

Epidemiology of Injuries in Ice Hockey

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Context: Hockey is a skillful contact sport with an elevated injury risk at higher levels of play. An understanding of injury incidence, type, mechanism, and severity at various levels of competition aids the clinician treating these athletes. The purpose of this clinical review is to discuss the epidemiology of hockey injuries at various levels of participation, including youth, high school, junior, college, and professional.

Evidence Acquisition: A literature search was performed by a review of PubMed, Embase, and Cochrane databases and included articles published from 1988 to 2017. Studies were included in this review if determined to be of high quality and containing injury data relevant to the levels of competition. Pertinent data regarding ice hockey injury epidemiology and prevention at various levels of competition were analyzed.

Study Design: Clinical review.

Level of Evidence: Level 4.

Results: Youth, high school, junior, college, and professional hockey players have unique injury patterns. Injuries occur much more often in a game compared with a practice, and injury risk increases with each level of competition. Preventative measures, such as mandatory facial protection and delayed body checking in games until age 13 years, are proven strategies to reduce the risk of facial injury and concussion.

Conclusion: An understanding of common injury types and mechanisms according to age and level of play aids the clinician in diagnosis and management. This information can also guide preventative strategies in the areas of education, coaching, rule enforcement, rule modifications, equipment improvement, and sportsmanship.

Keywords: hockey; injuries; prevention; treatment

Ice hockey is currently played in 76 countries and continues to gain in popularity worldwide. Players of this skillful and dynamic sport skate at speeds approaching 30 miles per hour (mph)¹⁰ using knifelike skate blades. Composite material sticks can propel a frozen puck with a velocity of over 100 mph. Body contact and body checking take place in an environment that is enclosed by plastic composite boards and glass. Fighting still occurs in some junior leagues and at the professional level. Given the nature of the sport and increasing number of participants, the injury rate is expected to increase. The goal of sports epidemiology research is evidence-based injury prevention. An understanding of injury types and mechanisms in a specific sport allows for the development of focused strategies such as education, training and conditioning, rule enforcement or changes, equipment modifications, and arena characteristics.

The risk of injury in ice hockey increases as players become bigger, stronger, faster, more violent, and wear less protective

equipment. Sports medicine clinicians should be familiar with ice hockey injuries in order to skillfully evaluate, treat, and prevent injuries to ice hockey players at all levels. We reviewed the existing literature regarding injury risk, type, mechanism, and severity in youth, high school, junior, college, and professional players. The published articles focus on individual groups of players, but do not compare injury epidemiology across all levels of competition. A general knowledge of the most common injuries in each age group will aid clinicians who evaluate and treat hockey athletes.

METHODS

A literature search was performed by a review of PubMed, Embase, and Cochrane articles published from 1988 to 2017 using the words “epidemiology, ice hockey, injuries,” which led to 469 hits. Articles were analyzed for their relevance to the various levels of competition. Pertinent data from high-quality

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Youth Hockey Injury Distribution

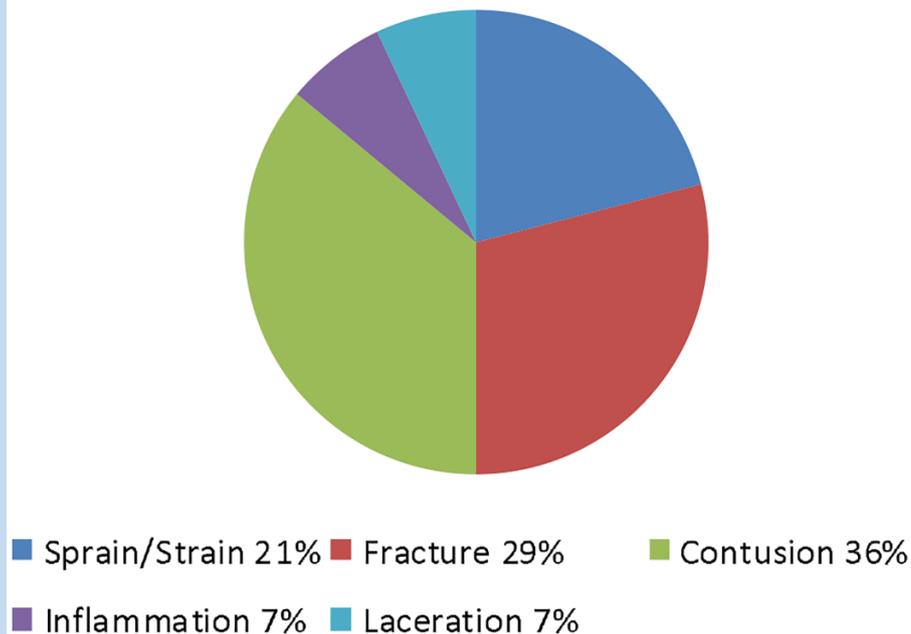


Figure 1. Pie chart demonstrating the distribution of different types of injuries in youth hockey. Figure adapted from Stuart et al.²⁶

studies regarding ice hockey injury epidemiology and prevention at various levels of competition was included in this study. A narrative literature review¹⁷ was performed to compile a general overview of hockey injuries at varying levels of play. The paucity of literature on this particular subject does not allow for an exhaustive systematic review. This summary of relevant research aids clinicians who care for hockey athletes.

EPIDEMIOLOGY

Youth and High School Hockey

More than 12,590 players younger than 19 years in the United States seek medical attention at emergency departments for ice hockey-related injuries per year.³² The most frequent injuries seen in youth hockey are contusions, fractures, sprains/strains, and lacerations involving the head, neck, and upper extremities (Figure 1).^{15,26}

On a yearly basis, the number of hockey-related injuries in athletes aged 9 to 14 years presenting to the emergency department increased by 163% from 1990 to 2006,⁶ and these numbers have continued to rise. True incidence statistics are lacking and the apparent increased risk of injury may be explained by increased exposure resulting from amplified youth hockey participation. An investigation of youth hockey players that included exposure data found that the incidence of injury increased with each higher level of participation. Mite players (8 years and younger) had only 0.8 injuries per 1000 hours, but

high school players sustained 9.3 injuries per 1000 hours.²⁶ The higher injury risk was likely due to increased player size, strength, and speed as well as a greater intensity of competition with advanced level of play. Injury risk is also affected by the rules of the game, specifically body checking at the PeeWee level. Emery et al⁸ documented a significant increased risk of overall injury and 3 times increased risk of concussion to PeeWee players competing in a league that allowed body checking in games as compared with a league where body checking was not allowed. In addition to injuries that are caused by a legal body check, dangerous and/or illegal activities resulting from loss of body control, unanticipated hits, and high-risk collisions may be more prevalent at the younger age levels where body checking is permitted.⁸ A prospective cohort study of Bantam players (age 13-14 years) by Emery et al⁸ showed that the risk of injury resulting in more than 7 days of time loss from play was reduced by 33%. In this league, body checking was allowed 2 years earlier in PeeWee compared with Bantam players introduced to body checking for the first time at age 13 years.⁷ In light of the increased risk of concussion and other injury among PeeWee players in a league where body checking is permitted, policy regarding the age at which hockey players are introduced to body checking requires further investigation.⁷

The risk of injury in a hockey game is higher than a hockey practice. Bantam players had an injury rate of 10.9 per 1000 player hours in games compared with 2.5 injuries per 1000

player hours in practices.²⁶ This increase of injuries in games compared with practices is also supported by Council on Sports Medicine and Fitness et al,⁴ who showed that the injury rate for boys' high school ice hockey from 2008 to 2012 ranged from 2.03 to 2.56 injuries per 1000 athlete-exposures (AEs; 1 athlete participating in 1 practice or competition), with a game-related injury rate of 4.18 to 6.08 per 1000 AEs.

Women's ice hockey does not allow checking at any level of play and likely leads to a decreased incidence of injuries. Decloue et al⁵ found that female youth ice hockey players had fewer injuries per 1000 AEs when compared with males of the same group. Previous injury and the onset of menarche were risk factors that played a role in injury rates. Although the role of menarche is not completely understood, a change in hormone levels is a possible explanation.⁵

Junior Hockey

Junior hockey typically includes 16- to 21-year-old players with various levels of competition based on experience and skill. Tuominen et al²⁸ conducted a 9-year prospective study of injuries at the International Ice Hockey Federation (IIHF) Under-20 World Championships (World Junior tournament). The overall injury rate for these male athletes was 11.0 per 1000 player games and 39.8 per 1000 player game hours.²⁸ Game injuries occurred to the head and face in 39%, upper body in 29%, lower body in 24%, and the spine or trunk in 9%. There were varying causes of injuries including body checking and stick or puck contact. A collision caused 51% of the overall injuries in junior players competing in the United States Hockey League.²⁴

The head and face were the most commonly injured anatomic regions to players in the Under-20 World Championships, and lacerations were the most common type of injury.²⁸ The face was involved in 76% with a laceration diagnosed in 80%. The hockey stick was involved in almost half of the diagnosed facial lacerations, yet a penalty was called in only 18% of these cases. In contrast, the most common head and face injury was a concussion at the IIHF Under-18 World Championships, comprising 46% of the injuries with an incidence of 4.2 concussions per 1000 player-game hours.²⁸ The most common mechanism for a concussion in all Junior World Championships was checking to the head and body. Sixty-three percent of concussions were caused by illegal hits, and a penalty was called in 53% of the events when these illicit maneuvers were used. It is also interesting to note that the majority of concussions took place during the third period when players were likely more fatigued or the intensity of the game increased.²⁸

Major differences between the junior leagues affect injury risk, including mandatory facial protection and fighting rules. A prospective cohort observational analysis of 282 Junior A ice hockey players revealed that players wearing no protection sustained facial injuries at a rate more than twice that of players wearing partial protection and almost 7 times higher than those wearing full protection.²⁵ The risk of eye injury was 4.7 times greater for players wearing no protection compared with those

wearing partial protection (Figure 2). This study demonstrates that both full and partial facial protection significantly reduce injuries to the eyes and face without increasing neck injuries and concussions.

Understanding injury prevalence and types, especially concussion, face, and eye injuries, reinforces the importance of quality helmets and full facial protection.

College Hockey

Multiple studies have analyzed the rate, type, and mechanism of hockey injuries at the collegiate level. Interestingly, the rate of injury in games is one of the highest in college athletics, but practice injury rates are among the lowest.¹¹ Flik et al¹⁰ reported a game injury rate of 13.8 per 1000 AEs and a practice injury rate of 2.2 per 1000 AEs. Other studies have reported slightly higher game injury rates ranging from 16.27 to 18.69 per 1000 AEs.^{1,2,11} Agel and Harvey² found that men's collegiate hockey has a higher risk of injury (18.69/1000 AEs) when compared with the women's game (12.10/1000 AEs). There is a discrepancy in the literature as to the most common anatomic location and type of injury identified in college hockey. The knee was most often injured in games according to Agel et al,¹ whereas a concussion was the most common injury in the series reported by Flik et al.¹⁰ Concussion rates have been reported as 0.72 per 1000 AEs for men and 0.82 per 1000 AEs for women.² The reasons for the higher concussion risk for women are not clear, but may be related to better recognition, unanticipated collisions and falls, or decreased neck strength. Other common injuries include muscle strains, contusions, lacerations, acromioclavicular (AC) joint sprains, and ankle sprains.¹¹

Player to player contact is the most frequent mechanism of injury in multiple studies contributing to a rather high rate of concussion. Player to board, puck, or stick contact was also common.^{1,2,10} Interestingly, a high percentage of injuries sustained in practice are due to noncontact mechanisms.¹

Professional Hockey

Injuries at the most elite levels of hockey are frequent, likely due to equipment and rule differences as well as the high speed and aggressive nature of play. Ice hockey was the highest risk sport at the 2010 Olympic Games with 13% to 35% of participants affected.⁹ Tuominen et al²⁷ analyzed the injuries that occurred during men's IIHF World Championship tournaments between the years of 2006 and 2013. The injury rate was 52.1 per 1000 player-game hours. Other studies describe injury rates ranging from 53 to 84 per 1000 player-game hours.¹²⁻¹⁴ The risk of injury in women's international competition is much lower with a rate of 20 per 1000 player-game hours.²⁹ This discrepancy reflects numerous differences between men's and women's games, including player size, skating speed, body checking, and lack of facial protection.

The most common types of injury in the Adult Men's World Championships were lacerations, ligament sprains, contusions, and fractures.²⁷ Lacerations are most common in the head and neck region because players wear only partial facial protection

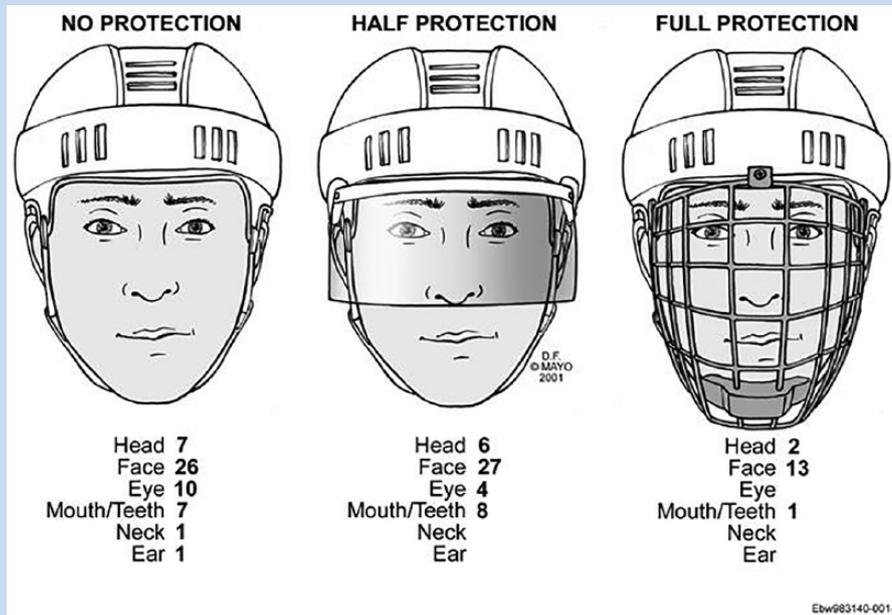


Figure 2. Full facial protection eliminated eye injuries and greatly decreased head and face injuries. No facial protection is associated with a two times increased risk of facial injury compared to partial protection and an almost seven times increased risk compared to full protection. Image from Stuart et al.²⁵

(visor). Knee ligament sprains and shoulder injuries, including AC joint sprains are also prevalent.²⁷ The medial collateral ligament is the most commonly injured knee ligament.

Anterior cruciate ligament (ACL) disruption is less common in hockey compared with sports such as soccer and football. Nonetheless, ACL injury can be devastating with a documented decline in performance after return to play.^{18,27} Concussion and the potential long-term consequences of traumatic brain injury are a major concern for professional hockey players. The incidence of concussion in the National Hockey League decreased from 1.81 per 1000 AEs in 1998-1999 to 1.04 per 1000 AEs in 2005-2006.³¹ The decrease in concussions is probably the result of improved prevention strategies since recognition has likely increased. The most common mechanisms of injury are a hit to the head, an unexpected, open ice body check, or contact with the boards.

PREVENTION

Prevention of hockey injuries is an important area of study with special emphasis on catastrophic injuries such as spine trauma with spinal cord involvement, concussion with permanent cognitive deficit, eye injury with visual impairment or blindness, and permanent disability from any cause that results in a substantial reduction of physical ability. A significant effort has increased awareness and implemented prevention strategies for catastrophic injuries. Monitoring and eliminating the dangerous infractions of charging, boarding, checking from behind, head hits, and fighting are now points of emphasis.

Full facial protection reduced the risk of facial and dental injuries, without an increase in the risk of neck injuries and

concussions.³ In Junior A ice hockey players, full facial protection eliminated eye injuries, and no protection was associated with a 4.7 times greater risk of eye injury when compared with partial facial protection (visor) (Figure 2).²⁵ Fifty-two injuries (158.9 per 1000 player-game hours) occurred in players wearing no facial protection, 45 (73.5 per 1000 player-game hours) in players wearing partial facial protection (half shield), and 16 (23.2 per 1000 player-game hours) in players wearing full facial protection (full cage or shield). Players wearing no protection were injured at a rate more than twice that of players wearing partial protection and almost 7 times higher than those wearing full protection. Full facial protection was not associated with an increased risk of brain or cervical spine injuries.

USA Hockey has enacted a “Heads Up, Don’t Duck” initiative to decrease the frequency of cervical spine and spinal cord injuries.³⁰ Players are taught to make contact with the boards with any body part except the head. For example, if head contact is unavoidable the player should lift the head (don’t duck) to prevent an axial load to the top of the head. Fortunately, the number of catastrophic and potentially catastrophic injuries among USA Hockey players continues to decline (Figure 3).

Concussion prevention has been a collaborative effort with the identification and implementation of prioritized action items.^{20-23,30} USA Hockey has taken important measures including teaching body checking skills in practice, delaying body checking in games until age 13 years, and penalizing both intentional and unintentional hits to the head.^{20,30} Additionally, the development of improved hockey equipment is under way, especially after a scientific rating system reinforced the

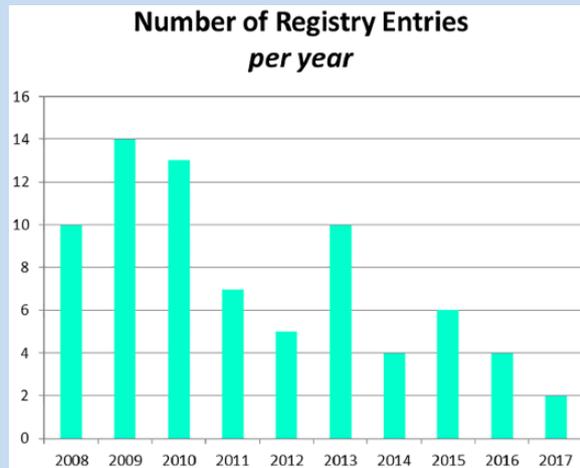


Figure 3. Total catastrophic and potentially catastrophic injuries from 2008 to 2017. Source: USA Hockey Health & Safety menu.³⁰

perceived need for more effective helmets.¹⁶ Novel helmet designs incorporate a custom fit, secure chin strap suspension, and multiple layers that mitigate forces. The improved outer shells and energy absorbing liners dissipate both linear and rotational acceleration to the brain. Additional strategies to reduce the risk of concussion involve teaching on-ice awareness and body control skills, improving neck muscle strength and proprioception and expanding Fair Play rules to all levels of youth hockey.¹⁹ Current playing rules in professional and some junior leagues promote tolerance of fighting and head hits. The most obvious and effective approach to eliminate fighting and head hits is to change the existing rules to penalize all hits to the head and eject players from the game for fighting. Energy-absorbing boards and glass could also decrease the risk of concussion and shoulder injuries.^{9,27}

A multifaceted approach to injury prevention in the sport of ice hockey is necessary, including quality education and coaching, improved protective equipment, enforcement of existing rules, elimination of dangerous activities (head hits, charging, boarding, fighting, checking from behind), promotion of sportsmanship, and mutual respect for the opponent and the game of hockey.

DISCUSSION

A systematic review on hockey injuries is not possible because of the lack of medical evidence, resulting in the inability to answer specific clinical questions.

CONCLUSION

Hockey is a skillful contact sport that can cause a large spectrum of injuries including very serious musculoskeletal trauma and even catastrophic events. This information can not only aid the clinician in diagnosis and management but also

guide preventative strategies in the areas of education, coaching, rule enforcement, rule modifications, equipment improvement, and sportsmanship.

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