Risk of Injury Associated With Body Checking Among Youth Ice Hockey Players

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Context Ice hockey has one of the highest sport participation and injury rates in youth in Canada. Body checking is the predominant mechanism of injury in leagues in which it is permitted.

Objective To determine if risk of injury and concussion differ for Pee Wee (ages 11-12 years) ice hockey players in a league in which body checking is permitted (Alberta, Canada) vs a league in which body checking is not permitted (Quebec, Canada).

Design, Setting, and Participants Prospective cohort study conducted in Alberta and Quebec during the 2007-2008 Pee Wee ice hockey season. Participants (N=2154) were players from teams in the top 60% of divisions of play.

Main Outcome Measures Incidence rate ratios adjusted for cluster based on Poisson regression for game- and practice-related injury and concussion.

Results Seventy-four Pee Wee teams from Alberta (n=1108 players) and 76 Pee Wee teams from Quebec (n=1046 players) completed the study. In total, there were 241 injuries (78 concussions) reported in Alberta (85 077 exposure-hours) and 91 injuries (23 concussions) reported in Quebec (82 099 exposure-hours). For game-related injuries, the Alberta vs Quebec incidence rate ratio was 3.26 (95% confidence interval [CI], 2.31-4.60 [n=209 and n=70 for Alberta and Quebec, respectively]) for all injuries, 3.88 (95% CI, 1.91-7.89 [n=73 and n=20]) for concussion, 3.30 (95% CI, 1.77-6.17 [n=51 and n=16]) for severe injury (time loss, >7 days), and 3.61 (95% CI, 1.16-11.23 [n=14 and n=4]) for severe concussion (time loss, >10 days). The estimated absolute risk reduction (injuries per 1000 player-hours) that would be achieved if body checking were not permitted in Alberta was 2.84 (95% CI, 2.18-3.49) for all game-related injuries, 0.72 (95% CI, 0.40-1.04) for severe injuries, 1.08 (95% CI, 0.70-1.46) for concussion, and 0.20 (95% CI, 0.04-0.37) for severe concussion. There was no difference between provinces for practice-related injuries.

Conclusion Among 11- to 12-year-old ice hockey players, playing in a league in which body checking is permitted compared with playing in a league in which body checking is not permitted was associated with a 3-fold increased risk of all game-related injuries and the categories of concussion, severe injury, and severe concussion.

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Ice hockey is a popular North American winter sport, with more than 550 000 registered youth players in Hockey Canada and more than 340 000 registered players in the USA Hockey Association in 2008-2009.[1,2] Despite the advantages of sport participation, there is increasing concern regarding the frequency of ice hockey injuries in youth. Canadian data suggest that hockey injuries account for 10% of all youth sport injuries.[3,4] Body checking has been associated with 45% to 86% of injuries among youth ice hockey players.[5-8] Recently, attention has been focused on the increased frequency of concussive head injuries in youth hockey.[9] Concussion has been found to be the most common type of specific injury, accounting for more than 15% of all injuries in 9- to 16-year-old players.[7,10]

Internationally, there are different regulations regarding the age at which body checking is introduced in ice hockey. In the United States, body

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checking is introduced in all leagues in the Pee Wee age group (ages 11-12 years), but leagues not permitting body checking exist through all ages up to Midget (ages 15-16 years).[11] In Canada, the youngest age group in which body checking is permitted is Pee Wee (ages 11-12 years).[12] In the province of Quebec, however, Bantam (ages 13-14 years) is the youngest age group in which body checking is permitted. Otherwise, in Canada, rules of play are mandated by Hockey Canada and are consistent across all provinces.[12]

The policies allowing body checking at the Pee Wee level in Alberta and the Bantam level in Quebec provided a unique opportunity to examine whether the risk of concussion and injury differs for Pee Wee ice hockey players in a league that permits body checking vs a league that does not.

METHODS

Study Objectives

The primary objectives of this study were to examine whether the risk of concussion and other injury during games and practices differs for Pee Wee ice hockey players in a league that permits body checking vs a league that does not. Secondary objectives included examining the difference between the cohorts for severe concussion (time loss, >10 days) and severe injury (time loss, >7 days). In addition, the risk associated with other previously identified risk factors were examined: year of play (ie, first or second), previous injury or concussion, player size, level of play, position of play, and attitudes toward body checking.

Sample, Design, and Data Acquisition

A prospective cohort study was conducted during 1 season of play (October 2007-March 2008). The study population was Pee Wee (ages 11-12 years) ice hockey players. Cohorts were defined by their exposure to a league with rules that permitted body checking. Inclusion criteria were the following: players aged 11 through 12 years during the season of play; male or female players; written informed consent to participate (player and one parent or guardian); players registered with Hockey Calgary, Hockey Edmonton, or Hockey Quebec; players participating in the Pee Wee age group only; players in the top 60% by level of play; agreement of the head coach to participate in the study; and agreement of a team designate (coach, safety manager, or other team parent) to collect information on individual player participation. Teams and players were excluded if they participated in a "girls-only" Pee Wee league or had sustained a previous injury or chronic illness that prevented full participation in hockey at the beginning of the 2007-2008 season.

Written informed consent was obtained from each player and parent or guardian. Approval was granted from the ethics offices at the University of Calgary, University of Alberta, McGill University, Université de Montréal, and Laval University.

A sample size of 1944 (972 from each province) was determined necessary for a minimally important incidence rate ratio (IRR) of 2 or greater based on an expected concussion rate of 1 per 1000 player-hours in the Alberta cohort, adjusting for cluster and an anticipated drop-out rate of 10% (2-sided test; $\alpha = .05$, $\beta = .20$).[13]

Definitions and Analytic Design

The injury surveillance system used in this study was based on the Canadian Intercollegiate Sport Injury Registry, which was modified and validated for use in youth ice hockey.[4,14] Three data collection documents were used: a preseason baseline questionnaire, weekly exposure sheet, and injury report form. All forms were translated into French for Quebec players and therapists whose preferred language was French. Each team was assigned a physiotherapist, athletic therapist, or senior therapy student who attended 1 session per week for their assigned team. The team therapist was responsible for all data collection and injury assessment.

Preseason questionnaires were distributed to all consenting players. The forms were completed with parental assistance when necessary. Baseline data collected included height, weight, date of birth, previous injuries, previous concussion, years of hockey participation, and skill level. In addition, the Sport Concussion Assessment Tool[15] and a body checking questionnaire[16] examining attitudes toward body checking were completed at baseline.

The weekly exposure sheet was a record of the daily participation data collected by a team designate on each consenting player for all team practices and games. For teams missing occasional weeks of weekly exposure information, exposure data were imputed based on the mean game and practice hours in the weeks that the team had complete weekly exposure data. Given the consistency of ice time distribution for games and practices within a given hockey association and league, this was felt to be an appropriate estimate.

The injury report form included details related to mechanism of injury, time, date, session type, time loss, medical follow-up, and the therapist's specific injury assessment. The injury mechanism categories included body checking, other intentional player-player contact (elbowing, cross checking, slashing, tripping, roughing), incidental body contact (contact with another player that did not meet the definition of body checking or other intentional contact), environmental contact independent of contact with another player (puck, boards, net), and no contact. These previously validated mechanisms were defined a priori, and all study personnel (team designates and therapists) were educated regarding injury mechanism definitions.[7]

All ice hockey injuries requiring medical attention, resulting in the inability to complete a session, and/or time loss from hockey were identified by the team designate or therapist and recorded on an injury report form. Concussions were included if they met the reportable injury definition for this study based on the therapist assessment and definition for concussion based on consensus guidelines.[15] The study definition for severe injury was based on time loss. Considering all injuries (including concussion), severe injuries were those that resulted in more than 1 week missed from hockey (ie, does not include slight and minimal injuries based on previous consensus agreement for injury definitions).[17] All concussions included severe concussions that resulted in time loss from hockey of more than 10 days. A 10-day time-loss cutpoint has been suggested as a marker to retrospectively distinguish concussion severity and has been supported in the literature for male sport participants.[15,18-22] Any study therapist not present at the time of injury was notified by the team designate, and the injured player was assessed at the next weekly visit to the team.

All players with a suspected concussion or an injury resulting in time loss greater than 1 week were recommended for review by a study sport medicine physician. Standardized follow-up and return-to-play guidelines were followed by all study physicians and study therapists, based on International Concussion Consensus guidelines.[15] This included graded symptom-free exertion prior to full return to unrestricted competition. In the event that parents elected to follow up with their own family physician, standardized physician follow-up was not ensured, but study therapist recommendations were consistent with guidelines.

All injury report forms were reviewed by the research coordinators (also physiotherapists or athletic therapists) to ensure they met the injury criteria and to provide follow-up until complete recovery prior to inclusion in the database.

In addition to the primary risk factor under consideration (ie, participation in a league permitting vs not permitting body checking), we examined the role of other previously suggested risk factors. The information for these were obtained by self-report at baseline and included year of play (first or second), previous injury or concussion, weight, level of play (leagues are divided into levels according to ability), predicted primary position of play, and attitudes toward body checking.[7,23,24] Weight was dichotomized at the 25th percentile (37 kg) using these data based on the a priori consideration that the smallest players would be at greatest risk of injury. Attitude toward body checking was dichotomized at the 75th percentile using these data (36/55 items on a body-checking questionnaire) based on the a priori consideration that players with higher total scores would be at the greatest risk of injury.

Statistical Analysis

Stata version 10.0 was used for all statistical analyses.[25] Baseline characteristics were compared between Alberta and Quebec.

Incidence rate ratios for each risk factor for the primary outcomes of injury and concussion were estimated with 95% confidence intervals using Poisson regression. In each model, player-hours were included as an offset; clustering by team effect was accounted for with adjustment for all included covariates (year of play, previous injury or concussion, player size, level of play, position, and attitudes toward body checking). Sex was not considered a covariate in any model.

Because of the smaller event rates for the secondary outcomes of severe injury and severe concussion, we limited the Poisson regression to univariate analyses for each risk factor separately (still including player-hours as an offset and accounting for clustering effects by team). Given the expectation of effect modification by session type (game vs practice), analyses were stratified by this variable for all injury definitions. Significance was based on $\alpha < .05$, and all hypothesis tests were 2-sided.

RESULTS

A total of 183 teams were approached to participate in the study (90 in Alberta and 93 in Quebec), with 162 teams (88.5%) agreeing to participate (75 [83.3%] in Alberta and 87 [93.6%] in Quebec). The reasons for nonparticipation were primarily at the team level and included the inability to identify a team designate, team therapist, or a coach decision not to participate. Seventy-four Pee Wee teams from Alberta (n=1108 players; 821 in Calgary and 287 in Edmonton) and 78 Pee Wee teams from Quebec (n=1046 players; 567 in Montreal and 479 in Quebec City) completed this study. One team from Alberta and 9 teams from Quebec dropped out of the study based on team decision or the inability to secure a study therapist. The mean number of players participating in the study from each team was 15 (range, 6-19) in Alberta and 13 (range, 4-17) in Quebec.

TABLE 1 summarizes baseline characteristics. The distributions of sex, height, weight, year of play, level of play, and position of play in the 2 provinces were similar. There were greater proportions of players reporting previous injury and previous concussion in Alberta compared with Quebec. Player attitudes toward body checking suggested a stronger preference for body checking in Alberta.

The median (interquartile range [IQR]) individual total season game and practice exposure-hours were similar in Alberta and Quebec (43 [IQR, 37-52] and 48 [IQR, 39-57] game-hours, respectively; 32 [IQR, 26-38] and 26 [IQR, 18-40] practice-hours). Although similar between provinces, the IQRs for total game- and practice-hours suggest significant variability (37-57 and 18-40, respectively). Because of some missing weekly exposure information, we imputed some of these data. In Alberta, the proportion of weeks for which exposure-hours required imputation was 10.91%. In Quebec, the proportion of weeks in which exposure-hours were imputed was 17.25%.

There were a total of 241 injuries (78 concussions) reported in Alberta in 85 077 player exposure-hours and 91 injuries (23 concussions) reported in Quebec in 82 099 player exposure-hours. In Alberta, 169 players had 1 injury, 31 players had 2 injuries, 2 players had 3 injuries, and 1 player had 4 injuries. In Quebec, 73 players had 1 injury, 6 players had 2 injuries, and 2 players had 3 injuries. Injury rates were stratified by session type (game and practice).

The province-specific injury rates and the comparative IRRs are summarized for game-related injuries in TABLE 2. The unadjusted IRRs comparing Alberta with Quebec were 3.07 for game-related injuries, 3.30 for severe injuries, 3.75 for concussion, and 3.61 for severe concussion. The estimated absolute risk reduction (injuries per 1000 player-hours) that would be achieved if body checking were not permitted in Alberta was 2.84 for game-related injuries, 0.72 for severe injuries, 1.08 for concussion, and 0.20 for severe concussion. There were no differences between provinces with respect to practice-related injuries. The proportion of players who had 2 or more independent game injuries was 2.17% (95% confidence interval [CI], 1.41%-3.33%) in Alberta and 0.38% (95% CI, 0.14%-0.97%) in Quebec. The proportion of players who had 1 or more independent practice injuries was similar in Alberta and Quebec (2.62% [95% CI, 1.70%-4.02%] and 1.91% [95% CI, 1.11%-3.29%], respectively).

TABLE 3 summarizes results for game-related injury risk factors including province, using the adjusted multiple Poisson regression models for the primary outcomes of injury and concussion and unadjusted models for secondary outcomes of severe injury and severe concussion. Players with miss-

Table 1. Baseline Characteristics Comparing Pee Wee (11-12 Years) Hockey Players in Alberta and Quebec, 2007-2008

	No. (%)			
	Injured		Not Injured	
Characteristic	Alberta (n = 203)	Quebec (n = 81)	Alberta (n = 905)	Quebec (n = 965)
Sex				
Male	201 (99.01)	79 (98.75)	888 (98.45)	949 (98.34)
Female	2 (0.99)	1 (1.25)	14 (1.55)	16 (1.66)
Height, mean (SD), cm	151.4 (9.0)	151.7 (8.8)	151.9 (8.8)	152.5 (8.5)
Missing data	15 (7.4)	2 (2.5)	84 (9.3)	12 (1.2)
Weight, mean (SD), kg	43.3 (8.3)	43.9 (9.2)	43.1 (8.4)	44.4 (9.0)
Missing data	14 (6.9)	1 (1.2)	74 (8.2)	6 (0.6)
Year of play				
First	98 (48.3)	25 (30.9)	392 (43.3)	403 (41.8)
Second	105 (51.7)	53 (65.4)	500 (55.2)	541 (56.1)
Missing data	0	3 (3.7)	13 (1.4)	21 (2.2)
Level of play				
Upper (top 20%)	108 (53.2)	34 (42.0)	587 (64.9)	622 (64.5)
Lower (mid 40%)	95 (46.8)	47 (58.0)	318 (35.1)	343 (35.5)
Position				
Forward	124 (61.1)	46 (56.8)	499 (55.1)	539 (55.9)
Defense	66 (32.5)	26 (32.1)	266 (29.4)	307 (31.8)
Goalie	10 (4.9)	7 (8.6)	123 (13.6)	106 (11.0)
Missing data	3 (1.5)	2 (2.5)	17 (1.9)	13 (1.3)
Previous injury				
Yes	66 (32.5)	24 (29.6)	152 (16.8)	144 (14.9)
No	133 (65.5)	56 (69.1)	724 (80.0)	817 (84.7)
Missing data	4 (2.0)	1 (1.2)	29 (3.2)	4 (0.4)
Previous concussion				
Yes	49 (24.1)	23 (28.4)	148 (16.4)	108 (11.2)
No	147 (72.4)	56 (69.1)	733 (81.0)	850 (88.1)
Missing data	7 (3.4)	2 (2.5)	24 (2.7)	7 (8.0)
Attitude toward body checking total score, mean (SD), XX/55 items	35.3 (5.7)	27.4 (7.1)	34.8 (5.8)	26.0 (6.5)
Missing data	6 (3.0)	6 (7.4)	91 (10.1)	82 (8.5)

Table 2. Summary of Outcome Variables for Pee Wee Ice Hockey Injuries in Alberta and Quebec (2007-2008)

	Injury		Severe Injury		Concussion		Severe Concussion	
Outcome	Alberta	Quebec	Alberta	Quebec	Alberta	Quebec	Alberta	Quebec
No. of injuries or concussions	209	70	51	16	73	20	14	4
Athlete participation, h	49 687	51 103	49 687	51 103	49 687	51 103	49 687	51 103
Injury rate, injuries per 1000 player-hours (95% CI)	4.20 (3.49-5.07)	1.37 (1.04-1.80)	1.03 (0.73-1.46)	0.31 (0.19-0.53)	1.47 (1.08-1.99)	0.39 (0.23-0.67)	0.28 (0.15-0.53)	0.08 (0.03-0.20)
Incidence rate ratio[a]	3.07 (2.21-4.27)	1 [Reference]	3.30 (1.77-6.17)	1 [Reference]	3.75 (2.02-6.98)	1 [Reference]	3.61 (1.16-11.23)	1 [Reference]
Absolute risk reduction if checking were not permitted, injuries per 1000 player-hours (95% CI)	2.84 (2.18-3.49)		0.72 (0.40-1.04)		1.08 (0.70-1.46)		0.20 (0.04-0.37)	

Abbreviation: CI, confidence interval.
[a] Ratios based on Poisson regression analysis offset for exposure hours, adjusted for clustering by team, unadjusted for covariates.

ing covariates were excluded in the adjusted model. Previous injury and previous concussion were risk factors for injury and concussion, respectively. Small player size and higher levels of play were also risk factors for all injuries; however, for concussion and severe concussion there was uncertainty because of the small number of events. Position played and attitude toward body checking were also significantly associated with severe concussion only.

Injury rates by mechanism of game injury and province are summarized in the FIGURE. Examining mechanism of injury in Alberta, the game-injury rate associated with body checking was higher (2.72 [95% CI, 2.21-3.35] injuries per 1000 player-hours) than any of the other mechanisms (0.24-0.46). In Quebec, incidental contact led to the highest injury rate (0.49 [95% CI, 0.32-0.74] injuries per 1000 player-hours) compared with the other mechanisms (0.20-0.24). The injury rate attributable to other intentional contact in Alberta (0.46 [95% CI, 0.29-0.73] injuries per 1000 player-hours) was twice that found in Quebec (0.22 [95% CI, 0.10-0.47]). The injury rates associated with other mechanisms (ie, environmental contact, no contact) were similar in the 2 provinces.

By specific body part, the game-injury rates in Alberta were consistently greater than those in Quebec (TABLE 4). The head or face was the most frequently injured body part in Alberta, followed by the knee and the shoulder or clavicle. In Quebec, injuries to the head or face and the knee were the most frequent, followed by injuries to the hip or thigh. In examining injury types (Table 4), concussion had the highest incidence among other types of injury in Alberta and the greatest disparity by province. Fractures were the other injury type with the greatest disparity between provinces.

COMMENT

To our knowledge, this is the first prospective cohort study using a validated injury surveillance system, including therapist and physician assessment, to examine the risk of playing in an ice hockey league that permits body checking compared with one that does not. In addition, this study allowed for the estimation of IRRs for concussion and overall injury based on analyses that accounted for clustering by team, exposure-hours, and other important covariates. Our results indi-

Table 3. Risk Factor Analyses for Game-Related Injury, Severe Injury, Concussion, and Severe Concussion in Pee Wee Ice Hockey in Alberta and Quebec (2007-2008)

Risk Factor	Incidence Rate Ratio (95% CI)			
	All Injury[a]	Severe Injury[b]	Concussion[a]	Severe Concussion[b]
Province				
Alberta	3.26 (2.31-4.60)	3.30 (1.77-6.17)	3.88 (1.91-7.89)	3.61 (1.16-11.23)
Quebec	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Year of play				
First	1.04 (0.80-1.36)	0.75 (0.45-1.23)	1.03 (0.62-1.70)	0.57 (0.14-2.36)
Second	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Previous injury				
Yes	2.07 (1.49-2.86)	3.78 (2.36-6.06)	NA	NA
No	1 [Reference]	1 [Reference]	NA	NA
Previous concussion				
Yes	NA	NA	2.14 (1.28-3.55)	2.76 (1.10-6.91)
No	NA	NA	1 [Reference]	1 [Reference]
Player size				
Low weight (≤37 kg)	1.40 (1.01-1.93)	1.19 (0.69-2.05)	1.32 (0.78-2.23)	0.69 (0.23-2.09)
High weight (>37 kg)	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Level of play				
Upper (top 20%)	1.46 (1.06-2.03)	1.81 (0.99-3.32)	1.28 (0.75-2.17)	0.83 (0.30-2.31)
Lower (mid 40%)	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Position				
Defense	0.89 (0.66-1.20)	0.74 (0.44-1.24)	1.00 (0.62-1.60)	0.22 (0.06-0.84)
Goalie	0.58 (0.33-1.02)	0.12 (0.02-0.86)	0.51 (0.16-1.64)	0
Forward	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Attitudes toward body checking[c]				
High (≥36/55 items)	0.89 (0.69-1.15)	1.73 (1.05-2.83)	0.99 (0.61-1.60)	2.52 (1.00-6.35)
Low (<36/55 items)	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]

Abbreviations: CI, confidence interval; NA, not applicable (based on examining the risk factor of interest for all previous injury for injury definitions and for previous concussion for concussion definitions).
[a] Incidence rate ratios based on Poisson regression analysis offset for exposure hours and adjusted for clustering by team and covariates (year of play, previous injury or concussion, player size, level of play, position of play, and attitudes toward body checking).
[b] Incidence rate ratios based on Poisson regression analysis offset for exposure hours and adjusted only for clustering by team, owing to fewer injuries.
[c] High scores on the Body Checking Questionnaire suggest a greater preference to body check.

cate a greater than 3-fold increased risk of concussion, injury, severe concussion, and severe injury in game play in Pee Wee (ages 11-12 years) leagues in which body checking was permitted (Alberta) compared with similar leagues by level of play in which body checking was not permitted (Quebec). There was no evidence of a difference in practice-related injury rates between provinces. Other potential models—zero-inflated Poisson, quasi Poisson, and negative binomial—did not lead to different results.

Our findings support those from recent systematic reviews examining risk factors for injury in youth ice hockey that examine data from less rigorous methodological and retrospective study designs.[23,24] Warsh et al[23] concluded that increased injuries attributable to body checking were found where body checking was allowed. Emery et al[24] combined data examining the risk of body-checking policy in youth ice hockey in a meta-analysis and reported combined estimates for injury (IRR, 2.45 [95% CI, 1.7-3.6]) and concussion (odds ratio, 1.71 [95% CI, 1.2-2.44]).

The overall injury and concussion rate found in Alberta in this study are consistent with the literature.[8,26] Mechanisms of injury, body part, and injury types were also consistent. The greatest disparity in injury rates between provinces was for concussions and fractures—not surprising, given the mechanics of body checking. Other than the significantly increased risk of injuries related to body-checking mechanism, there was also a 2-fold increased risk of other intentional contact injuries in Alberta compared with Quebec, suggesting a more aggressive style of play in which body checking is permitted.

Consistent with the literature, previous injury and concussion increased the risk of injury and concussion, respectively.[27] This may be related to incomplete healing/rehabilitation, susceptibility of a player to injury based on other factors (eg, on-ice behaviors), or both.

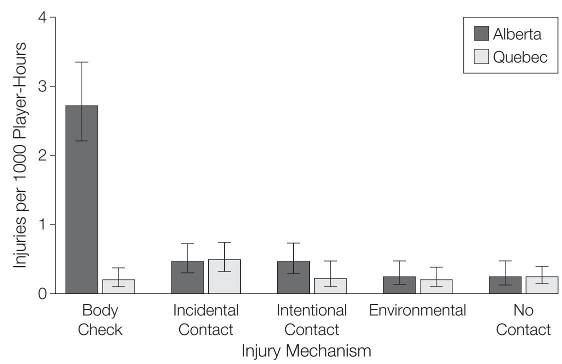
Smaller player size was also a risk factor for all injuries. This may be owing to the contact mechanisms of injury reported in both cohorts and the size differential between players participating in these leagues. Lighter players have previously been reported to be at a greater risk of injury in youth ice hockey leagues.[6,28]

Limitations

Recruitment rates were similar between provinces, but a greater number of teams dropped out in Quebec (n=9) compared with Alberta (n=1). However, given that dropouts were at a team level and the reasons for dropouts were related to the inability to identify a therapist or team designate, one would not expect a systematic selection bias associated with dropout.

With a therapist present at only 1 session each week, it is possible that minor injuries may have been underestimated if the team designate was not aware of the injury. However, in the weekly follow-up the therapist was to communicate with the team designate

Figure. Game-Related Injury Rates by Injury Mechanism and Province in Pee Wee Ice Hockey, Alberta and Quebec (2007-2008)



Error bars indicate 95% confidence intervals.

Table 4. Game-Injury Rate by Body Part and Injury Type in Alberta and Quebec (2007-2008)

	Injuries per 1000 Game-Hours (95% CI)	
	Alberta	Quebec
Body part		
Head/face	1.59 (1.19-2.12)	0.41 (0.24-0.69)
Knee	0.62 (0.43-0.90)	0.39 (0.24-0.64)
Shoulder/clavicle	0.44 (0.26-0.75)	0.04 (0.01-0.15)
Hip/groin/upper leg	0.42 (0.28-0.63)	0.16 (0.08-0.30)
Neck/throat	0.26 (0.15-0.47)	0.06 (0.02-0.18)
Back/side	0.24 (0.14-0.43)	0.08 (0.03-0.20)
Arm/elbow/forearm	0.16 (0.08-0.34)	0.04 (0.01-0.15)
Lower leg/ankle/foot	0.16 (0.08-0.33)	0.14 (0.06-0.34)
Wrist/hand	0.16 (0.08-0.31)	0.04 (0.01-0.16)
Ribs/abdomen/pelvis	0.14 (0.06-0.31)	0.02 (0.003-0.14)
Injury type		
Concussion	1.47 (1.08-1.99)	0.39 (0.23-0.67)
Contusion	1.17 (0.86-1.59)	0.37 (0.22-0.63)
Muscle strain/tendonitis	0.70 (0.51-0.98)	0.18 (0.10-0.32)
Joint/ligament sprain/dislocation	0.36 (0.23-0.58)	0.25 (0.16-0.42)
Fracture	0.34 (0.20-0.57)	0.06 (0.01-0.25)
Abrasion/bleeding/burn/cut	0.04 (0.01-0.16)	0.04 (0.01-0.15)
Other	0.08 (0.03-0.21)	0.08 (0.02-0.26)

Abbreviation CI, confidence interval.

and players to reduce the number of missed injuries. In addition, it is unlikely this reporting issue differed by province.

Concussions were included if they met the injury and concussion definitions based on study therapist injury report. It is a limitation, however, that not all players followed up with a physician. In Alberta, 39 of 78 (50% [95% CI, 38.5%-61.5%]) players with reported concussion saw a physician, compared with 14 of 23 (60.9% [95% CI, 38.5%-80.3%]) in Quebec. Given that the proportions of players with concussion following up with physicians did not differ between provinces, it is unlikely that bias was introduced in the estimates of IRRs associated with concussion.

This study aimed to collect both the exact number of sessions missed from hockey (assessed using the weekly exposure sheet) and the total number of days a participant was unable to play hockey (assessed using the injury report form). Many different factors contribute to this decision, such as the importance of a game or practice, pain tolerance, motivation, personality factors, and parental influence. These differ for each player and may affect the precision of equating time loss with severity of injury. Guidelines for return to play established based on the Concussion Consensus Guidelines facilitated consistency for return to play following concussion between centers.[15] However, it is possible that there was nondifferential misclassification of concussion severity based on the 10-day time-loss cutpoint if there was a delay of more than 4 days until the athlete had first seen a physician and then progressed through the return-to-play protocol.

The reasons for missing data on the weekly exposure sheet (10.91% in Alberta, 17.25% in Quebec) were related to team designate error and not to participation-hours, injury, or any confounding factors. As such, the missing mechanism is arguably missing completely at random, and there is no reason to suspect that the information on missing weeks differed from that on weeks for which values were present.

Baseline risk factors were self-reported and are subject to nondifferential misclassification. In particular, the position of play may not have been consistent for every game during the season.

Rules of play and referee qualifications did not differ between provinces other than the rule allowing body checking in Alberta and not in Quebec; however, the reward systems for Fair-Play Programs did differ in Alberta and Quebec. In Quebec and in Edmonton, Alberta, reward systems were based on the number of penalty minutes called by referees. While there was an emphasis on Fair-Play conduct also in Calgary, Alberta, there was no official reward system in place. Although the Fair-Play systems differed, in Calgary and Edmonton the injury rates did not differ (Calgary, 2.79 [95% CI, 2.28-3.40] injuries per 1000 player-hours; Edmonton, 2.94 [95% CI, 2.04-4.23]). This strengthens the conclusion that our results did not depend on differences between provinces in the Fair-Play Programs. Consistent with this, there is also evidence in the literature that injury rates and the observed number of transgressions does not differ in a Bantam League that rewards teams through a Fair-Play point system for low penalty minutes compared with a Bantam League with no reward system (body checking allowed in both leagues).[29]

CONCLUSION

Among 11- to 12-year-old ice hockey players, playing in a league in which body checking is permitted compared with a league in which body checking is not permitted was associated with a 3-fold increased risk of all game-related injuries, concussion, severe injury, and severe concussion. These findings may have important implications for policy decisions related to body checking in youth ice hockey. The public health implications associated with injury in Pee Wee hockey in which body checking is permitted are significant. Future research should compare the injury and concussion risk in the next age group of play (Bantam, ages 13-14 years), in which players in one cohort will have 2 years of body checking experience prior to Bantam participation. This research can inform the development and rigorous evaluation of prevention strategies to reduce the risk of injury in this population of youth ice hockey participants.

Author Contributions: Dr Emery had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Emery, Shrier, Goulet, Hagel, Benson, Nettel-Aguirre, Meeuwisse.
Acquisition of data: Emery, Shrier, Goulet, McAllister, Meeuwisse.
Analysis and interpretation of data: Emery, Kang, Shrier, Goulet, Hagel, Benson, McAllister, Hamilton, Meeuwisse.
Drafting of the manuscript: Emery, Kang, Shrier, Benson, McAllister, Hamilton, Meeuwisse.
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I never taught language for the purpose of teaching it; but invariably used language as a medium for the communication of thought; thus learning of language was coincident with the acquisition of knowledge.

—Anne Sullivan (1866-1936)

Effect of bodychecking on rate of injuries among minor hockey players

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ABSTRACT

Background: Bodychecking is a leading cause of injury among minor hockey players. Its value has been the subject of heated debate since Hockey Canada introduced bodychecking for competitive players as young as 9 years in the 1998/1999 season. Our goal was to determine whether lowering the legal age of bodychecking from 11 to 9 years affected the numbers of all hockey-related injuries and of those specifically related to bodychecking among minor hockey players in Ontario.

Methods: In this retrospective study, we evaluated data collected through the Canadian Hospitals Injury Reporting and Prevention Program. The study's participants were male hockey league players aged 6–17 years who visited the emergency departments of 5 hospitals in Ontario for hockey-related injuries during 10 hockey seasons (September 1994 to May 2004). Injuries were classified as bodychecking-related or non-bodychecking-related. Injuries that occurred after the rule change took effect were compared with those that occurred before the rule's introduction.

Results: During the study period, a total of 8552 hockey-related injuries were reported, 4460 (52.2%) of which were attributable to bodychecking. The odds ratio (OR) of a visit to the emergency department because of a bodychecking-related injury increased after the rule change (OR 1.26, 95% confidence interval [CI] 1.16–1.38), the head and neck (OR 1.52, 95% CI 1.26–1.84) and the shoulder and arm (OR 1.18, 95% CI 1.04–1.35) being the body parts with the most substantial increases in injury rate. The OR of an emergency visit because of concussion increased significantly in the Atom division after the rule change, which allowed bodychecking in the Atom division. After the rule change, the odds of a bodychecking-related injury was significantly higher in the Atom division (OR 2.20, 95% CI 1.70–2.84).

Interpretation: In this study, the odds of injury increased with decreasing age of exposure to bodychecking. These findings add to the growing evidence that bodychecking holds greater risk than benefit for youth and support widespread calls to ban this practice.

Bodychecking is the most common cause of all ice hockey injuries. The practice has raised particular concern because it can lead to severe injuries such as fractures and traumatic brain injury.[1–5] Unfortunately, bodychecks from behind, which send players headfirst into the boards, are still a frequent cause of injury, despite rules prohibiting this practice.[3] The debate about the value of bodychecking for Canadian minor hockey players has increased since the 1998/1999 hockey season, when Hockey Canada introduced a 5-year voluntary pilot program that lowered the legal age for body contact from 12 and 13 years (PeeWee division[6]) to 10 and 11 years (Atom division[7]) (see Table 1 for Hockey Canada's age divisions over the period of this study). Proponents of the rule change have argued that lowering the age limit for body contact enables minor hockey players to learn how to properly receive and give a bodycheck at an earlier age and that this early learning and repeated reinforcement of proper technique would reduce injuries at older ages. In 2005, Hockey Canada approved continuation of the pilot program beyond the initially planned 5-year period. By that time, the age categories had also been changed, and the youngest players in the Atom division were 9 years old (see Table 1).

The purpose of this study was to examine available data on injuries among competitive minor hockey players in Ontario to determine whether there has been any change in the rate of bodychecking injuries since the legal age for body contact was lowered in 1998/1999. We also examined whether available data support the claim that allowing body contact at an early age (i.e., in the Atom Division) reduces bodychecking injuries at older ages (i.e., in PeeWee, Bantam and Midget divisions).

Methods

This study is based on data from 5 Ontario hospitals that participate in the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP). We used data from 3 pediatric hospitals (The Hospital for Sick Children in Toronto, the Children's Hospital of Eastern Ontario in Ottawa and the Children's Hospital of Western Ontario in London) and 2 general hospitals (Kingston General Hospital and Hotel Dieu Hospital, both in Kingston). CHIRPP is a national surveillance system that collects data on injuries of people who visit the emergency departments of 14 hospitals across Canada. The information collected consisted of what the injured person was doing at the time of the injury, the cause of the injury, the factors contributing to the injury, the time and place of the injury and the patients' age and sex.[9] Although only selected hospitals report to CHIRPP, previous authors have reported that the data collected through the program represent general injury patterns among Canadian youth.[10,11]

We included in the study male patients between the ages of 6 and 17 years who visited an emergency department because of a hockey-related injury between September 1994 and May 2004 (10 hockey seasons). We excluded female patients because Hockey Canada's rule change related to bodychecking was limited to minor hockey leagues for boys. We also excluded patients from the province of Quebec who visited the Children's Hospital of Eastern Ontario (by checking the residence postal codes of patients at this hospital).

Narrative descriptions of injuries are captured in the CHIRPP database under the variable "What happened?" We used these descriptions to identify hockey-related injuries and to classify injuries as being related or not related to bodychecking, according to the automated methodology developed by McFaull.[2] For narratives containing the term "check," "checked," "cross checked," "pushed from behind," "hit from behind," "was hit by other/another player," "got hit by other/another player," "hit against boards," "hit into boards," "hit by elbow," "elbowed," "hit by knee," "kneed," "body contact," "*mis en échec*," "*heurté*," and "*plaqué*," we classified the injury as being related to bodychecking; all other injuries were grouped as non-bodychecking injuries.

We excluded injuries for which the narrative contained the term "collision between players" or "collided with a player" because we believed that such injuries might or might not relate to bodychecking, and the information contained in the narratives was insufficient to conclusively determine whether the injuries had occurred as a result of bodychecking or other mechanisms.

To assess the potential for misclassification by the automated system that we used to classify bodychecking and non-bodychecking injuries, a 10% random sample of the data for hockey-related injuries was manually coded, and the level of agreement between manual and automated coding was determined.

We classified players, on the basis of age and the date of injury, into specific divisions of Hockey Canada (The Canadian Hockey Association became Hockey Canada). The association changed its age categorization for minor league divisions in the 2002/2003 season.[8] Therefore, for the last 2 seasons under consideration in this study (2002/2003 and 2003/2004), we classified players according to the new groupings (Table 1).

Table 1: Age divisions in Canadian minor hockey*

Division	Period; player's age, yr†	
	Before 2002/2003 season	2002/2003 and 2003/2004 seasons
Novice	8–9	7–8
Atom	10–11	9–10
PeeWee	12–13	11–12
Bantam	14–15	13–14
Midget	16–17	15–17

*Source: Hockey Canada.[8]
†As of Dec. 31 of current season.

Most minor hockey leagues in Ontario implemented the pilot program that lowered the legal age for body contact during the 1998/1999 season. The Ottawa District Minor Hockey League and the Kingston Area Minor Hockey Association joined the program during the 2001/2002 hockey season. Accordingly, if the injured player presented to any of the 5 Ontario hospitals between the 1994/1995 and 1997/1998 hockey seasons or presented to the Children's Hospital of Eastern Ontario, the Kingston General Hospital or the Hotel Dieu Hospital of Kingston between the 1998/1999 and 2000/2001 hockey seasons, the injury was categorized as having occurred before the rule change. If the injured player presented to The Hospital for Sick Children or the Children's Hospital of Western Ontario after the 1998/99 hockey season or presented to the Children's Hospital of Eastern Ontario, the Kingston General Hospital or the Hotel Dieu Hospital between the 2001/2002 and 2003/2004 hockey seasons, the injury was classified as having occurred after the rule change.

We compared visits to the emergency department by minor hockey league players for bodychecking injuries (i.e., hockey-related injuries attributed to bodychecking) and non-bodychecking injuries (i.e., hockey-related injuries resulting from mechanisms other than bodychecking). We calculated the odds of sustaining a bodychecking injury as the proportion of emergency department visits for hockey-related injuries that were due to bodychecking after the rule change divided by the proportion of visits for hockey-related injuries due to bodychecking before the rule change.

The St. Michael's Hospital Research Ethics Board approved this study. Statistical analyses were performed with the SAS 8.0 system (SAS Institute Inc, Cary, N.C.). We used Mantel-Haenszel χ^2statistics to calculate the odds ratios (ORs), with 95% confidence intervals (CIs), for sustaining bodychecking injuries relative to non-bodychecking injuries.

Results

Our analysis of the CHIRPP data revealed 9043 hockey-related injuries among children aged 6 to 17 years. We excluded 491 of these injuries because the narratives contained the terms "collision between players" or "collided with a player," and we could not determine if they were related to bodychecking or some other mechanism. The remaining 8552 hockey-related injuries represented 4.9% of the 175 984 injuries (including the 491 excluded injuries) for this age group in the CHIRPP or 48.6 hockey-related injuries per 1000 injuries of all types (Table 2).

Manual coding of a 10% random sample of the hockey-related injuries (n = 855) revealed that the automated system misclassified only 30 (3.5%) of the injuries. The level of agreement between automated and manual coding was excellent (α = 0.93, p < 0.001).

More than half of all hockey-related injuries (4460 or 52.2%) reported through CHIRPP by the study hospitals during the study period were related to bodychecking. The number of bodychecking injuries fluctuated over the study period, in a pattern similar to that for all hockey-related injuries (Table 2). Because of a lack of data on the number of minor hockey players in each season, we could not determine whether an increase in the number of hockey-related injuries (and corresponding increases in bodychecking injuries) was due to an increase in the number of players, an increase in the rate of injuries or both.

Table 2: Hockey-related injuries among children aged 6–17 years in Ontario, 1994/1995 to 2003/2004

	Hockey-related injuries			
Hockey season*	Bodychecking injuries	All hockey injuries	All types of injuries reported to CHIRPP	No. of hockey-related injuries per 1000 injuries
1994/1995	423	830	17 672	47.0
1995/1996	376	795	16 849	47.2
1996/1997	361	741	16 475	45.0
1997/1998	416	815	16 302	50.0
1998/1999	478	864	17 067	50.6
1999/2000	479	906	17 885	50.7
2000/2001	443	901	18 672	48.3
2001/2002	458	907	19 079	47.5
2002/2003	549	936	21 125	44.3
2003/2004	477	857	14 858	57.7
Overall	4460	8552	175 984	48.6

Source: Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP).
*Data for the 2003/2004 season are until May; data for all other seasons reflect injuries reported up to August.

Overall, the odds of sustaining a bodychecking injury increased after the rule change in all divisions of the various minor hockey leagues (except in the Novice division, in which body contact is not allowed) relative to the period preceding the rule change (Table 3). The rule change had the greatest effect in the Atom division. For that division, representing the youngest age group in which bodychecking was allowed after the rule change, there was a significant increase in the odds of an emergency department visit due to a bodychecking injury (OR 2.20, 95% CI 1.70–2.84).

The body parts most often affected as a result of bodychecking injuries were the shoulders and/or arms, followed by the head and/or neck and the hip and/or leg (Table 4). The odds of an emergency department visit because of an injury to the head or neck related to bodychecking increased significantly (OR 1.52, 95% CI 1.26–1.84) after the legal age for bodychecking was reduced.

We also analyzed the odds of an emergency department visit due to bodychecking after the rule change relative to before the rule change for concussions and head and neck injuries. The odds of a visit to the emergency department due to concussion increased significantly after the rule change within the Atom division, for which bodychecking was not allowed before the rule change but was allowed after the rule change (OR 10.08, 95% CI 2.35–43.29) (Table 5). Similarly, the odds of a visit to the emergency department due to a head or neck injury increased significantly after the rule change in both the Atom division (OR 2.27, 95% CI 1.42–3.65) and the Bantam division (OR 1.62, 95% CI 1.12–2.34) divisions (Table 6).

Table 3: Comparison of bodychecking injuries, by minor hockey league division, before and after the rule change allowing bodychecking in the Atom division*

	Timing†; no. of bodychecking injuries‡		
Division	Before rule change	After rule change	OR (95% CI)
Novice	44 (149)	65 (221)	0.99 (0.63–1.57)
Atom	158 (518)	243 (495)	2.20 (1.70–2.84)§
PeeWee	549 (1002)	831 (1452)	1.10 (0.94–1.30)
Bantam	546 (1031)	990 (1785)	1.11 (0.95–1.29)
Midget	320 (627)	714 (1272)	1.23 (1.01–1.49§
All divisions	1617 (3327)	2843 (5225)	1.26 (1.16–1.38)§

OR = odds ratio, CI = confidence interval.

*Source: Canadian Hospitals Injury Reporting and Prevention Program.

†Date delimiting "before" and "after" varies by hospital, because minor hockey leagues in Ottawa and Kingston did not adopt the new rule until the 2001/2002 season; see text for further explanation.

‡Value within parentheses refers to the total number of injuries (both bodychecking-related and non-bodychecking-related) used to calculate the OR.

§Significant at the 0.05 level (2-tailed).

Table 4: Number of bodychecking injuries, by body part affected, before and after the rule change allowing bodychecking in the Atom division*†

	Timing;‡ no. of bodychecking injuries§		
Body part	Before rule change	After rule change	OR (95%) CI
Head and/or neck	342 (646)	824 (1306)	1.52 (1.26–1.84)**
Spine and/or spinal cord	17 (27)	24 (36)	1.18 (0.41–3.34)
Trunk	172 (318)	297 (491)	1.30 (0.98–1.73)
Shoulder and/or arm	797 (1523)	1287 (2279)	1.18 (1.04–1.35)**
Hip and/or leg	256 (750)	356 (1014)	1.04 (0.86–1.27)
Others¶	33 (63)	55 (99)	

OR = odds ratio, CI = confidence interval.

*Source: Canadian Hospitals Injury Reporting and Prevention Program.

†For the period 1994/1995 to 2003/2004.

‡Date delimiting "before" and "after" varies by hospital, because minor hockey leagues in Ottawa and Kingston did not adopt the new rule until the 2001/2002 season; see text for further explanation.

§Value within parentheses refers to the total number of injuries (bodychecking-related and non-bodychecking-related) used to calculate the OR.

¶Includes multiple injuries of more than 1 body part, systemic injury and injury to unspecified body parts.

**Significant at the 0.05 level (2-tailed).

Table 5: Number of bodychecking-related concussions, by minor hockey league division, before and after the rule change allowing bodychecking in the Atom division*†

Division	Timing;‡ no. of concussions§		OR (95% CI)	*p* value
	Before rule change	After rule change		
Novice	3 (4)	2 (7)	0.13 (0.01–2.18)	0.16
Atom	4 (15)	22 (28)	10.08 (2.35–43.29)	0.01
PeeWee	18 (25)	64 (86)	1.13 (0.42–3.07)	0.81
Bantam	16 (23)	65 (99)	2.23 (0.31–2.23)	0.72
Midget	15 (21)	59 (77)	1.31 (0.44–3.88)	0.63

OR = odds ratio, CI = confidence interval.
*Source: Canadian Hospitals Injury Reporting and Prevention Program.
†For the period 1994/1995 to 2003/2004.
‡Date delimiting "before" and "after" varies by hospital, because minor hockey leagues in Ottawa and Kingston did not adopt the new rule until the 2001/2002 season; see text for further explanation.
§Value within parentheses refers to the total number of concussions (bodychecking-related and non-bodychecking-related) used to calculate the OR.

Table 6: Number of head and neck injuries related to bodychecking, by minor hockey league division, before and after the rule change allowing bodychecking in the Atom division*†

Division	Timing;‡ no. of concussions§		OR (95% CI)	*p* value
	Before rule change	After rule change		
Novice	20 (49)	24 (67)	0.81 (0.38–1.73)	0.59
Atom	55 (134)	95 (155)	2.27 (1.42–3.65)	0.001
PeeWee	105 (169)	254 (387)	1.16 (0.80–1.69)	0.43
Bantam	89 (167)	259 (399)	1.62 (1.12–2.34)	0.01
Midget	73 (127)	192 (298)	1.34 (0.88–2.05)	0.18

OR = odds ratio, CI = confidence interval.
*Source: Canadian Hospitals Injury Reporting and Prevention Program.
†For the period 1994/1995 to 2003/2004.
‡Date delimiting "before" and "after" varies by hospital, because minor hockey leagues in Ottawa and Kingston did not adopt the new rule until the 2001/2002 season; see text for further explanation.
§Value within parentheses refers to the total number of head and neck injuries (bodychecking-related and non-bodychecking-related) used to calculate the OR.

Interpretation

In this study, more than half of the hockey-related injuries leading to visits to the emergency department were attributable to bodychecking. Players in the division affected by the change in rules that allowed bodychecking at a younger age (the Atom division) sustained a significantly higher number of bodychecking-related injuries after the rule change. The proportion of bodychecking injuries relative to non-bodychecking injuries also increased slightly among players in the PeeWee, Bantam and Midget divisions (Table 3).

In a previous study,[12] the odds of bodychecking injuries among hockey players 10 to 13 years of age were higher in Ontario (where bodychecking was introduced at a younger age) than Quebec, which indicates that there was no protective effect from learning to bodycheck earlier. Although Macpherson and colleagues[12] also used the CHIRPP database, their focus was on injuries that occurred between 1995 and 2002, whereas we analyzed the period before and after the rule change (that is, 1994 to 2004), and we focused solely on Ontario.

The authors of another study[13] found a 2-fold increase in the rate of injuries among 11-year-old children who initially played at the Atom level (where bodychecking was not allowed) but were subsequently moved to the PeeWee division (where bodychecking was allowed) after the change in age classification implemented by Hockey Canada for the 2002/2003 season (see Table 1). Similarly, after a 3-year longitudinal study examining injury rates among Atom players in the Ottawa District Hockey Association (where bodychecking was prohibited) and in minor leagues within the Ontario Hockey Federation (where bodychecking was allowed), Montelpare and colleagues[14] reported that the proportion of checking-related injuries in the leagues that allowed checking was 3 times greater than in the league that did not allow checking.

Willer and colleagues[15] found that hockey leagues that allowed bodychecking for all players between 9 and 14 years of age had higher rates of injury than leagues that did not allow bodychecking. Despite these results, the authors stated that bodychecking should be introduced at an earlier age, attributing their results to a speculated increase in testosterone and aggression at these ages. Dryden and colleagues[16] calculated rate ratios (bodychecking v. non-bodychecking) in each age group in the study by Willer and colleagues,[15] comparing the bodychecking and non-bodychecking teams. Their analysis showed that, for all age groups, the leagues that allowed bodychecking always had higher rates of injury. The rate ratios ranged from 2 to 10, clearly demonstrating that bodychecking increased the odds of injury for every age group.[16] From these studies, it is clear that learning to bodycheck at a younger age does not reduce a player's odds of injury; instead, it prolongs the exposure to risk.

In our study, we found that the odds of head and brain injuries (including concussion) increased significantly after the legal age for body contact was reduced. Furthermore, the odds of trauma to the head and brain increased as soon as children were exposed to bodychecking (i.e., in the Atom division) and did not decline in the older age divisions.

The strong relation between bodychecking and the occurrence of concussions suggested by these results is consistent with the results of a study by Emery and Meeuwisse,[1] who examined the mechanisms and types of injury sustained by players in a Canadian minor hockey league. Those authors found that bodychecking was the primary mechanism of injury in age divisions that allowed checking, and concussion was the most prevalent type of injury.[1] These results heighten concerns about bodychecking, because concussions have been shown to cause impairments in information processing and cognition, postconcussion syndrome[17–19] and neuropsychological deficits. Furthermore, multiple concussions have a cumulative detrimental effect.[20–22] Such traumatic brain injuries should be a priority concern for players, parents, league administrators and others involved in the sport.

There is no evidence that changes in other aspects of the game (e.g., equipment use or training regimens) during the study period contributed to the increase in injury rate observed since the change in the bodychecking rule. Unfortunately, the head and neck are the most susceptible sites for increased injury. Although Hockey Canada has reversed the earlier change, and bodychecking is now allowed only in the PeeWee, Bantam and Midget divisions,[23] thousands of children are still needlessly exposed to the risk of potentially serious injury, especially repeated brain injury.

Limitations. This study was based on injury data for players who visited emergency departments of hospitals participating in the CHIRPP surveillance program and did not include players who visited hospitals not participating in this program or those who sought medical care in physicians' offices or clinics. The CHIRPP data set captured only relatively severe injuries requiring hospital treatment, and use of this data source might have limited the number of minor injuries included in the analysis. The large sample size and the study design allowed us to calculate odds ratios; however, the total number of minor hockey players each year was not available, and hence we could not calculate injury rates.

Another limitation of using the CHIRRP data set is that we did not know the specific age divisions and competitive levels of the players; we based our categorization solely on patients' ages. In addition, we could not determine whether players had been injured in non-league play, such as high school games. However, other studies have shown that the risks in competitive play are higher than those in less competitive environments.[4] We may also have undercounted the number of injuries related to bodychecking because we categorized an injury as being related to bodychecking only if the narrative text in the database explicitly indicated that bodychecking had been involved. Some injuries in the database might have resulted from a bodycheck, but the narrative description might have focused on another aspect of the injury (for example, "injured arm after sliding into the boards").

Implications. Ultimately, the issue of bodychecking in ice hockey needs to be resolved by a weighing of the risks and benefits of the practice by all those with a stake in ice hockey and in the health of children and youth. There is now a substantial consensus, based on a multitude of research studies, that bodychecking increases the number of injuries. In particular, the incidence of concussion and other injuries increases consistently with increase in exposure to bodychecking, reaching its zenith at the elite levels of collegiate leagues and the National Hockey League.[24–26] Bodychecking is also clearly associated with significant risks of fracture[27–29] and spinal injury.[30]

Despite the growing evidence of the detrimental effects of bodychecking, there is no evidence to indicate that earlier exposure to bodychecking and earlier learning about how to give and receive a bodycheck lowers subsequent odds of injury in hockey.

Several years ago, 14 governmental jurisdictions in Canada established a Canadian sport policy, with the intent of having Canadians of all ages participate in sport.[31] The policy describes sport as "a powerful vehicle for the enhancement of health, well-being, and community development."[31] In Canada, hockey is a sport with great potential to increase the health of individuals; however, it is clear that the risks of bodychecking far outweigh any potential benefits.

Conclusion

In our study, the odds of injuries, especially injuries to the head and brain, increased when bodychecking was allowed among younger players. The increased odds were noted in the first year of exposure to bodychecking and were sustained during all subsequent years. Players not exposed to bodychecking did not show any changes in rates of injury over time.

This study has contributed to the extensive evidence base that bodychecking causes substantial risks of all types of injuries, especially injuries to the head and brain. Although bodychecking can have the effect of intimidating those who receive the bodycheck, there is no evidence that this has any beneficial effect for any player, team, organization or for the sport. Stakeholders such as hockey organizations, insurers, sponsors, the media, parents and players should commit to multifaceted approaches to reduce the risks of injury in ice hockey. In addition to eliminating bodychecking from the sport[4] and changing the rules of the game, educational, legal and financial approaches ought to be introduced to reduce the risk of injury and to correct those factors that contribute to risk and attrition from the sport.

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