Bodychecking experience and rates of injury among ice hockey players aged 15–17 years

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Abstract

Background: Although high rates of injury occur in youth ice hockey, disagreements exist about the risks and benefits of permitting bodychecking. We sought to evaluate associations between experience with bodychecking and rates of injury and concussion among ice hockey players aged 15–17 years.

Methods: We obtained data from a prospective cohort study of ice hockey players aged 15–17 years in Alberta who played in leagues that permitted bodychecking. We collected data over 3 seasons of play (2015/16–2017/18). We compared players based on experience with bodychecking (≤ 2 v. ≥ 3 yr), estimated using local and national bodychecking policy and region of play. We used validated methodology of ice hockey injury surveillance to identify all injuries related to ice hockey games and defined concussions according to the Consensus Statement on Concussion in Sport.

Results: We included 941 players who contributed to 1168 player-seasons, with 205 players participating in more than 1 season. Compared with players with 2 years or less of bodychecking experience, those with 3 or more years of experience had higher rates of all injury (adjusted incidence rate ratio [IRR] 2.55, 95% confidence interval [CI] 1.57–4.14), injury with more than 7 days of time loss (adjusted IRR 2.65, 95% CI 1.50–4.68) and concussion (adjusted IRR 2.69, 95% CI 1.34–5.42).

Interpretation: Among ice hockey players aged 15–17 years who participated in leagues permitting bodychecking, more experience with bodychecking did not protect against injury. This provides further support for removing bodychecking from youth ice hockey.

In Canada, more than 74 000 adolescents aged 15–17 years are registered as ice hockey players.[1] In an effort to reduce the high burden of injury in Canadian youth ice hockey,[2–4] evidence-informed policy changes have been implemented to restrict bodychecking nationally among leagues for younger players (age 11–12 yr), as well as in certain nonelite (lower 60%) divisions of play in older age categories (age 13–17 yr) (see Appendix 1 for a brief description of the organization of minor ice hockey in Canada and of bodychecking policy, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.211718/tab-related-content).[5–8] These policy changes have been associated with reduced rates of injury, including concussion.[4,9,10] Despite this strong evidence, some argue that gaining experience in bodychecking earlier may protect players from injuries, including concussions, when they play in the older age categories where bodychecking is allowed.[11] A previous prospective cohort study of 13- and 14-year-old players found similar rates of overall injury and concussion among those with 2 years of experience with bodychecking and those with none.[12]

The changes in bodychecking policy have presented a unique opportunity to evaluate the associations between experience with bodychecking and rates of injury and concussion among players aged 15–17 years. Research is needed to evaluate the effects of the recent policy decisions regarding bodychecking in youth ice hockey, to help ensure that no unintended consequences have occurred because of these policy changes, and to inform future policy.[13–15] Therefore, we sought to determine the association between cumulative experience with bodychecking and rates of injury and concussion among ice hockey players aged 15–17 years.

Methods

Study design and participants

We obtained data from a prospective cohort (2015/16–2017/18) of players (aged 15–17 yr) who played in leagues permitting bodychecking in 3 regions of Alberta, Canada (Calgary, the Calgary-surrounding area and Edmonton), including both male and female players. We took an inclusive sampling

approach and invited all hockey associations for this age group that were affiliated with Hockey Calgary, Airdrie Minor Hockey Association or Hockey Edmonton to participate. Recruitment began at the association level, and if associations agreed to allow researchers to contact teams, we invited them to participate. We included teams if they could identify a team designate (e.g., manager) to report weekly participation and injuries. All players from eligible teams could participate provided they had written informed consent (player or parent) and had no previous injury or illness that prevented full participation in hockey at the beginning of the season. We excluded players from "girls-only" leagues, where policy does not permit bodychecking.

Hockey Canada, Hockey Calgary, and Hockey Edmonton were involved as knowledge brokers, contributing to approval of study design, study recruitment, injury surveillance methods, support of safety designate role and dissemination of research findings within the hockey community. The research questions and outcome measures were developed and informed by the priorities, experience and preferences of the knowledge brokers. Hockey players, parents, coaches and administrators in Hockey Canada, Hockey Calgary, Airdrie Minor Hockey and Hockey Edmonton were dedicated to the collection of weekly exposure data, identification of a player with a suspected concussion and supporting communication with the research team for injury follow-up. A knowledge broker from Hockey Canada and Hockey Calgary informed the methods and time commitment for study participation by players, parents and safety designates.

Data collection

The injury surveillance methodology, validated in youth ice hockey, included a preseason baseline questionnaire, a weekly exposure sheet and an injury report form (see Appendix 2, 3 and 4, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.211718/tab-related-content).[3] We estimated years of bodychecking experience based on year of study, local and national bodychecking policy and, if applicable, player data from the baseline questionnaire regarding repeated years of participation, as it included a question on whether they played in a bodychecking league or not. In the uncommon situation where players participated in the study in more than 1 season, but in nonconsecutive years, we assumed their experience with bodychecking for the most recent season based on their history of participating in a league permitting or not permitting bodychecking. Bodychecking experience included time spent playing in leagues for 15- to 17-year-old players and in leagues for younger age groups that permitted bodychecking.

As bodychecking policies focus on games only, our study evaluated only game-related exposures and outcomes. Each team designate collected information on weekly exposures and identified players with an injury or suspected concussion related to ice hockey. An athletic therapist affiliated with the study validated all injury report forms. Further details of this validated injury surveillance system have been previously published.[8,9,12,16]

Outcomes

The outcomes of this study were the incidence rates of game-related injury, injury resulting in more than 7 days of time lost from hockey (time loss) and concussion. All injuries resulting in medical attention, the inability to complete a game or practice, or time away from hockey were included. We defined concussions as injuries that met the definition of the Consensus Statement on Concussion in Sport.[17]

The 7-day cutpoint for injury has been supported in the literature and allows for comparison to previous studies of youth ice hockey.[3,7,9,12,16,18,19] Participants with a suspected concussion could follow-up with a sport medicine physician affiliated with the study within 72 hours. All study physicians followed standardized follow-up and return-to-play protocols, based on the Consensus Statement on Concussion in Sport.[17]

Statistical analysis

We conducted all analyses using R and Stata. We did not calculate an a priori sample size as this project was a secondary data analysis. The original sample size calculation was based on a previous study of youth ice hockey that investigated differences in injury rates associated with bodychecking policy, which suggested that 46 teams (13 players per team) was sufficient to identify a difference between the cohorts (powered based on an incidence rate ratio [IRR] of 0.5 and a concussion rate of 1.5/1000 player-hours, adjusted for cluster by team and an anticipated drop-out of 10% [α 0.05, β 0.20]).[20]

Few player-seasons had 1 year of bodychecking experience (n = 20) or no experience (n = 1); therefore, we grouped players with 2 years or less of bodychecking experience. Moreover, we grouped players with 3 or more years of bodychecking experience together. This decision was supported from a practical perspective because it allowed us to compare players who likely had experience with bodychecking only in younger leagues (i.e., players with experience ≤ 2 yr), and those who had more experience both in younger leagues and leagues for players aged 15–17 years (i.e., players with experience ≥ 3 yr).

We stratified the baseline characteristics, described as frequencies and percentages or medians and quartiles, on years of bodychecking experience (≤ 2 yr or ≥ 3 yr) and by whether players sustained at least 1 game-related injury during the study period. Where weekly game exposures were missing, we estimated weekly means using a recommended approach based on within-participant, within-team or within-city and division data, according to level of data completion appropriate for estimates.[21] Several studies of youth ice hockey have supported this approach.[7,9,16] We estimated crude game-related injury rates and absolute rate increases (ARIs) (offset for game-hours) for injuries, injuries resulting in more than 7 days of time loss and concussions for each study group, with 95% confidence intervals (CIs), adjusted for cluster by team and individual. We estimated IRRs with corresponding 95% CIs using multilevel Poisson regression models, with random effects at the team and individual level and offset by game-hours, unadjusted for other covariates.

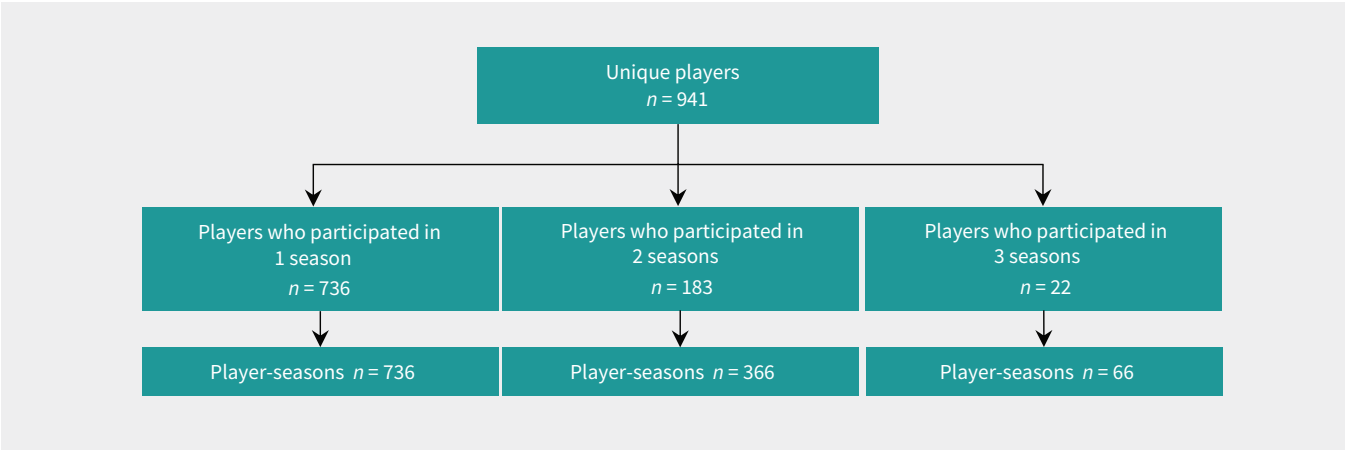

Figure 1: Recruitment of participants and total player-seasons over 3 seasons of play.

We used separate, multiple, multilevel Poisson regression models for game-related injuries, injuries resulting in more than 7 days of time loss and concussions to evaluate the association between years of bodychecking experience and each outcome. The regression models were adjusted for the following important covariates: injury in the previous 12 months, lifetime concussion history, player weight, level of play (elite divisions of play, representing the top 20% by division of play, and subelite, representing the lower 80%) and position (forward, defence or goalie). We used player game-hours as an offset in all models, and explored team- and subject-level random effects to account for clustering. Given concerns with age and year of play in this age category (first, second or third) being multicollinear with our primary exposure variable (bodychecking experience), we conducted a separate analysis limited to only players in their first year of play in leagues for 15- to 17-year-old players.

We imputed missing covariate data using multivariate imputation by chained equations, including a linear mixed effects model and using Rubin combination rules (30 imputations completed). We did not consider sex, given the low numbers of female players. We calculated crude injury rates by body location and injury type with 95% exact Poisson CIs or adjusted for cluster by team (offset by game-hours), when outcome numbers were sufficient for model convergence.

Ethics approval

This study was approved by the research ethics boards at the University of Calgary (14-0348 and 14-2209) and University of Alberta (Pro00024093).

Results

A total of 186 teams, including 941 players, were recruited to participate over the 3 seasons of play. Of these, 205 players participated in more than 1 season (183 participated in 2 seasons and 22 participated in 3 seasons) for a combined 1168 player-seasons (148 with ≤ 2 years of bodychecking experience and 1020 with ≥ 3 years) (Figure 1). The median number of players recruited per team was 7 (range 4–19) in the group with 2 years or less of bodychecking experience and 14 (range 4–20) in the group with 3 or more years of bodychecking experience. Some participants were placed on teams in subsequent seasons where the other players on the team did not participate, including 51 with 2 years or less of bodychecking experience and 66 with 3 or more years of bodychecking experience. Players were followed for 7–30 (median 20) weeks, as some teams were recruited after the playing season had started. Almost all players (98%) had at least 1 week of game exposure estimated. The median number of game weeks estimated per player when exposure was missing was 3 (first quartile 2, third quartile 4).

Table 1 summarizes the baseline characteristics of the study cohorts by injury status. Nearly all players with 2 years or less of bodychecking experience were in their first year of play in a league for players aged 15–17 years, and most players with 3 or more years of bodychecking experience were in their second or third year of play in this age group. A history of injury in the previous 12 months was more frequent among players with less bodychecking experience, but a lifetime history of previous concussion was more frequent among players with more bodychecking experience.

Table 2 summarizes the crude analyses assessing bodychecking experience and all injury outcomes. The crude multilevel Poisson regression models, unadjusted for other covariates, converged with both random effects for the injury outcomes, but failed for the concussion outcome. The statistical program was not able to find a solution, so it was not possible to fit the model, likely from too few participants with repeated seasons of play sustaining a concussion; therefore, the concussion IRR includes only a random effect at the team level. Relative to players with less bodychecking experience, those with more experience had an increased rate of all injury (ARI 7.12, 95% CI 3.33–10.90), injury resulting in more than 7 days of time loss (ARI 4.57, 95% CI 1.51–7.62), and concussion (ARI 2.78, 95% CI 4.22–1.34).

Results of the mixed multilevel Poisson regression models that evaluated each game outcome are summarized in Table 3. As with the crude multilevel Poisson models, the models for all

Table 1: Baseline characteristics for ice hockey players aged 15–17 years by years of bodychecking experience and injuries

Characteristic	No. (%) of player-seasons with ≤ 2 yr bodychecking experience*†			No. (%) of player-seasons with ≥ 3 yr bodychecking experience*†		
	Total *n* = 148	With injuries‡ *n* = 27	Without injuries *n* = 121	Total *n* = 1020	With injuries‡ *n* = 259	Without injuries *n* = 761
City or area						
Calgary	141 (95.3)	25 (92.6)	116 (95.9)	674 (66.1)	156 (60.2)	518 (68.1)
Calgary-surrounding area	7 (4.7)	2 (7.4)	5 (4.1)	47 (4.6)	20 (7.7)	27 (3.6)
Edmonton	0 (0.0)	0 (0.0)	0 (0.0)	299 (29.3)	83 (32.0)	216 (28.4)
Year						
2015–16	1 (0.7)	0 (0.0)	1 (0.8)	489 (47.9)	134 (51.7)	355 (46.6)
2016–17	3 (2.0)	0 (0.0)	3 (2.5)	332 (32.6)	78 (30.1)	254 (33.4)
2017–18	144 (97.3)	27 (100.0)	117 (96.7)	199 (19.5)	47 (18.2)	152 (20.0)
Age, yr, median (Q1, Q3)	15 (15, 15)	15 (15, 15)	15 (15, 15)	16 (15, 16)	16 (15, 16)	16 (15, 16)
Sex						
Male	147 (99.3)	27 (100.0)	120 (99.2)	1008 (99.1)	258 (99.6)	750 (98.6)
Female	1 (0.7)	0 (0.0)	1 (0.8)	6 (0.6)	1 (0.4)	5 (0.7)
Prefer not to respond or missing	0 (0.0)	0 (0.0)	0 (0.0)	6 (0.6)	0 (0.0)	6 (0.8)
Anthropometrics						
Height, cm, median (Q1, Q3)	175.7 (170.2, 180.3)	176.1 (170.2,182.2)	175.6 (170.2, 179.5)	177.8 (172.7, 182.9)	177.8 (172.7, 181.7)	177.8 (172.7, 182.9)
Missing	20 (13.5)	4 (14.8)	16 (13.2)	145 (14.2)	44 (17.0)	101 (13.3)
Weight, kg, median (Q1, Q3)	65.0 (59.0, 71.9)	65.8 (58.9, 71.1)	64.6 (59.0, 72.6)	70.3 (63.5, 77.2)	69.4 (63.2, 76.9)	70.3 (64.0, 77.4)
Missing	19 (12.8)	4 (14.8)	15 (12.4)	144 (14.1)	47 (18.2)	97 (12.8)
Level of play						
Elite (top 20%)	50 (33.8)	9 (33.3)	41 (33.9)	402 (39.4)	94 (36.2)	308 (40.5)
Subelite (lower 80%)	98 (66.7)	18 (66.7)	80 (66.1)	618 (60.6)	165 (63.7)	453 (59.5)
Year of play in this age group						
First	144 (97.3)	26 (96.3)	118 (97.5)	376 (36.9)	106 (40.9)	270 (35.5)
Second	4 (2.7)	1 (3.7)	3 (2.5)	424 (41)	103 (39.8)	321 (42.2)
Third	0 (0.0)	0 (0.0)	0 (0.0)	220 (21.6)	50 (19.3)	170 (22.3)
Position						
Forward	86 (58.1)	15 (55.6)	71 (58.7)	529 (51.9)	144 (55.6)	385 (50.6)
Defence	44 (29.7)	12 (44.4)	32 (26.4)	311 (30.5)	83 (32.0)	228 (30.0)
Goalie	15 (10.1)	0 (0.0)	15 (12.4)	92 (9.0)	14 (5.4)	78 (10.2)
Missing	3 (2.0)	0 (0.0)	3 (2.5)	88 (8.6)	18 (7.0)	70 (9.2)
Injury or concussion in previous 12 mo						
No	70 (47.3)	13 (48.2)	57 (47.1)	387 (38.0)	80 (30.4)	307 (40.3)
Yes	77 (52.0)	14 (51.8)	63 (52.1)	436 (42.8)	133 (51.4)	303 (39.8)
Missing	1 (0.7)	0 (0.0)	1 (0.8)	197 (19.3)	46 (17.8)	151 (19.8)
Previous concussion ever						
No	71 (48.0)	15 (55.6)	56 (46.3)	480 (47.1)	100 (38.6)	380 (49.9)
Yes	58 (39.2)	8 (29.6)	50 (41.3)	498 (48.8)	150 (57.9)	348 (45.7)
Missing	19 (12.8)	4 (14.8)	15 (12.4)	42 (4.1)	9 (3.5)	33 (4.3)

Note: Q1 = first quartile, Q3 = third quartile.
*Unless indicated otherwise.
†Total number of players includes 205 players who participated in more than 1 season, and thus totals 1168.
‡Any game-related injury during study period.

Table 2: Game-related injury outcomes for ice hockey players aged 15–17 years by years of bodychecking experience

Variable	All injuries		Injuries with > 7 d of time loss		Concussions	
	≤ 2 yr bodychecking experience	≥ 3 yr bodychecking experience	≤ 2 yr bodychecking experience	≥ 3 yr bodychecking experience	≤ 2 yr bodychecking experience	≥ 3 yr bodychecking experience
No. of player-seasons	148	1020	148	1020	148	1020
No. of outcomes	29	309	19	200	10	115
Player participation (game-hours)	6010.62	25 877.74	6010.62	25 877.74	6010.62	25 877.74
Crude rate, per 1000 player game-hours, (95% CI)*	4.82 (1.81–7.84)	11.94 (9.65–14.23)	3.16 (0.72–5.60)	7.73 (5.89– 9.57)	1.66 (0.89–3.12)	4.44 (3.57–5.53)
Incidence rate ratio (95% CI)†	1 (ref.)	2.53 (1.46–4.39)	1 (ref.)	2.56 (1.70–3.88)	1 (ref.)	2.66 (1.32–5.38)
Absolute rate increase, per 1000 player game-hours (95% CI)*	1 (ref.)	7.12 (3.33–10.90)	1 (ref.)	4.57 (1.51–7.62)	1 (ref.)	2.78 (1.34–4.22)

Note: CI = confidence interval, ref. = reference.
*Crude rates and absolute rate increases with a design effect accounting for clustering by team and individual for all injury and injury with > 7 days of time loss, and by team only for concussion, offset for exposure game-hours.
†Incidence rate ratios based on multilevel Poisson regression, offset by exposure game-hours. For injury outcomes, the analysis was performed with 2 random effects, 1 at a team level and 1 at an individual level. For concussion, the analysis was performed with 1 random effect at the team level.

Table 3: Adjusted incidence rate ratios for game-related injury outcomes for ice hockey players aged 15–17 years

Variable	IRR (95% CI)		
	All injuries*	Injuries with > 7 d of time loss*	Concussions†
Bodychecking experience			
≤ 2 years	Ref.	Ref.	Ref.
≥ 3 years	2.55 (1.57–4.14)	2.65 (1.50–4.68)	2.69 (1.34–5.42)
Level of play			
Elite (top 20%)	Ref.	Ref.	Ref.
Subelite (lower 80%)	1.46 (1.01–2.12)	1.42 (0.96–2.11)	1.49 (0.94–2.36)
Player weight	0.99 (0.98–1.00)	0.99 (0.98–1.01)	0.99 (0.98–1.01)
Injury or concussion in previous 12 mo			
No	Ref.	Ref.	Ref.
Yes	1.37 (1.03–1.81)	1.27 (0.88–1.84)	1.31 (0.83–2.08)
Previous concussion ever			
No	Ref.	Ref.	Ref.
Yes	1.33 (1.02–1.74)	1.33 (0.94–1.88)	1.59 (1.05–2.41)
Position			
Forward	Ref.	Ref.	Ref.
Defence	1.20 (0.92–1.57)	1.19 (0.85–1.67)	1.31 (0.90–1.92)
Goalie	0.69 (0.41–1.17)	0.82 (0.44–1.54)	0.96 (0.48–1.93)

Note: CI = confidence interval, IRR = incidence rate ratio, Ref. = reference.
*Incidence rate ratios based on multiple multilevel Poisson regression analysis, offset for exposure game-hours, with 2 random effects, 1 at a team level and 1 at an individual level, and adjusted for covariates (level of play, player weight, injury in the previous year, previous concussion and position).
†Incidence rate ratios based on multiple, mixed effects Poisson regression analysis, offset for exposure game-hours, with a random effect at a team level, and adjusted for covariates (level of play, player weight, injury in the previous year, previous concussion and position).

Table 4: Adjusted incidence rate ratios for game-related injury outcomes for ice hockey players aged 15–17 years for first-year players only (*n* = 520)

Variable	IRR (95% CI)		
	All injuries*	Injuries with > 7 d of time loss†	Concussion†
Bodychecking experience			
≤ 2 years	Ref.	Ref.	Ref.
≥ 3 years	3.51 (2.13–5.80)	3.44 (1.88–6.29)	3.95 (1.95–8.01)
Level of play			
Elite (top 20%)	Ref.	Ref.	Ref.
Subelite (lower 80%)	1.67 (1.08–2.59)	1.65 (0.97–2.79)	2.02 (1.16–3.51)
Player weight	1.00 (0.98–1.02)	1.00 (0.98–1.02)	1.02 (0.99–1.04)
Injury or concussion in previous 12 mo			
No	Ref.	Ref.	Ref.
Yes	1.50 (1.00–2.24)	1.60 (0.97–2.62)	1.24 (0.70–2.19)
Previous concussion ever			
No	Ref.	Ref.	Ref.
Yes	1.11 (0.76–1.61)	1.27 (0.82–1.97)	1.30 (0.76–2.22)
Position			
Forward	Ref.	Ref.	Ref.
Defence	0.95 (0.65–1.40)	0.96 (0.61–1.52)	0.97 (0.56–1.69)
Goalie	0.62 (0.31–1.25)	1.03 (0.51–2.06)	0.74 (0.29–1.89)

Note: CI = confidence interval, IRR = incidence rate ratio, Ref. = reference.
*Incidence rate ratios based on multiple multilevel Poisson regression analysis, offset for exposure game-hours, with 2 random effects, 1 at a team level and 1 at an individual level, and adjusted for covariates (level of play, player weight, injury in the previous year, previous concussion and position).
†Incidence rate ratios based on multiple mixed effects Poisson regression analysis, offset for exposure game-hours, with a random effect at a team level, and adjusted for covariates (level of play, player weight, injury in the previous year, previous concussion and position).

injuries and injuries resulting in more than 7 days of time loss converged using both random effects, but the concussion outcome converged with only 1 random effect at the team level. Players with 3 or more years of bodychecking experience had higher rates of injury (adjusted IRR 2.55, 95% CI 1.57–4.14), injury with more than 7 days of time loss (adjusted IRR 2.65, 95% CI 1.50–4.68) and concussion (adjusted IRR 2.69, 95% CI 1.34–5.42) relative to those with less experience.

Participants in their first year of play were similar to the overall study cohort, except that a greater proportion of first-year players with 3 or more years of bodychecking experience were playing at elite levels than in the full cohort (Appendix 1). The analysis of this group resulted in even greater effect estimates, suggesting that players with 3 or more years of bodychecking experience had even higher rates of injury (adjusted IRR 3.51, 95% CI 2.13–5.80), injury with more than 7 days of time loss (adjusted IRR 3.44, 95% CI 1.88–6.29) and concussion (adjusted IRR 3.95, 95% CI 1.95–8.01) (Table 4).

For both levels of bodychecking experience, the head or face was the most commonly injured location. This accounted for 34% (10/29) of injuries, at a rate of 1.67 (95% CI 0.89–3.12) injuries per 1000 player-hours, among those with less bodychecking experience and 39% (119/309) of injuries, at a rate of 4.60 (95% CI 3.71–5.70) injuries per 1000 player-hours, among those with more experience (Table 5). Concussion was the most common injury type in both groups, accounting for 34% (10/29) of all injuries, at a rate of 1.67 (95% CI 0.89–3.12) injuries per 1000 player-hours, in players with less bodychecking experience and 37% (115/309) of all injuries, at a rate of 4.44 (95% CI 3.57–5.53) injuries per 1000 player-hours, among players with more experience.

Interpretation

We found that, among ice hockey players aged 15–17 years, the rates of all injury, injury resulting in more than 7 days of time loss and concussion were significantly higher among those with more bodychecking experience (≥ 3 yr) than in those with less experience (≤ 2 yr). These estimates were even higher when we restricted the analysis to those in their first year of play in leagues of this age category. This suggests that greater bodychecking experience does not protect adolescent ice hockey players from injury or concussion, and that the policy change to disallow bodychecking had no unintended consequences with regard to injury in subsequent years. In addition to the strong evidence showing reduced rates of injury in evaluations of the policy change,[4,9,10] our results provide further evidence in support of removing bodychecking in youth

Table 5: Number and rates of game-related injuries among ice hockey players aged 15–17 years by years of bodychecking experience and location and injury type

Injury	≤ 2 yr bodychecking experience		≥ 3 yr bodychecking experience	
	No. (%) of injuries* *n* = 29	Rate per 1000 player-hours (95% CI)†	No. (%) of injuries* *n* = 309	Rate per 1000 player-hours (95% CI)†
Location				
Head or face‡	10 (34)	1.67 (0.89–3.12)	119 (39)	4.60 (3.71–5.70)
Neck or throat	1 (3)	0.17 (0.00–0.93)	6 (2)	0.23 (0.09–0.50)
Shoulder or clavicle	7 (24)	1.16 (0.47–2.40)	51 (17)	1.97 (1.47–2.59)
Arm, elbow or forearm	0 (0)	0.00 (0.00–0.61)	9 (3)	0.35 (0.16–0.66)
Wrist or hand	4 (14)	0.67 (0.18–1.70)	28 (9)	1.08 (0.72–1.56)
Back or side	2 (7)	0.33 (0.04–1.20)	9 (3)	0.35 (0.16–0.66)
Chest, ribs or abdomen	0 (0)	0.00 (0.00–0.61)	3 (1)	0.12 (0.02–0.34)
Pelvis, hips, groin or upper leg	1 (3)	0.17 (0.00–0.93)	20 (6)	0.77 (0.47–1.19)
Knee	1 (3)	0.17 (0.00–0.93)	28 (9)	1.08 (0.72–1.56)
Lower leg, ankle or foot	2 (7)	0.33 (0.04–1.20)	12 (4)	0.46 (0.24–0.81)
Missing or unknown	1 (3)	0.17 (0.00–0.93)	24 (8)	0.93 (0.59–1.38)
Type				
Contusion	2 (7)	0.33 (0.04–1.20)	23 (7)	0.89 (0.56–1.33)
Concussion‡	10 (34)	1.67 (0.89–3.12)	115 (37)	4.44 (3.57–5.53)
Joint or ligament sprain or dislocation	5 (17)	0.83 (0.27–1.94)	59 (19)	2.28 (1.74–2.94)
Fracture	7 (24)	1.16 (0.47–2.40)	40 (13)	1.55 (1.10–2.10)
Muscle strain or tendinitis	3 (10)	0.50 (0.10–1.46)	30 (10)	1.16 (0.78–1.65)
Abrasion, bleeding, burn or blister	0 (0)	0.00 (0.00–0.61)	3 (1)	0.12 (0.02–0.34)
Other	0 (0)	0.00 (0.00–0.61)	9 (3)	0.35 (0.16–0.66)
Missing or unknown	2 (7)	0.33 (0.04–1.20)	30 (10)	1.16 (0.78–1.65)

Note: CI = confidence interval.
*Percent frequencies do not total 100 because of rounding error.
†Crude rates with 95% exact Poisson CIs.
‡Corresponding 95% Poisson CIs adjusted for cluster by team (offset by game-hours).

ice hockey to prevent injury. Although the effect of bodychecking experience has not been previously explored among 15- to 17-year-old players, previous research among 13- and 14-year-old players found similar rates of injury and concussion among those who had 2 years of bodychecking experience and those who had none.[12] The rates of injury resulting in more than 7 days of time loss were previously reported to be 33% lower among 13- and 14-year-old players with more bodychecking experience.[12] However, the change in bodychecking policy was associated with a 70% reduced rate of severe injury among 11- and 12-year-old players in leagues that disallowed bodychecking.[20] We found more than a twofold greater rate of injury with more than 7 days of time loss among players with more bodychecking experience. The increased rates of injury and concussion with greater bodychecking experience may be related to increased levels of player skill and speeds of play. This may not be captured entirely by the level of play (elite v. subelite) covariate. Considerations for future research include a greater understanding of on-ice behaviours and performance measures associated with bodychecking experience in leagues that permit bodychecking.

In this study, player weight was not significantly associated with injury or concussion. This finding was consistent with a previous study of 13- and 14-year-old players, but inconsistent with another that suggested an increased rate of injury in heavier players,[12,16] and a study of 11- and 12-year-old players that found lighter players had an increased rate of concussion.[7] Consistent with the literature of youth ice hockey, players with a history of injury or concussion had higher rates of injury and concussion, respectively.[7,9,12,20,22] Position of play was not significantly associated with any outcome in the present study. This was contrary to previous studies, which have suggested a protective effect for goaltenders.[7,9,12,20,22] Less elite players had significantly higher rates of all injury relative to more elite players. The point estimates also suggested higher rates of injury resulting in more than 7 days of time loss and concussions for less-elite players, although these were not statistically significant. This finding was inconsistent with previous studies.[3,5,9]

Limitations

Although this study has many strengths, such as a prospective cohort design and a strong analytical approach, including multiple imputation of missing covariate data and mixed effects modelling with 2 levels of clustering, it also has limitations. There is the potential for misclassification of exposure status, as we assumed bodychecking experience based on the year of the study, local and national bodychecking policy and, if applicable, repeated player data from the preseason baseline questionnaire. In certain circumstances, we assumed bodychecking experience despite missing data. For instance, if players played with bodychecking in their first year, had missing data in their second season and participated again in their third year with bodychecking, we assumed they participated with bodychecking in their second season, which was added to their experience in their third year. We feel this approach was satisfactory, as players typically continue to play in leagues with the same bodychecking policy. Further, any misclassification was likely independent of the outcome (injury) and would result in a bias toward the null. Position of play may also not have been consistent for every game during the season for each player, as reported at baseline. As some individuals were recruited before team rosters were finalized, we do not know if they ended up on the same team as other participants in the study. Nonparticipation was largely based on the inability to identify a team designate who was willing to record injury and exposure information. As such, it seems unlikely that nonparticipation would be related to bodychecking experience and subsequent injury. All players with 2 years or less of bodychecking experience were recruited from either Calgary or the Calgary-surrounding area, which limits the ability to examine region of play. Additional covariates, such as presence of certain medical conditions (e.g., attention-deficit/hyperactivity disorder, learning disorder) or style of play (i.e., aggressiveness), were not included in the multiple multilevel models, which may affect the association between years of bodychecking experience and rates of injury or concussion. Finally, we included all concussions that met the study definition, although not all players with a suspected concussion followed up with a physician (8 [80.0%] of 10 players with ≤ 2 yrs of bodychecking experience and 98 [85.2%] of 115 of those with ≥ 3 yrs of experience saw a physician).

Conclusion

The rates of all injury, injury resulting in more than 7 days of time loss and concussion were significantly higher among players aged 15–17 years with more bodychecking experience (≥ 3 yr) than those with less experience (≤ 2 yr). This suggests that bodychecking experience does not protect youth ice hockey players from injury, and that there are no unintended injury consequences after implementation of the policy disallowing bodychecking. This study provides further evidence in support of removing bodychecking in youth ice hockey to reduce rates of injury and concussion.

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