Injury Rates in House League, Select, and Representative Youth Ice Hockey

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ABSTRACT

WILLER, B., B. KROETSCH, S. DARLING, A. HUTSON, and J. LEDDY. Injury Rates in House League, Select, and Representative Youth Ice Hockey. *Med. Sci. Sports Exerc.*, Vol. 37, No. 10, pp. 1658–1663, 2005. **Purpose:** The purpose of this study was to determine injury rates in a youth ice hockey program over two seasons (2002–2004). Injury rates for age groups (4–18 yr) and for different levels of competition were compared. Another purpose was to determine the effect of body checking on injury rates among these youths. **Methods:** A prospective injury report form was completed by a volunteer trainer for each injury that caused a loss of player time and resulted in evaluation by a physician. The injury form documented age group, type of injury, length of time that the player missed action due to the injury, location of the injury, and circumstances that led to the injury. Participants included 2632 boys aged 4–18 who played in the 2002–2003 season and 2639 boys who played in the 2003–2004 season. **Results:** Injuries were four times more likely to occur in games than practices. Boys who played in the most advanced levels of competition are 6.1 times more likely to be injured than boys playing in house leagues. Injury rates during games showed a trend toward increasing with the age of the player. Injury rates spiked the first year that body checking was introduced in two different competition levels. Injury rates also spiked with the onset of adolescence (age 13). **Conclusion:** The study findings suggest that the introduction of body checking at age 9 to competitive youth hockey causes an immediate but relatively short-term increase in injury rates. The period of adjustment that accompanies body checking should be taken into account when determining the age at which body checking is introduced. **Key Words:** INJURY PREVENTION, INJURY SEVERITY, CONCUSSION, SPORTS

The sport of ice hockey is considered one of the fastest and most dangerous of sports for youths and adults to participate in. An analysis of catastrophic injuries and fatalities in high school and college sports in the United States over a 15-yr period (1982–1997) indicates that ice hockey has a higher rate of injury or death than basketball, soccer, or football (3). On the basis of the injury rates in youth ice hockey, the American Academy of Pediatrics recommended that body checking should not be allowed in youth hockey for children younger than age 16 (1). Recent literature reviews also conclude that ice hockey as it is currently played (with body checking) represents too high a risk for our youths (7,8). Marchie and Cusimano (7) suggest that the rate of concussion in ice hockey is too high and that concussion may be especially debilitating for young hockey players.

Koh et al. (6) provide what is perhaps the most systematic review of research on concussion in contact sports. Although they conclude that ice hockey and rugby have the highest rates of concussion injuries among team sports, the authors caution that the research on injury rates in sports is marred by inconsistencies in key definitions and design. One critical factor was the definition of an injury. Most studies only counted injuries which led to time lost for the player but there was no clear standard definition. In their review, only epidemiologic investigations of injury which clearly articulated the exposure for athletes were included. Player exposure might be described as the number of games played or ideally, the number of hours the player was involved in games or practices. As such, only five studies in Koh's review met these criteria, and of these, only two investigated youth players.

Although most of the published research of youth hockey did not meet the criteria for inclusion in the Koh et al. (6) review, these studies are nonetheless instructive. The earliest investigation by Sutherland (13) provided the injury rates of 706 boys and one girl ages 5–14 yr playing ice hockey in the state of Ohio. The author reported a very low injury rate of 17 injuries in one season. Daffner (4) studied youths ages 5–17 in a newly developed youth hockey program in the state of Kentucky. Over the first two seasons of study, there were four injuries and no concussions among the 130 youths included. Again, the Daffner (4) study indicates a remarkably low rate of injury among youths involved in hockey.

Brust et al. (2) looked at injury rates of youths ($N = 150$) in Minnesota over one season and discovered an injury incidence rate of 15 injuries per 100 players. It should be noted that the authors used a very broad definition of injury. Half of the injuries reported were contusions, and most of the injuries were classified as minor. These same authors (9) investigated injury rates among high school players (ages

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Submitted for publication January 2005.
Accepted for publication February 2005.

0195-9131/05/3710-1658/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/01.mss.0000181839.86170.06

11–19) involved in tournaments and reported a fourfold increase in injury that was postulated to be the result of the higher competitiveness of tournament play. Fifteen percent of injuries were concussions. The investigators also found that the rate of injury increased dramatically with age. Ten and 11 yr olds had an injury rate 6.7 per 1000 player hours and 12 and 13 yr olds had a rate of 12.3 per 1000 player hours. Girls playing hockey had much lower rates of injury than boys.

Gerberich et al. (5) also studied high school hockey players in Minnesota. The injury rate of 5 per 1000 player hours was considerably lower than the tournament injury rate reported by Roberts et al. (9). However, Gerberich et al. (5) also reported a high rate of concussion. Although concussions only accounted for 12% of total injuries, the authors indicate that 9% of players experienced at least one concussion in a season. Players with a history of concussion were at much greater risk of a subsequent concussion.

Stuart et al. (12) studied youth hockey players in Minnesota over a single season and also reported a significant increase in injury rates across ages. In a subsequent study, Stuart and Smith (11) examined injury rates in nine communities on behalf of U.S. hockey. The total population exposure represented 45,970 h of player participation for which there were 102 injuries. Stuart and Smith used more stringent criteria for injury such that the injury had to be accompanied by a minimum of 24 h of missed action. Injury rates increased with age from 0.8 per 1000 player hours for children 8 and younger to 4.6 injuries per 1000 player hours for adolescents aged 15–17. However, the authors were openly concerned about the reliability of the injury-reporting system used because there was considerable disparity in the numbers of injuries reported by the different communities involved.

All the above studies relied on injury reporting systems and are therefore prospective in nature. One retrospective study (10) involved a survey of team managers and coaches of 49 teams of 11- to 12-yr-old players in the province of Quebec, Canada. Twenty-eight of the teams surveyed played in leagues that allowed body checking and 21 of the teams played in leagues that did not allow body checking. The authors found the rate of injury reported was higher for the body checking teams, although the rate of concussion was the same for both conditions.

The current investigation looks at injury reports for a youth hockey program in Ontario, Canada over a 2-yr period. When compared to previous studies with known population exposure, this investigation includes a larger sample size for the very young players ages 4–18. The larger sample size allows for greater precision regarding differences by age group and level of competition. Some of the teams included in this study play in leagues where body checking is part of the game, whereas others play in leagues without body checking. The relationship of body checking to injury rates can be evaluated. However, the results may be confounded by the increased skill and competitiveness of the checking leagues. This study includes all injuries that led to a minimum of 24 h of missed activity, per the injury definition used by Stuart et al. (11,12).

METHODS

Participants. The participants included 2642 children aged 4–17 yr who were enrolled in a youth hockey program in the 2002–2003 season, and 2652 children enrolled in the same hockey program during the 2003–2004 season. Most of the children enrolled during year 1 (2002–2003) were also registered to play in year 2 (2003–2004). In year 1, there were 10 girls registered to play and in year 2 there were 13 girls registered. None of the girls experienced an injury during the 2 yr of the study. We did not include the girls in any of the analyses in order to keep the sample homogeneous for gender.

Children registered to play were placed on teams that were age specific. Four and 5 yr olds played on what are called development teams. In this division, children played an almost equal number of games and practices. There was also a 6- and 7-yr-old development division that operated in a similar fashion albeit with more games and fewer practices. Some 7 yr olds were more skilled and played in the Tyke (house league) division against teams of other 7 yr olds in the same league. These house league Tyke teams generally played 15 games per year and had another 20 h of practice. There was also a Tyke representative (Rep) team made up of the most skilled 7 yr olds who played games against teams from other municipalities. Players on any Rep team do not play in the house league. The Tyke Rep team played 50 games including tournament games during the season and had another 54 h of practice.

Eight-year-old players played in the Novice division against other 8 yr olds in the house league. Some house league players (aged 7 and 8) continued to play in the house league but also played on a Select team and occasionally played against Select teams from other communities. The most skilled 8 yr olds played on the Novice Rep team where they only played against Rep teams from other communities. The average annual game and practice hours for each group and division are presented in Table 1.

Nine year olds played in the Minor Atom Division, and again there were house league teams and one Rep team. Ten-year-old children played in the Atom division in house league, Atom Select or Atom Rep. The Atom Select team included 9- and 10-yr-old players. This pattern of house league, Select team, and two Rep teams continued through Peewee and Bantam (ages 11–14). All divisions and corresponding age groups and the sample size for each division are presented in Table 1.

Fifteen-year-old boys played in the Minor Midget division where the league only offers house league. Boys aged 16–18 played in the Midget division, and, again, only house league is offered. The hockey program under study did not offer Select or Rep hockey at the Midget level (15–18 yr).

There was no body checking allowed in the house league at any age. Rep teams have body checking in every division except Tyke (age 7) and Novice (age 8). Body checking was

TABLE 1. Boys registered to play in 2002–2003 and 2003–2004 and the average number of game and practice hours per player.

Division	Age	2002–2003 *N*	2003–2004 *N*	Annual No. of Game Hours	Annual No. of Practice Hours
Development 1	4–5	202	194	18	17
Development 2	6–7	336	300	29	3
Tyke HL	7	120	120	15	20
Tyke Rep	7	17	17	50	54
Novice HL	8	212	219	25	4
Novice Select	7–8	17	17	50	54
Novice Rep	8	17	17	54	50
Minor Atom HL	9	223	228	30	11
Minor Atom Rep[a]	9	17	17	64	64
Atom HL	10	210	222	28	8
Atom Select	9–10	17	17	58	50
Atom Rep[a]	10	17	17	63	64
Minor Peewee HL	11	226	233	24	7
Minor Peewee Rep[a]	11	17	17	73	61
Peewee HL	12	207	216	28	13
Peewee Select[a]	11–12	17	17	55	62
Peewee Rep[a]	12	17	17	65	58
Minor Bantam HL	13	192	203	28	8
Minor Bantam Rep[a]	13	17	17	67	59
Bantam HL	14	150	153	32	8
Bantam Select[a]	13–14	17	17	68	58
Bantam Rep[a]	14	17	17	60	56
Minor Midget HL	15	136	169	27	9
Midget HL	16–18	214	178	34	6
All ages		2632	2639		

[a] Divisions with body checking. HL, house league; Rep, representative.

introduced to Select teams only at Peewee (age 11–12) and older.

As part of the safety program for this particular league, all teams had a designated trainer. Trainers were volunteers to the organization and were required to attend an educational program on safety and injury management. They reported each injury using the Hockey Canada Injury Report, which was submitted with a game sheet and a team roster (see http://www.blomha.on.ca/public/Trainers/Hockey%20Canada%20Injury-%20Report%20Form.pdf). The child's physician completed a component of the injury report called the "physician's statement." The injury report includes a description of the injury and how the injury occurred, including whether the injury occurred in a game or practice and location (e.g., ice surface, dressing room). The physician's statement includes 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. The 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. Injuries were included in the study if they resulted in a physician evaluation and if they resulted in at least 24 h of activity restriction (9,11).

The rate of injury per 100 players annually in each age group and for each level of team play (house league, Select, Rep) was calculated. Injuries occurring in practices were calculated as a rate of injury per 1000 practice hours. The number of hours of practice for each team was determined and the assumption was made that every player attended every practice. Data presented in Table 2 are compiled from both years of the study. The game-related injuries were determined on the same basis as Stuart et al. (12), which assumed that six players from each team were on the ice at the same time. Thus, 1 h of game time is equivalent to approximately 20 min of actual ice time for each individual player. This method for calculating hours of ice time does not take into account time off for penalties. This method also makes the assumption that all players have equal ice time. The alternative is to calculate the exact ice time for each player. Although ideal, this would require resources beyond the scope of this investigation.

Logistic regression was used to examine the odds of an injury as a function of age, level of play (H = house league, R = Rep team (elite players), S = Select team) and year (year 1 or year 2). For the purpose of this analysis, age was treated as categorical in order to examine possible trends over time. Results are summarized as odds ratios along with the corresponding 95% confidence intervals. We limited the logistic regression analysis to ages 7–14 given that all levels of competition are represented across those age groups.

RESULTS

During year 1 (2002–2003) of the study, there were 45 injuries to boys playing in the youth hockey program that resulted in missing at least 1 d of activity. During year 2 (2003–2004), there were 56 injuries to boys in the youth hockey program. Excluded were two occasions of injury to a referee. In year 1, one boy was injured twice and in year 2, one boy was injured twice. There were two boys injured once in each year. For purposes of analysis, we treated all injuries as independent events.

Table 2 presents the injury incidence in practice and game play over the 2 yr of study for each age group and division. In addition, the rate of injuries as 1) the number of injuries per 100 players per year, 2) the number of injuries per 1000 practice hours, and 3) the number of injuries per 1000 game hours for each division are listed. One youngster developed a contusion on his face when he fell during a scheduled dry

TABLE 2. Injuries and injury rates for games and practices by division.

Division	Age Group	Game Injuries	Practice Injuries	Injuries per 100 Players per Year	Injuries per 1000 Practice Hours	Injuries per 1000 Game Hours
Development 1	4–5	0	1	0.253	0.149	0
Development 2	6–7	1	1	0.314	0.524	0.163
Tyke HL	7	0	1	0.417	0.208	0.000
Tyke Rep	7	1	0	2.941	0	1.765
Novice HL	8	3	2	1.160	1.160	0.835
Novice Select	7–8	0	0	0	0	0
Novice Rep	8	1	0	2.941	0	1.634
Minor Atom HL	9	4	0	0.887	0	0.887
Minor Atom Rep[a]	9	10	2	35.294	0.919	13.787
Atom HL	10	4	0	0.926	0	0.992
Atom Select	9–10	0	0	0	0	0
Atom Rep[a]	10	4	0	11.765	0	5.602
Minor Peewee HL	11	1	2	0.654	0.622	0.272
Minor Peewee Rep[a]	11	4	2	17.647	0.964	4.835
Peewee HL	12	8	1	2.128	0.182	2.026
Peewee Select[a]	11–12	3	0	8.824	0	4.813
Peewee Rep[a]	12	2	3	14.706	1.521	2.715
Minor Bantam HL	13	3	1	1.013	0.316	0.814
Minor Bantam Rep[a]	13	11	1	35.294	0.499	14.486
Bantam HL	14	6	0	1.980	0	1.856
Bantam Select[a]	13–14	0	0	0	0	0
Bantam Rep[a]	14	4	2	17.647	1.050	5.882
Minor Midget HL	15	4	0	1.311	0	1.457
Midget HL	16–18	6	2	2.041	0.850	1.351
All ages		80	21	1.916		

[a] Divisions with body checking. HL, house league; Rep, representative teams.

land training program, and this injury was coded as a practice injury. Two players developed contusions to the head in the dressing room before games, and the injuries were coded as game injuries. The factors for age ($P = 0.91$), level of play ($P = 0.16$), and year ($P = 0.49$) were nonsignificant in the logistic regression model in terms of predicting the probability of a practice-related injury.

Injuries are much more likely to occur during games than during practices. Rates of injuries during practices are generally low across all age groups and divisions. This being said, some of the 21 injuries that occurred during practices were serious. Six boys had fractures, three had dislocations, and five had concussions. The rates of injury during practice were slightly higher for the Rep teams in each age group.

Rates of injuries during games vary a great deal from division to division and between house league and Rep teams. Select teams have rates of injury that are much more similar to house league. The Tyke Rep teams had no injuries and the Novice Rep teams had one injury in 2 yr. The Minor Atom (age 9) team of 17 players had six game injuries the first year and four game-related injuries the second year, which translates to a rate of slightly more than 13 per 1000 game hours. The Minor Atom level is the first age group to allow body checking so it was important to examine individual injury reports. Of the 10 injuries in games, four were concussions, seven were minor contusions, and one was a knee strain. Five of the ten game related injuries related directly to body checking. The average time lost from injury for Minor Atom Rep team players was only 4.3 d, which was considerably below the overall average (13.7).

Atom (age 10), Minor Peewee (age 11), and Peewee (age 12) Rep teams had game-related injury rates that exceeded house league rates, but were considerably lower than the Minor Atom Rep team. The Select teams, which play both house league and games against Select teams from other communities, have injury rates that mirror those of house league players. The exception is the Peewee Select age group in which the injury rate per 1000 game hours was 4.8. This is the first age group in which body checking is allowed in Select hockey. This higher injury rate is accounted for by only three injuries over 2 yr but only 34 players are represented by Select teams. All three injuries resulted from body contact. One injury involved a concussion from a hit from behind and the other a fractured wrist from a body check.

The next dramatic peak in game injury rate is the Minor Bantam Rep team (13 yr olds). The rate of 14.5 injuries per 1000 game hours is substantially higher than other age groups or divisions except Minor Atom. The injuries included two concussions, one dislocated shoulder, one dislocated knee, and two fractured wrists. The 14-yr-old Bantam Rep team also had a much lower rate of game-related injuries (5.9 per 1000 player hours) than the Minor Bantam team.

The rate of injuries in house league games is quite low compared with Rep team hockey. In general, there is a slight increase with increasing age. The peak age for injury in the house league is Peewee (12 yr olds) and a second spike for the Midget group. However, overall there was a very low rate of injury in the house league.

From the logistic regression model predicting game-related injuries as a function of age, level of play, and year, the factor level of play ($P < 0.0001$) was highly significant, while age was trending toward significance ($P = 0.06$) and there was no difference between year 1 and year 2 ($P = 0.66$). The reference category for age was 14 yr olds and the reference category for level was set at S = Select. Age groups 9 , 12, and 13 yr had increased adjusted odds ratios of 1.3 to 1, 1.2 to 1, and 1.4 to 1, respectively (controlling for year and level of play), of injury relative to the 14-yr-old reference category. All other age categories had lower risk

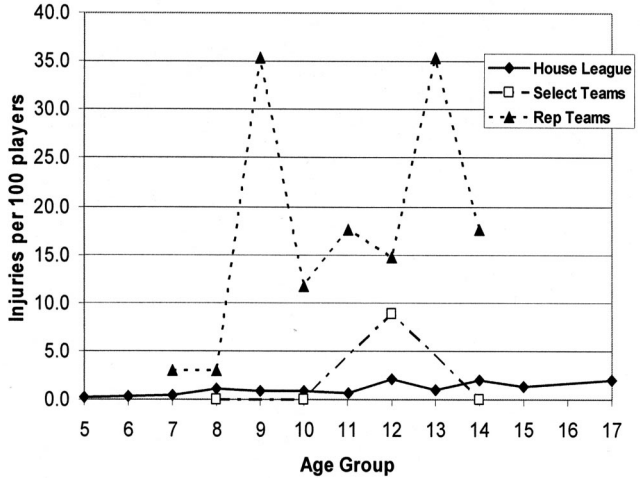

FIGURE 1—Injuries per 100 players for each age group and level of play (house league, Select, and Rep).

of injury relative to the 14-yr-old reference category except age 9 and age 13. This indicates a higher rate of injury for 9 yr olds and with a decreasing rate for 10, 11, and 12 yr olds trends toward being statistically significant as seen in Figure 1. The odds ratio of an injury for the Rep team as compared to the Select team was 5.3 to 1 with a corresponding 95% confidence interval of (1.6–17.8). The odds ratio of an injury for the house leagues relative to Select teams was 0.87 to 1 with a corresponding 95% confidence interval of (0.3–2.9) and was not statistically significant. Likewise, Rep teams are significantly different from the house league with an odds ratio of an injury of 6.1 to 1 and a corresponding 95% confidence interval of (3.8–10.0).

Figure 1 presents the injury rates per 100 players for all levels of competition and for all ages regardless of whether the injury occurred during practice or games. Please note the spikes for Rep teams and Select teams that correspond to the introduction of body checking. There is a second spike for Rep teams that corresponds to the Minor Bantam (age 13) group.

DISCUSSION

Injuries in ice hockey are not limited to a few risk takers. Only two players of nearly 3000 had more than one injury in a year and two more had an injury 2 yr in a row. The rates of injury presented in the current study are consistent with the rates of injury presented in other studies that have examined these younger aged players. However, the large sample size in this study has allowed us to determine more precise injury rates across specific age groups and levels of competition.

Most injuries (80%) occurred in games rather than practices. Practice-related injuries were spread fairly evenly over all age groups and did not vary in any substantial manner from house league to Rep teams. Game injuries were much more frequent among the highly skilled players on Rep teams. There was an early spike in injury rates for the players that experienced body checking for the first time. This was true for the 9 yr olds in Rep team hockey and the 11–12 yr olds in Select hockey. It appears that there is a period of learning to deal with body checking because the 10, 11, and 12 yr old Rep teams had a significant reduction in injury rates from the 9-yr-old group. The same pattern of adjustment to body checking was observed for the 11- to 12-yr old Select team when body checking was first introduced to this group of players. However, the rate of injury among the Select players was noticeably less than the Rep hockey players.

The age of players may be a factor in injuries. Minor Bantam (13 yr olds) Rep teams had a rate of injury similar to the Minor Atoms. Among the Minor Bantam players, 11 of 34 received at least one injury and one player was injured twice. Among the Bantam (14 yr old) Rep teams, 11 of 34 players were injured at least once during the two seasons. Additionally, the injuries sustained in these older aged and elite youth hockey players were generally of greater severity, with more concussions or fractures than younger players. We attribute the spike of injuries among the 13 yr olds as a consequence of adolescence, that is, increased testosterone levels and concomitant aggressiveness. Disparity in weight and size of players may also play a role. Prevention of injury in this age group may involve stricter interpretation of rules by referees.

There are a number of factors that suggest that body checking is a risk factor for injury. First, house league players who played without body checking had a much lower rate of injury than Rep teams who had body checking at the age of 9 and older. In fact, the injury rate spiked for the 9-yr-old Rep teams and declined the following 3 yr, suggesting that there is an adjustment period to body checking. The Select teams had a spike, albeit less than the Rep teams, at the 11- to 12-yr-old level when body checking was first introduced to Select team hockey. The injury rate for the Select teams also declined the following year even though body checking was still part of the game.

The issue of body checking in hockey is controversial and complex. At a basic level, one can say that the boys who played house league hockey without body checking had a very low rate of injury. More skilled youngsters that played competitive hockey had much higher rates of injury, but this may be due to higher speed of play as much as from body checking. The appropriate question may be, for those leagues that choose to allow body checking, at what age should body checking be introduced? The American Academy of Pediatrics has recommended that body checking be introduced no earlier than age 16. However, if body checking produces an initial period of adjustment as the current study suggests, then perhaps it would be better that the adjustment happens while the youngsters are smaller and have less speed. Therefore, the rash of injuries that characterize the adjustment period would be less severe.

The authors are extremely grateful to the Burlington Lions Optimist Minor Hockey Association (BLOMHA), the President R. Dawson for allowing us access to injury data, and to all the volunteer coaches and trainers who diligently reported injuries. The authors also thank a panel of hockey-knowledgeable advisors: G. Fairgrieve, T. Jackson, D. Martin, J. Miller, V. Montironi, and J. Randall.

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