan Power and Ciaran Simms, ‘Force Experienced by the Head during Heading is Influenced More by Speed than the Mechanical Properties of the Football’ (2021) 31(1) *Scandinavian Journal of Medicine & Science in Sports* 124.

¹⁸ Annabelle Shaffer et al, ‘Injury Characteristics and Risk Factors of Sport-Related Concussion Among High School Athletes in School-Sponsored Sports’ (2025) 96(6) *Neurosurgery* 1272.

NFL has had to ban the practice of hitting with the helmet.¹⁹ But this is not nearly sufficient. And concussions remain troublingly prevalent in football.²⁰

Adding soft outer padding to football helmets, like the Guardian Cap helmet cover, is proposed to reduce concussions in American football.²¹ Laboratory testing and helmet-lab metrics have shown reductions in measured impact and head acceleration associated with concussion with the addition of the Guardian Cap to football helmets.²² On the field, data from NFL preseason sessions in which Guardian Caps were mandated showed a 54-62 per cent reduction in concussion incidence.²³ Thus, a combination of lab, modeling, and field evidence supports the recommendation of mandating soft outer padding on helmets as a sport-specific way to effectively reduce concussions in football—and without any concern of altering the game. This one should be a “no-brainer”. It is therefore strongly recommended that the NFL and youth leagues require soft outer padding on helmets.

4 BASKETBALL

In basketball, concussions overwhelmingly result from player collisions—responsible for 83.8 per cent of men’s concussions and 64.1 per cent of women’s—with rebounding the most commonly identified activity implicated by studies.²⁴ Video analyses show that 61 per cent of moderate–severe injuries of all kinds occur in the area beneath the rim, with head injuries overwhelmingly (92%) caused by contact.²⁵ Rebounding is the activity most frequently involved.²⁶

A sport-specific way to prevent concussions in basketball is to modify the rebounding process. In particular, it is suggested that concussion-causing collisions and falls can be avoided by allowing only the defensive team to rebound a missed shot—provided the defense catches the rebound in the air.

¹⁹ NFL Football Operations, ‘NFL Video Rulebook: Use of the Helmet’ (Web Page, 2025) r 12 s 2 art 10 <<https://operations.nfl.com/the-rules/nfl-video-rulebook/use-of-the-helmet/>>.

²⁰ Christina D Mack et al, ‘Epidemiology of Concussion in the National Football League, 2015-2019’ (2021) 13(5) *Sports Health* 423.

²¹ Mark Moore, ‘Saving the Game: Pro Hockey’s Quest to Raise Its Game from Crisis to New Heights’, *All Faculty Publications* (Web Page, 2006) 242–244, 253 <https://commons.allard.ubc.ca/fac_pubs/2415> (‘Saving the Game’).

²² Ann M Bailey et al, ‘Laboratory Evaluation of Shell Add-On Products for American Football Helmets for Professional Linemen’ (2021) 49(10) *Annals of Biomedical Engineering* 2747.

²³ James R Funk et al, ‘An Analysis of Guardian Cap Use and Changes in the Concussion Rate in National Football League Preseason Practices From 2018 to 2023’ (2025) 53(10) *The American Journal of Sports Medicine* 2320.

²⁴ Zachary Y Kerr et al, ‘Concussion Incidence and Trends in 20 High School Sports’ (2019) 144(5) *Pediatrics* e20192180.

²⁵ Leonard Achenbach et al, ‘Collision with Opponents—but Not Foul Play—Dominates Injury Mechanism in Professional Men’s Basketball’ (2021) 13(1) *BMC Sports Science, Medicine and Rehabilitation* 94.

²⁶ *Ibid.*

The offense would be prohibited from initiating contact with or interfering with a defensive player attempting to catch the rebound. However, if the ball hits the floor, it becomes “live”—a free ball that either team can take possession of. This modification to the rebounding process would eliminate frequent and dangerous collisions within a small, crowded area beneath the basket, while preserving the skill and show of capturing rebounds in the air.

Overall, in addition to improving player safety, the effect of this modification in relieving congestion of players under the rim may also make for more interesting basketball. A similar outcome was observed through the expanded perimeter play area created by 3-point shooting, which increased ball movement, along with both variety and creativity of play.²⁷

5 ICE HOCKEY

Player collisions are the leading cause of concussions in ice hockey. In the NHL, 93 per cent of diagnosed concussions involve player collisions, with only a small percentage due to falls (7%).²⁸

Comparative analyses of play on NHL-size and Olympic-size rinks demonstrate that increased ice surface area per skater reduces collisions and hence concussions. For example, studies suggest the 15 per cent increased area-per-skater of Olympic rinks reduces collisions by around 35 per cent.²⁹ While resizing existing NHL-size rinks is not realistic, an even greater increase in area-per-skater (25%) can be achieved simply by shifting full-time from 5-on-5 play to 4-on-4. As a function of collisions based on density, this would yield a 58 per cent reduction in concussions.³⁰ This potential is supported by crowd-dynamics modeling, showing that lower density (as 4-on-4 creates) decreases the probability of high-speed impacts.³¹ Meanwhile 4-on-4 play, which already occurs when teams have coincidental penalties, is felt by many to be a more fun and exciting brand of hockey—with more play in the middle of the ice rather

²⁷ João Vítor Rocha Da Silva and Paulo Canas Rodrigues, ‘The Three Eras of the NBA Regular Seasons: Historical Trend and Success Factors’ (2021) 7(4) *Journal of Sports Analytics* 263 (‘The Three Eras of the NBA Regular Seasons’); ‘Men’s Basketball 3-Point Line Extended to International Distance’, *NCAA.org* (online, 5 June 2019) <https://www.ncaa.org/news/2019/6/5/men-s-basketball-3-point-line-extended-to-international-distance.aspx?utm_source=chatgptcom>.

²⁸ Michael G Hutchison et al, ‘A Systematic Video Analysis of National Hockey League (NHL) Concussions, Part I: Who, When, Where and What?’ (2015) 49(8) *British Journal of Sports Medicine* 547 (‘A Systematic Video Analysis of National Hockey League (NHL) Concussions, Part I’).

²⁹ Richard Wennberg, ‘Effect of Ice Surface Size on Collision Rates and Head Impacts at the World Junior Hockey Championships, 2002 to 2004’ (2005) 15(2) *Clinical Journal of Sport Medicine* 67.

³⁰ Ibid; Moore (n 21) 248–258.

³¹ Sujong Kim et al, ‘Velocity-Based Modeling of Physical Interactions in Dense Crowds’ (2015) 31(5) *The Visual Computer* 541.

than confined along the boards, enabling enhanced use of skating agility and stickhandling, and generating more scoring chances and goals.³²

6 CONCLUSION

The causes and mechanisms of concussions differ across sports, requiring sport-specific prevention strategies. Yet, it is suggested that for many sports, such strategies can be identified. This commentary recommends a single, targeted adjustment to four prominent sports. Each of these adjustments, alone, may significantly reduce concussions, while preserving and/or enhancing the essence and appeal of the game.

Undoubtedly, there will be community-members in each sport who oppose these adjustments, or other changes to the game that are sufficient to make a real difference in concussion safety. Resistance to change is human nature; and in sports, it is noted as being especially formidable.³³ But the concussion crisis makes clear that, in our sports, we are not doing nearly enough to put “safety first”. I submit that it is possible to do so, while simultaneously respecting the nature, tradition, and attraction of most sports. The foregoing are but a few examples of how this can be done through sport-specific strategies—in this case, through one adjustment per sport having the potential to significantly reduce concussions while protecting the nature of the sport, and keeping sports fun, entertaining and compelling.

³² Moore (n 21) 252.

³³ Moore (n 10); Moore (n 21) 36–42.