

The Impact of Body Checking on Youth Ice Hockey Injuries

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Background: Body checking is a common cause of youth ice hockey injuries. Consequently, USA Hockey raised the minimum age at which body checking is permitted from the Pee Wee level (11-12 years old) to the Bantam level (13-14 years old) in 2011.

Purpose/Hypothesis: The purpose of this investigation was to determine the impact of body checking on the distribution of injuries reported in youth ice hockey players. We hypothesized that the elimination of body checking at the Pee Wee level would lower the frequency of serious injuries, particularly concussions.

Study Design: Descriptive epidemiology study.

Methods: Injury data from the National Electronic Injury Surveillance System (NEISS), a United States Consumer Product Safety Commission database, were analyzed for Pee Wee and Bantam players between January 1, 2008 and December 31, 2010 and again between January 1, 2013 and December 31, 2015. Data on the location of injury, diagnosis, and mechanism of injury were collected. The location of injury was categorized into 4 groups: head and neck, upper extremity, lower extremity, and core. Diagnoses investigated included concussions, fractures, lacerations, strains or sprains, internal organ injuries, and other. The mechanism of injury was broken down into 2 categories: checking and other.

Results: Between the 2008-2010 and 2013-2015 seasons, overall injuries decreased by 16.6% among Pee Wee players, with injuries caused by body checking decreasing by 38.2% ($P = .012$). There was a significant change in the distribution of diagnoses in the Pee Wee age group during this time frame ($P = .007$): strains or sprains, internal organ injuries, and fractures decreased in frequency, while the number of concussions increased by 50.0%. In the Bantam age group, recorded injuries decreased by 6.8%, and there was no change in the distribution of the location of injury, diagnosis, or mechanism of injury ($P > .05$).

Conclusion: There was an observed reduction in the total number, mechanism, and type of injuries when body checking was eliminated from the Pee Wee level. There was, however, an unexpected increase in the number of concussions.

Keywords: hockey; injuries; concussion; body checking

Ice hockey has become an increasingly popular sport, with more than 1.1 million players registered in organized leagues across the United States (US) and Canada.^{8,14} Like other sports, ice hockey provides a number of benefits to players, such as improved physical

health and self-confidence. However, there are unique inherent risks to participation in a collision sport in which athletes skate up to 30 mph and pucks travel up to 100 mph.^{10,12} Given that youth sports injuries can impose significant immediate and long-term consequences, including the risk of future injuries, cognitive deficits, and other health burdens, it is imperative to prevent injuries at all levels. Body checking is one component of ice hockey that contributes to its fast-paced and exciting nature, but significant media attention, debate, and research have revolved around the appropriate age at which it should be permitted. A large 2010 prospective investigation performed in Canada demonstrated that body checking at the Pee Wee level (11-12 years old) put youth ice hockey players at a 3-fold greater risk of injuries.⁵ Other investigations have also concluded that body checking is a significant risk factor for injuries, being the reported mechanism for anywhere between 45% and 86% of all injuries.^{1,4,6,7,16,18}

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The growing body of evidence against body checking prompted USA Hockey to raise the age at which body checking is allowed from the Pee Wee age group to the Bantam age group (13-14 years) in 2011.¹³ Hockey Canada imposed a similar rule in 2013.¹¹ Understanding how such policy changes affect injury and concussion risks in youth players is essential for evidence-based decision making regarding injury prevention. At this time, it is currently unknown how the inhibition of checking has affected the rates and types of injuries experienced by youth ice hockey players in the US.

Prior investigations have utilized the National Electronic Injury Surveillance System (NEISS) to characterize injury types, rates, and mechanisms in ice hockey.^{3,9,18} The purpose of this investigation was to use the NEISS database to characterize ice hockey injuries, including concussions, that were sustained in Pee Wee and Bantam players before and after checking was prohibited in the younger players. We hypothesized that there would be a decreased rate of serious injuries, particularly concussions, among Pee Wee players. Our secondary objective was to analyze the locations of injuries and mechanisms by which injuries occurred.

METHODS

The NEISS, a US Consumer Product Safety Commission (CPSC) database, collects information from 100 nationally representative emergency departments and assigns a CPSC-specific product code, which designates products used and/or activities engaged in at the time of injury, to each case. We analyzed all cases with an ice hockey product code (1279) from January 1, 2008 to December 31, 2010 and from January 1, 2013 to December 31, 2015 for 11- to 12-year-old players (Pee Wee) and 13- to 14-year-old players (Bantam). During this time frame, no other significant rule changes occurred in these specific age groups. The narrative provided for each injury was reviewed to ensure that it was sustained while playing ice hockey. Injuries sustained while not playing ice hockey were excluded.

Data on the location of injury, emergency room diagnosis, and mechanism of injury were collected. The 26 possible locations of injury were divided into 4 groups: head and neck, upper extremity, lower extremity, and core. Injury diagnoses investigated included concussions, fractures, lacerations, strains or sprains, internal organ injuries, and other, which included a number of less-common diagnoses (eg, anoxia, dental injuries, nerve damage, punctures, etc). The mechanism of injury was broken down into 2 categories: body checking, which included injuries sustained from player-to-player contact or being body checked into the boards, and other, which included falls, contact with a stick, contact with the puck, contact with skates, and unknown.

Statistical analyses were performed using GraphPad Prism version 6.0e (GraphPad Software) and R 3.1.2. Statistical significance was determined using a chi-square test to analyze continuous data. Statistical significance was set at $P \leq .05$.

TABLE 1
Characterization of Pee Wee Hockey Injuries^a

	2008-2010	2013-2015	P Value ^b
Total injures	223 (100.0)	186 (100.0)	
Location of injury			.330
Head and neck	97 (43.5)	93 (50.0)	
Upper extremity	70 (31.4)	46 (24.7)	
Lower extremity	33 (14.8)	32 (17.2)	
Core	23 (10.3)	15 (8.0)	
Diagnosis			.007
Concussion	34 (15.2)	51 (27.4)	
Fracture	39 (17.5)	30 (16.1)	
Laceration	13 (5.8)	17 (9.1)	
Strain or sprain	41 (18.4)	18 (9.7)	
Internal organ injury	39 (17.5)	23 (12.4)	
Other	57 (25.6)	47 (25.3)	
Mechanism of injury			.012
Checking	110 (49.3)	68 (36.6)	
Other	113 (50.7)	118 (63.4)	

^aData are shown as n (%).

^bChi-square test.

RESULTS

Between the 2008-2010 and 2013-2015 seasons, player participation increased from 175,706 to 187,947 (7.0%) and from 167,233 to 171,311 (2.4%), respectively, in the Pee Wee and Bantam leagues.¹⁵ Over the same time course, the total number of injuries captured by the NEISS database decreased by 16.6% among Pee Wee players, from 223 during 2008-2010 to 186 during 2013-2015 (Table 1). For both time periods, the most common site of injury was the head and neck, comprising a total of 46.5% of all injuries. Interestingly, head and neck injuries comprised a greater percentage of injuries after checking was prohibited compared with before (50.0% vs 43.5%, respectively). Despite this, there were no significant changes in the distribution of the location of injuries between time periods ($P = .330$). On the other hand, there was a significant change in the distribution of diagnosed injuries after checking was prohibited ($P = .007$). More specifically, the seasons between 2013 and 2015 saw a 50.0% increase in the number of concussions diagnosed and a 30.8% increase in lacerations diagnosed. There was a 23.1%, 56.1%, 41.0%, and 17.5% decrease in fractures, strains or sprains, internal organ injuries, and other injuries, respectively. Finally, when the mechanism of injury was compared, injuries caused by body checking decreased by 38.2% ($P = .012$).

During the same time frame, recorded injuries decreased to a lesser extent, 6.8%, in Bantam players (Table 2). There were no significant changes in the distribution of the location of injury, diagnosis, or mechanism of injury in the Bantam age group ($P > .05$). The injury with the greatest change in frequency was a concussion, which saw a 14.6% increase in diagnosis. The most commonly reported site of injury for the Bantam age group was also the head and neck, with a frequency of 34.2% and 38.0% before and after the rule change, respectively.

TABLE 2
Characterization of Bantam Hockey Injuries^a

	2008-2010	2013-2015	P Value ^b
Total injures	339 (100.0)	316 (100.0)	
Location of injury			.513
Head and neck	116 (34.2)	120 (38.0)	
Upper extremity	131 (38.6)	112 (35.4)	
Lower extremity	54 (15.9)	56 (17.7)	
Core	38 (11.2)	28 (8.9)	
Diagnosis			.731
Concussion	48 (14.2)	55 (17.4)	
Fracture	87 (25.7)	80 (25.3)	
Laceration	23 (6.8)	27 (8.5)	
Strain or sprain	62 (18.3)	57 (18.0)	
Internal organ injury	41 (12.1)	35 (11.1)	
Other	78 (23.0)	62 (19.6)	
Mechanism of injury			.433
Checking	159 (46.9)	138 (43.7)	
Other	180 (53.1)	178 (56.3)	

^aData are shown as n (%).

^bChi-square test.

DISCUSSION

This is the first investigation evaluating the effect of USA Hockey's 2011 national policy inhibiting checking in Pee Wee ice hockey. Between 2008-2010 and 2013-2015, there was a significant change in the incidence, mechanism, and type of injuries that were diagnosed among the Pee Wee age group in US emergency rooms. Although the exact cause of this change cannot be determined, we hypothesize that the elimination of checking played a significant role. Furthermore, despite increased participation in youth ice hockey, and in line with our hypothesis, there was a significant decrease in the overall number of injuries diagnosed as well as injuries caused by body checking. With regard to specific diagnoses made in emergency rooms, fractures, strains or sprains, internal organ injuries, and injuries included in the other category all decreased in frequency. Most significantly, strains or sprains and internal organ injuries saw greater than 40% decreases in diagnosis. In the Bantam age group, the overall incidence of injuries decreased to a lesser extent compared to Pee Wee players, but there were no significant changes in the distribution of the location of injury, diagnosis, or mechanism of injury in older players.

An unexpected finding of this investigation, and contrary to our hypothesis, was the 50% increase in the number of concussions diagnosed among Pee Wee players after the rule change prohibiting body checking. These results are contradictory to what has been reported in the current literature. For instance, during the 2007-2008 Pee Wee ice hockey season in Canada, Emery et al⁴ compared injuries in 1108 players participating in a league in which checking was permitted to 1046 players playing in a league in which it was not. The authors found a greater than 3-fold increased risk of all injuries, inclusive of concussions, in the league permitting checking and identified an increased rate, 1.47 versus 0.39, respectively, of concussions per

1000 game-hours in the league with checking compared with the one without. Black et al¹ also recently performed a large cohort study comparing injuries of Canadian Pee Wee ice hockey players before and after body checking was inhibited in 2013. The authors found a 50% decrease in injuries and 64% decrease in concussions. Other investigations comparing different Canadian provincial policies on checking found a 2- to 4-fold increased risk of injuries and concussions in Pee Wee players allowed to check.^{2,5} Further, findings from systematic reviews evaluating the risk factors for an injury and concussion support a decreased rate when checking is eliminated from play.^{4,16}

Given the above literature, the increase in concussions seen among Pee Wee players in the current investigation after the checking ban seems surprising. However, unintended consequences after a rule change are not unprecedented. For example, in a study of American football injuries at the college level before and after rule changes to protect players from concussions, researchers found that the concussion rate increased from 1.64 per 1000 athlete-exposures in the 2009-2010 season to 2.87 per 1000 athlete-exposures in the 2013-2014 season.¹⁷ Furthermore, the authors postulated that to avoid head-to-head contact, the players were targeting the lower extremities, causing a rise in lower extremity injuries despite the rule changes. In the current study, after checking was eliminated, youth players may have tried to avoid physical contact with other players and in the process may have become off balance and fallen. These falls may have resulted in head-to-ice contact, which contributed to the increased number of concussions seen in emergency rooms. Additionally, players may have attempted to use their sticks more to slow down and avoid physical contact with their opponents, which may have contributed to the 30.7% increase in lacerations seen in these youth athletes. This is in line with a prior investigation by Deits et al³ showing that 26% of all lacerations in ice hockey were caused by sticks.

The increased number of concussion diagnoses may also be a result of traumatic brain injuries being brought to the forefront as a serious health care concern nationally, thus increasing awareness among players, parents, coaches, medical staff, and physicians. Evidence for this hypothesis is provided by Zhang et al¹⁹ in their 2016 national cross-sectional analysis, which documented a 60% increase in the concussion incidence between 2007 and 2014. Even more interesting was that a 143% increase in concussion diagnoses was found among 10- to 14-year-old players during that same time frame. Similar to our hypothesis, Zhang et al attributed this increase to a higher level of awareness for head injuries. This phenomenon likely occurred on a smaller scale within youth ice hockey but at a decreased rate compared to the general population because of the cessation of checking. Thus, despite the fact that our data suggest that concussions increased after inhibiting checking, we contend that the increase in diagnosed concussions among Pee Wee players would have been even larger had USA Hockey not taken preventative measures. However, by this argument, we would have also expected a similar increase in the concussion incidence among Bantam players over time. Given that concussions increased by only 14.6% in

this patient population, the higher incidence seen in Pee Wee players is likely multifactorial.

The limitations to this study include biases inherent to utilizing a large national database. It is important to note that the NEISS database captures only a small number of emergency room diagnoses, and thus, incidence rates for injuries cannot be calculated. Additionally, the injuries that present to NEISS emergency rooms represent the most severe injuries that would have occurred during ice hockey, and only the single most severe injury is recorded per patient. As opposed to visiting the emergency room, patients may have also chosen to present to primary care physicians, specialists, and/or urgent care clinics, which means that they would not have been accounted for in this study. Also, in that regard, the true incidence of ice hockey injuries sustained in our patient population is unknown, and the 1064 injuries documented in the current investigation likely represents a minority of injuries that occurred during the studied time frame.

With that being said, the sample size was sufficiently large to notice a significant change in the distribution of diagnoses, mechanisms of injury, and locations of injury in Pee Wee players over time. Furthermore, as patients were evaluated by emergency room doctors, this methodology does ensure the accuracy of diagnoses, specifically with regard to concussions. Prior ice hockey-related investigations included concussions diagnosed without the involvement of physicians.^{1,4} Another limitation of the NEISS database is that about a quarter of all included cases had an “unknown” mechanism of injury, and these cases were added to the “other” category for the mechanism of injury when checking may have been the actual cause for the injury. Despite these limitations, the NEISS dataset has been used in numerous previous investigations, and it allowed us to effectively examine a national representative sample of US ice hockey injuries and monitor the pattern of change over time. Finally, although body checking was not allowed in Pee Wee ice hockey between 2013 and 2015, 68 documented checking injuries occurred. It is possible that these injuries represented illegal contact hits or were documented as “checking” if the history provided in the emergency room included any player-to-player contact.

In conclusion, after the implementation of a rule change introducing body checking at the Bantam level instead of the Pee Wee level, there was a significant decrease in injuries due to checking in younger players, despite increased player participation. There were significant decreases in specific injuries such as fractures, strains or sprains, and internal organ injuries; however, there was an increase in the incidence of concussions that may be attributed to increased monitoring and awareness for traumatic brain injuries. This study provides objective data that can inform further preventative strategies and policy changes to reduce the risk of injuries in youth ice hockey players. This investigation would benefit from a large-scale prospective investigation of youth ice hockey players, which would definitively determine the protective effect of eliminating checking from Pee Wee ice hockey.

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