Intentional versus unintentional contact as a mechanism of injury in youth ice hockey

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ABSTRACT

Background Youth ice hockey injury rates and mechanisms have been described by various classification systems. Intentional versus unintentional contact was used to classify mechanisms of injuries. All injuries (n=247) in one youth hockey programme over a 5-year period were recorded and included in the analysis.

Purpose To evaluate youth ice hockey injuries and compare programmes that allow body checking versus programmes that do not allow body checking. A primary goal was to determine whether programmes that allow body checking have increased injury rates from intentional body contact. Another goal was to describe the rates of injury across ages, levels of competitive play and during games versus practices.

Methods Rates of injury were compared for three levels of competition (house, select and representative) for approximately 3000 boys aged 4–18 years over a 5-year period. This represents 13 292 player years. Data were collected prospectively in this cohort study. All injuries were reported prospectively by a designated team official and verified by a physician. The log injury rate (per 1000 player hours) was modelled via Poisson regression with log player hours used as an offset. Rate ratio was used to explain the covariate-adjusted injury rate for each of three groups (all injuries, intentional injuries, unintentional injuries).

Results Unintentional contacts accounted for 66.0% of overall injuries (95% CI 60.0 to 72.0), compared with 34.0% from intentional contacts ($p<0.001$;$Z=5.25$). Serious injuries (fractures, dislocations, concussions) resulted more often from unintentional collisions ($p=0.04$). Players in more competitive leagues that allow body checking had a greater incidence of total injuries than less competitive leagues.

Conclusions Most injuries in the youth hockey programme studied were the result of unintentional contact, and were generally more severe. These findings were not expected given previously published research.

Ice hockey is possibly a dangerous youth sport but remains popular particularly in North America. A total of 558 117 youths was registered with Hockey Canada for the 2007–8 season and presently over 600 000 are registered participants with USA Hockey.[1 2] Stuart *et al*[3] studied youth hockey players in Minnesota over a single season and reported a significant increase in injury rates with increasing age. On behalf of USA Hockey, Stuart and Smith[4] later examined injury rates in nine communities. The total population exposure represented 45 970 h of player participation for which there were 102 injuries. The authors provided more stringent criteria for injury than previous studies, requiring recorded injuries to be accompanied by a minimum of 24 h of missed participation. Injury rates increased with age, from 0.8 per 1000 player hours for children aged 8 years and younger to 4.6 injuries per 1000 player hours for adolescents aged 15–17 years. Emery and Meeuwisse[5] provided the most recent comprehensive report on injury rates across various youth age groups. Their study reported on the injury rates of 986 player years with ages ranging from 9 to 16 years and multiple levels of play. The authors reported a higher incidence of injury with increasing age: 1.57 injuries per 1000 game hours was reported at the Atom age group (age 9/10 years), whereas 8.97 was reported for the Midget age group (ages 15/16 years). It was reported that 61% of the injuries were the result of intentional contact (body check, illegal contact) with the rest due to unintentional player-to-player contact, environmental contact (eg, running into the boards) or physical strain.

Emery and Meeuwisse[5] and other investigators have concluded that body checking poses a significant risk factor for young hockey players.[6–8] Willer *et al*[9] observed that the most competitive (representative; rep) league players were 6.1 times more likely to be injured than players in the recreational (house) leagues. That study noted a spike in injuries the first year that body checking was introduced in two different competition levels. Based on the most current research on injury rates and mechanisms in youth ice hockey, the American Academy of Pediatrics recommends that body checking should not be allowed in youth hockey for children younger than 16 years.[10]

There are at least two ways that body checking could increase injury rates. The first is that body checking simply increases the probability that players will have physical contact with each other. The second is that when players are allowed, in fact encouraged, to body check it may increase the intentionality of contact. Cheng *et al*[11] describe the concept of intentionality as separate and distinct from the act of inflicting injury. Intentionality refers to the motive for contact. These investigators examined 986 consecutive cases of injury among 10–19 year olds in seven hospital emergency departments. They found that 87% of sports injuries resulted from unintentional contact with other players or objects of the game. Intentional contact injury in the study, used the definition provided by Emery and Meeuwisse[5] to include body checking and other intentional

player–player contact (eg, elbowing, cross-checking, slashing, tripping, roughing).[11]

In this study, we compare injuries classified as intentional contact versus unintentional contact in a youth ice hockey programme over five seasons (2002–7). Rates of injury were compared across five age groups, at three levels of play and in practices versus games. This study included a large proportion of youngsters in the recreational (house) league programmes, consistent with the proportion of youngsters who play in recreational programmes across Canada and the USA.

This study was formulated around the hypothesis that programmes that allow body checking have increased rates of injury and that a greater proportion of these injuries are related to intentional contact. We were then able to examine how rates of injury increase with the level of competitive play and with increasing age. In addition, we described how rates of injury vary in games compared with practices.

METHODS

This investigation is a prospective cohort study. The participants included 2632 boys aged 4–18 years who were enrolled in a youth hockey programme in the 2002–3 season, 2639 enrolled in the 2003–4 season, 2680 enrolled in the 2004–5 season, 2594 enrolled in the 2005–6 season and 2730 enrolled in the 2006–7 season, yielding 13 292 player-years of data. Many of the boys enrolled during year one (2002–3) were also registered to play in subsequent years. Injury reports for the ice hockey programme located in Ontario, Canada, were collected over the 5-year period. Injuries were included only if they led to a minimum of 24 h of missed activity, per the injury definition used by Stuart and colleagues.[3 4]

No body checking was allowed in the house league at any age. Body checking was allowed in select teams at peewee (age 11 years) and older. Rep teams were allowed body checking in every division except tyke (age 7 years) and novice (age 8 years). In order to estimate exposure (time the player was on the ice), we obtained coaches logs, which detail the number of games and practices played during the season. All players were assumed to attend all practices and to participate in one third of all games (as part of the typical three shifts). This assumes that players have equal ice time.

As part of the safety programme all teams have a designated 'trainer'. Trainers are volunteers to the organisation who are required to attend educational programmes on safety and injury management. As part of their responsibility, they must attend each game and practice or have another trainer take their place. They were also responsible for reporting on each injury that occurred in games or practices. They reported each injury using the Hockey Canada injury report that was submitted with a game sheet and a team roster (see http://www.blomha.on.ca/2007/docs/HCIR.pdf). A physician completed a component of each injury report called the 'physician's statement'. The injury report included a description of the injury and how the injury occurred, including whether the injury occurred in a game or practice and the location (eg, ice surface, dressing room). The physician's statement included a diagnosis. The time missed by the player as a result of the injury was added to the database of information gathered from the injury reports. Investigators had access to the injury data. However, to protect participant confidentiality, personal identifiers of the injured players were removed. Human subject approval was obtained from the University at Buffalo.

To assess the reliability of the data, a sample of 22 families was contacted by phone to confirm original injury type, circumstances and days missed. Before the verification phone call, the league obtained consent from the families via an initial phone call. In all circumstances, the family-reported injury events matched data obtained on the original injury report form.

Each injury report was carefully evaluated to determine whether the injury resulted from an attempt on the part of another player from the opposing team intentionally causing contact. As stated, the injury report contained check boxes for 'cause of injury' and a narrative description of the injury. If a player was injured during contact with an opposing player, the injury was classified by the researchers as a body check and represented intentional contact. During practice scrimmages, body contact with a player from the same team was also classified as a body check (intentional contact). All injuries resulting from illegal contact such as cross-checking or slashing were also classified as intentional contact. Injuries that resulted from a player colliding with the boards or ice surface, not as a result of body contact, were classified as unintentional contact. Player-to-player collisions with skaters on the same team (during games), injuries caused by ruts in the ice or being hit by the puck were classified as unintentional. This format for classifying the mechanism of injury as intentional or unintentional is the same as that applied in the study by Emery and Meeuwisse.[5]

The mechanism of injury, injury type and injury severity were determined for each age group and in each level of team play (house league, select, rep). Injury occurrence was calculated as the number of injuries per 1000 game or practice hours. The log injury rate (per 1000 player hours) was modelled by Poisson regression with log player hours used as an offset. The rate ratio (RR) was used to explain the covariate-adjusted injury rate for each of the three groups (all injuries, intentional injuries, unintentional injuries).

Each model included covariates for age, game versus practice, checking allowed (yes vs no) and rep league (yes vs no). For the purpose of this analysis, age was treated as categorical in order to examine the possible trends over time. The RR was used to quantify the covariate-adjusted effect of level, allowance of body checking, age group (tyke/novice, atom, peewee, bantam, midget) and game versus practice. For each covariate, one level was defined as the reference (RR 1), with which all other levels are compared. For each non-referent level, the RR was interpreted as the rate for that level, divided by the rate for the reference level, in the setting in which all other covariates are equal.

RESULTS

During year 1 (2002–3) of the study, 45 injuries resulted in missing at least 1 day of activity. There were 56 injuries in year 2 (2003–4), 60 injuries in year 3 (2004–5), 40 injuries in year 4 (2005–6) and 46 injuries in year 5 (2006–7). The total number of injuries for the 5-year period was 247. One player was injured twice in year 1 and two players were injured twice each year in years 2, 3, 4 and 5. Only one player was injured three times in any year. There were also 10 players who had injuries in two different years and one who had an injury in three different years. The majority of injuries (66.0%; 95% CI 0.60 to 0.72) in all leagues were the result of unintentional collisions with other players or hard objects ($p<0.001$; $Z=5.25$). House/select league unintentional collisions accounted for 69.3% of the total injuries, whereas in the rep leagues, 60.8% were due to unintentional collisions. These unintentional injuries were also significantly more serious in nature (increased

number of fractures, dislocations and concussions) than intentional injuries (p=0.04; figure 1). Effect modification by league type was apparent if body checking versus non-body checking leagues were stratified.

Table 1 presents the effect of level of play on injury rates. These injuries were again classified based on 'intentionality'. Players in the more highly competitive rep leagues (in which body checking was allowed at the age of 9 years and above) had more overall injuries than players in the select leagues (body checking allowed at the age of 11 years and above) and house leagues (body checking not allowed). Rep leagues experienced a 70% increased rate of any type of injury (RR 1.70), a 165% increased risk of intentional injury (RR 2.65) and a 50% increased risk of unintentional injury (RR 1.50) when compared with house leagues (RR 1; reference). These results, however, did not achieve statistical significance.

In general, there was a slight increase in injury rates with increasing age, as shown in table 2. Injury occurrence and rates are given for tyke/novice (age 7–8 years), atom (age 9–10 years), peewee (age 11–12 years), bantam (age 13–14 years) and midget (age 16–18 years) levels. For comparison purposes, the peewee division was assigned a RR of 1 and other ages were compared with this age group.

Injury incidence in practice and game play over the 5 years of the study for each age group and division are summarised in table 3. The rate of injuries as (A) the number of injuries per 1000 game hours and (B) the number of injuries per 1000 practice hours for each division are listed. Injuries were much more likely to occur during games than during practices. Rates of injuries during practices were generally low across all age groups and divisions. Rates during games, however, varied a great deal from division to division and between house teams and rep teams. Select teams had rates of injury that were similar to the house league. The younger age groups demonstrated less variability between game and practice injuries; however, the older age groups demonstrated a much higher incidence of game injuries compared with practice injuries.

The effect of body checking is demonstrated in table 4. The rate of unintentional injuries in leagues that allowed body checking was over three times that in non-checking leagues (RR 3.27; 95% CI 1.07 to 10.00), a statistically significant finding (p=0.038). In checking leagues, the intentional injury rate was approximately four times that in non-checking leagues (RR 3.95; 95% CI 0.80 to 19.50), a finding that approached but did not attain significance (p=0.09).

DISCUSSION

This study represents an analysis of injury rates with the largest published sample of young ice hockey players, particularly those playing recreational or house league hockey.[12-18] When compared with previous studies with known population exposure, this investigation included a larger sample size of the very young players starting at ages 4–18 years (refer to table 3 for ages and league descriptions). The larger sample size provided greater analytical precision regarding injury rate differences by age group and level of competition.

The injury rates presented in this study are similar to the rates of injury presented by Emery and Meeuwisse[5] for the age groups and levels of play in common. Emery and Meeuwisse[5] only studied rep (competitive) team players and presented rates for age groups rather than ages. The injury rate for peewee (ages 11 and 12 years) was 4.79 in the study by Emery and Meeuwisse[5] and 4.69 in the current study (peewee and minor peewee rates combined to compare appropriate age groups). The injury rates for bantam (ages 13 and 14 years) competitive players in the study by Emery and Meeuwisse[5] was 6.22 per 1000 game hours played, compared with 10.20 in the current study (bantam and minor bantam rates combined to compare appropriate age groups). An identifiable difference was minor atom/atom (ages 9 and 10 years) in which the current study reports a rate of 4.47 injuries per 1000 game hours compared with 1.57 injuries reported in the study by Emery and Meeuwisse.[5] The competitive players at the atom level in the current study were allowed to body check, whereas the competitive players in the atom level of the study by Emery and Meeuwisse[5] were not allowed to body check.

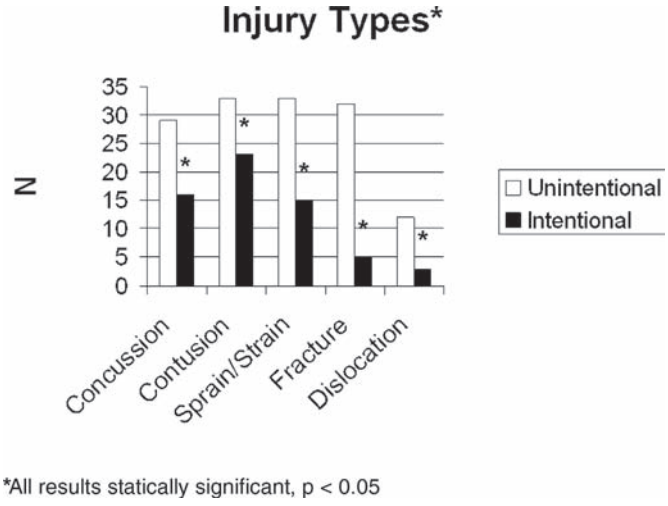

Figure 1 Incidence of injury type over a 5-year period (unintentional vs intentional).

Table 1 Effect of level of play on injury rate for intentional versus unintentional contacts

		Intentional injuries			Unintentional injuries			Total injuries		
Level	Player hours	Count	Rate	RR (95% CI) (p value)	Count	Rate	RR (95% CI) (p value)	Count	Rate	RR (95% CI) (p value)
House	459866	30	0.065	1 (–)	92	0.2	1 (–)	122	0.265	1 (–)
Select	41670	16	0.384	2.33 (0.49 to 11.04) (p=0.29)	12	0.288	0.64 (0.20 to 2.00) (p=0.44)	28	0.672	1.02 (0.41 to 2.52) (p=0.97)
Rep	85224	39	0.458	2.65 (0.53 to 13.35) (p=0.24)	57	0.669	1.50 (0.51 to 4.445) (p=0.46)	96	1.126	1.70 (0.69 to 4.16) (p=0.25)

RR, rate ratio.

Table 2 Injury rates for intentional versus unintentional body contact by age group

	Tyke, novice (age 7–8 years)	Atom (age 9–10 years)	Peewee (age 11–12 years)	Bantam (age 13–14 years)	Midget (age 16–18 years)
Player hours	166698	119480	114728	107122	78732
Intentional					
Count	4	15	19	35	12
Rate	0.024	0.126	0.166	0.327	0.152
RR	0.40	0.91	1	1.95	2.13
95% CI	0.12 to 1.35	0.46, 1.83	–	1.12 to 3.41	0.95 to 4.65
p Value	0.14	0.79	ref	0.019	0.058
Unintentional					
Count	20	22	49	40	30
Rate	0.12	0.184	0.427	0.373	0.381
RR	0.49	0.45	1	0.86	1.41
95% CI	0.28 to 0.89	0.27 to 0.75	–	0.57 to 1.31	0.86 to 2.31
p Value	0.020	0.002	ref	0.49	0.17
Total					
Count	24	37	68	75	42
Rate: total	0.144	0.31	0.593	0.7	0.533
RR	0.50	0.57	1	1.16	1.61
95% CI	0.30 to 0.86	0.38 to 0.86	–	0.84 to 1.62	1.06 to 2.44
p Value	0.011	0.007	ref	0.36	0.025

RR, rate ratio.

Table 3 Injury rates in games and practice by division

Division	Age (years)	N	Injuries per 1000 game hours	Injuries per 1000 practice hours
House league				
Development 1	4–5	1003	0.00	0.10
Development 2	6–7	1337	0.33	0.26
Tyke HL	7	676	0.00	0.15
Novice HL	8	990	0.69	0.51
Minor atom HL	9	1057	0.38	0.00
Atom HL	10	1063	0.57	0.00
Minor peewee HL	11	1125	0.58	0.11
Peewee HL	12	1080	2.30	0.09
Minor bantam HL	13	1042	0.81	0.00
Bantam HL	14	906	1.45	0.24
Minor midget HL	15	794	1.40	0.00
Midget HL	16–18	1109	1.93	0.26
Select league				
Novice select	7–8	85	0.00	0.50
Atom select	9–10	86	1.22	0.00
Peewee select*	11–12	102	5.23	0.20
Bantam select*	13–14	85	3.36	0.21
Minor midget select*	15	35	7.33	0.74
Rep league				
Tyke rep	7	85	0.73	0.00
Novice rep	8	86	0.60	0.00
Minor atom rep*	9	102	5.30	0.81
Atom rep*	10	102	3.68	0.16
Minor peewee rep*	11	86	3.54	0.57
Peewee rep*	12	85	5.92	0.82
Minor bantam rep*	13	86	9.80	0.80
Bantam rep*	14	85	10.64	0.43
Total		13 292		

*Divisions with body checking.
HL, house league; rep, representative.

Table 4 Intentional versus unintentional contact injury rates by divisions that allow body checking

	Body checking not allowed	Body checking allowed
Player hours	495 254	91 506
Injuries: intentional	32	53
Rate: per 1000	0.065	0.579
RR	1	3.95
95% CI	–	0.80 to 19.50
p Value	ref	0.09
Injuries: unintentional	96	65
Rate: per 1000	0.194	0.71
RR	1	3.27
95% CI	–	1.07 to 10.00
p Value	Ref	0.038
Total	128	118
Rate: per 1000	0.258	1.29
RR	1	3.75
95% CI	–	1.51 to 9.34
p Value	ref	0.005

RR, rate ratio.

Our primary hypothesis was that a higher incidence of injuries would be related to intentional contacts. However, averaged across all leagues, it appears that the majority of injuries are the result of unintentional contact. These unintentional injuries were more severe in nature, causing players to miss more days of play than the injuries associated with intentional contact. Effect modification by league type was apparent if body checking versus non-body checking leagues were stratified.

One explanation for this observation may be that, in both the USA and Canada, players are being taught to play more 'heads up' in order to anticipate an intentional contact such as a body check better. Hockey programmes have also discouraged acts that are likely to cause injury such as hitting from behind. Injuries resulting from unintentional collisions may be more common and more severe because players are less prepared to anticipate unintentional body contact.

The hypothesis that rates of injury increase with the level of play was supported as there were higher injury rates among the rep teams when compared with the house/select teams. Rates of injury increased with the age of a player, consistent with other studies.[4 5] However, statistical significance was only achieved between certain age groups such as peewee (age 12 years) compared with midget (age 16–18 years).

Finally, rates of injuries during practices were generally low across all age groups and divisions. The rates of injury reported during practices in the current study were virtually the same as those reported in the study by Emery and Meeuwisse[5] with approximately one injury for every 2000 h of practice. Rates during games varied a great deal from division to division and between house teams and rep teams. Game injuries were much more frequent among the highly skilled players on rep teams.

The role of body checking in hockey injuries is complex and controversial.[4 9 10 19] There are a number of factors that suggest body checking is a risk factor for injury. We have demonstrated that leagues in which body checking is permitted have a nearly fourfold increase in injury rates when compared with non-body checking leagues due to both intentional and unintentional mechanisms. When we compare competitive players matched in age and level of play with other studies, we find an eightfold increase in injury for 9 and 10-year-old players when body checking is allowed. On the surface, these data suggest that body checking should be removed from the sport, at least for younger players. Certainly, there is no need to have body checking at any age for the recreational (house league) players who enjoy a very low risk of injury.

The decision of when and if competitive young players should be allowed body checking cannot be based on an assessment of injury risk alone. Body checking is a part of competitive men's hockey and is likely to remain so, and aspiring hockey players will have to learn to give and receive a body check at some age if they hope to play competitively as an adult. Furthermore, these players must learn to play heads-up hockey both for increased skill in puck handling and the avoidance of body checks. It is possible that body checking increases the likelihood of the player playing heads up. Certainly, having one's head down leaves the youngster vulnerable to contact, intentional or otherwise. Unfortunately, the relationship of body checking and heads-up hockey could not be determined on the basis of injury reports studied as part of this investigation.

There are several limitations to this study, not the least of which was our reliance on volunteer personnel who may not have sufficient medical training. These individuals were designated trainers who attended one or more safety and injury management courses before being considered qualified trainers. Nevertheless, every injury report form contained a physician assessment of injury. To assess the accuracy of the injury reports, we contacted 22 families in follow-up, and each family confirmed the original injury type, circumstances and days missed for their player. Additional family phone calls confirming the accuracy of injury reporting could also have increased our data precision. In addition, the authors cannot account for injuries that were not reported to team officials or when the player refused to return to hockey after an injury. Emery and Meeuwisse[5] also relied heavily on the coaches and team trainers for information. They also had certified athletic therapists or athletic therapy candidates who observed a portion of games and found that there was a great deal of consistency between the injury reports and observations of injury mechanism among the trained observers and the volunteer trainers. Emery and Meeuwisse[5] did not consistently have a physician report on each injury, whereas the current study had every injury report confirmed by a physician. Another limitation is that previous injury may be a cofounder for future injury. The number of years of participation varied from player to player. Also, in order to protect the confidentiality of the players, no names were used; and therefore the number of years of participation for individuals was not known.

This study does not answer the question regarding the age at which body checking should be allowed or whether body checking should be allowed at all. The study does, however, suggest that regardless of whether young players are allowed to body check, an important source of serious injury is unintentional contact with the boards, ice surface or other players. A means to prevent such injuries is to teach young players to keep their head up rather than look down at the puck. Hockey Canada and USA Hockey have both emphasised heads-up hockey for just this reason. Future research might look specifically at the effects of heads-up training on injury rates using a randomised control trial.

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What is already known on this topic

- Research on paediatric ice hockey players has provided rates of injuries for various age groups.
- Injury rates increase with age and are more likely to occur in more competitive levels of play.
- The primary mechanism of injury is body contact, although there is often no distinction between intentional versus unintentional body contact.

What this study adds

- This study has the largest sample of paediatric ice hockey players and includes a much larger proportion of youngsters who play ice hockey for leisure and exercise.
- This study focused on the intentionality of body contact and concludes that most injuries result from unintentional contact.
- Prevention programmes should emphasise heads-up hockey.

organisation and Hockey Canada for their commitment to the culture of safety in hockey.

Competing interests None.

Ethics approval This study was conducted with the approval of the State University of New York at Buffalo.

Provenance and peer review Not commissioned; not externally peer reviewed.

Detail has been removed from this case description/these case descriptions to ensure anonymity. The editors and reviewers have seen the detailed information available and are satisfied that the information backs up the case the authors are making.

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