# Body checking in non-elite adolescent ice hockey leagues: it is never too late for policy change aiming to protect the health of adolescents

Carolyn A Emery ,[1,2] Paul Eliason,[1] Jean-Michel Galarneau,[1] Vineetha Warriyar,[1] Luz Palacios-Derflingher,[1] Amanda Marie Black ,[1] Maciek Krolikowski,[1] Nicole Spencer,[1] Stacy Sick,[1] Stacy Kozak,[1] Kathryn J Schneider,[1] Shelina Babul,[3,4] Martin Mrazik,[5] Constance Lebrun,[6,7] Claude Goulet,[8] Alison Macpherson,[9] Brent E Hagel [1,2]

For numbered affiliations see end of article.

**Correspondence to**
Dr Carolyn A Emery, Sport Injury Prevention Research Centre, Faculty of Kinesiology, University of Calgary, Calgary AB T2N 1N4, Canada; caemery@ucalgary.ca

Accepted 1 May 2021
Published Online First 20 May 2021

## ABSTRACT

**Objectives** The objective of this study is to evaluate the effect of policy change disallowing body checking in adolescent ice hockey leagues (ages 15–17) on reducing rates of injury and concussion.

**Methods** This is a prospective cohort study. Players 15–17 years-old were recruited from teams in non-elite divisions of play (lower 40%–70% by division of play depending on year and city of play in leagues where policy permits or prohibit body checking in Alberta and British Columbia, Canada (2015–18). A validated injury surveillance methodology supported baseline, exposure-hours and injury data collection. Any player with a suspected concussion was referred to a study physician. Primary outcomes include game-related injuries, game-related injuries (>7 days time loss), game-related concussions and game-related concussions (>10 days time loss).

**Results** 44 teams (453 player-seasons) from non-body checking and 52 teams (674 player-seasons) from body checking leagues participated. In body checking leagues there were 213 injuries (69 concussions) and in non-body checking leagues 40 injuries (18 concussions) during games. Based on multiple multilevel mixed-effects Poisson regression analyses, policy prohibiting body checking was associated with a lower rate of injury (incidence rate ratio (IRR): 0.33 (95% CI 0.21 to 0.51)) and concussion (IRR: 0.41; 95% CI 0.23 to 0.73. This translates to an absolute rate reduction of 5.51 injuries/1000 game-hours (95% CI 3.21 to 7.81) and the prevention of 8770 injuries (95% CI 5111 to 12429) in Canada annually.

**Conclusions** The rate of injury was 70% lower (concussion 57% lower) in leagues not permitting body checking in non-elite 15–17 years old leagues highlighting the potential public health impact of policy prohibiting body checking in older adolescent ice hockey players.



**To cite:** Emery CA, Eliason P, Galarneau J-M, *et al*. *Br J Sports Med* 2022;**56**:12–18.

## INTRODUCTION

In Canada, an estimated 500 000 players under age 18 participate in ice hockey each year; 74 885 adolescents were registered as Midget players (ages 15–17) in 2018–2019.[1] Participating in ice hockey in adolescent years has important benefits related to physical fitness, development of social skills, self-confidence and mental health.[2–4] However, adolescent ice hockey (ages 15–17) has a high burden of injury and concussion (17.6 concussions/100 players/season).[5 6] In adolescent ice hockey players, 20%–50% of all injuries are concussions.[5 7 8] Ice hockey also accounts for the highest proportion of injuries reported to an emergency department compared with other sports in Canada.[9] Ice hockey is among the top three youth team sports for highest concussion rate, along with rugby and tackle football.[10]

Body checking is a method used to gain advantage on an opposing player using the body with an intentional forceful contact to stop an attack or separate the opponent from the puck.[11] In body checking leagues in youth ice hockey (ages 13–17), game-related injury rates of 6 injuries/1000 game-hours and 2.31 concussions/1000 game-hours have been reported.[5 7 8] Evidence-informed policy change prohibiting body checking in games in Pee Wee (ages 11–12) leagues nationally (USA 2011, Canada 2013) and in non-elite levels of play (lower 70% by division of play) in older age groups (ages 13–17) provincially and regionally in Canada since 2014.[12–17] The appropriate age and level of play to permit body checking has been a topic of debate for three decades.[18]

Following national policy change prohibiting body checking in Pee Wee (ages 11–12), injury rates fell 50% and concussion rates fell 64%.[17] Regional policy change disallowing body checking in non-elite Bantam (ages 13–14, lower 60% by level of play) led to a significant injury rate reduction of 56% and non-statistically significant concussion rate reduction of 40%. The province of British Columbia (Canada) prohibited body checking in non-elite Midget (ages 15–17) leagues (lower 70% of players by division of play) prior to 2014 (2012–13 season), and like policy changes followed regionally (lower 40% by division of play) in the neighbouring province of Alberta (Canada) in 2015. The objective of this study was to prospectively evaluate differences in injury and concussion rates associated with a policy change that prohibited body checking in games in non-elite older adolescent (ages 15–17) ice hockey players.

**Table 1** Recruitment of players by season of play, body checking policy and region (proportions based on total participating players in each region, excluding players in the elite divisions of play or top 30% by division of play)

| | 2015/2016 | | 2016/2017 | | 2017/2018 | |
|---|---|---|---|---|---|---|
| | BC permitted (lower 70% by division of Play) | BC prohibited (lower 70% by division of Play) | BC permitted (lower 40%–70% by division of Play) | BC prohibited (lower 40% by division of Play) | BC permitted (lower 40%–70%by division of Play) | BC prohibited (lower 40% by division of Play) |
| Calgary | Divisions 1–6 (n=181) | – | Divisions 1–4 (n=126) | Divisions 5–6 (n=25) | Divisions1-4 (n=193) | Divisions 5–6 (n=16) |
| Edmonton | Divisions 1A-7A (n=140) | – | Divisions A,B,1A-5A (n=34) | Divisions 3–6 (n=47)_ | – | – |
| Vancouver | – | Divisions C1-C8 (n=365) | – | – | – | – |

## METHODS

### Design

This was a cohort study implemented prospectively in three cities in Canada (British Columbia (Vancouver) and Alberta (Calgary, Edmonton)).

### Participants

Study cohorts were delineated by their exposure to policy that permitted (Edmonton 2015–17, Calgary 2015–18) or prohibited (Vancouver 2015–2016, Edmonton 2016–2017, and Calgary 2016–2018) body checking in non-elite Midget ice hockey (see table 1 for participant inclusion by year). Inclusion criteria were (1) players 15–17 years old; (2) male or female players; (3) informed player consent; (4) Midget players registered in Hockey Alberta (Calgary and area, Edmonton and area) or BC Hockey; (5) players in the lower 70% by division; (6) head coach agreement to participate; and (7) team designate (eg, manager) agreement to collect player participation and injury information. Players were excluded if they: (1) participated in a 'girls-only' league (body checking policy has always disallowed body checking in games) or (2) participated in the most elite 30% by division of play (where players are selected to play in the top divisions of play based on preseason tryouts) or (3) prior injury or illness preventing full participation in hockey at the commencement of the season.

### Procedures

Injury surveillance methods validated in youth sport included a Preseason Baseline Questionnaire, Sport Concussion Assessment Tool (SCAT3 2015–17, SCAT5 2017/18), weekly exposure sheet (WES) and injury report form (IRF).[7 19] Each team designate (safety coach or manager trained by study athletic therapist) collected exposure data (participation hours) and identified players with a suspected concussion or injury. A certified athletic therapist followed up on all injuries reported on an IRF or if a player's WES indicated absence from a session due to injury, by phone and/or at physician follow-up. Details of injury surveillance methods are reported in previous studies.[7 8 14–18] All ice hockey injuries requiring medical attention, resulting in an incomplete session and/or time loss from hockey were recorded by the team designate on an IRF. All players with a suspected concussion were referred to a study sport medicine physician within 72-hours for follow-up. Concussion definition, standardised follow-up and return to play protocols were adhered to based on the fourth International Consensus Statement on Concussion in Sport.[19] More severe injuries were identified as those that resulted in >7 days missed from hockey and more severe concussions as those that resulted in time loss >10 days as supported in the sport literature and to allow for comparisons with other studies.[7 8 14–25]

### Analyses

A sample size of 46 teams per cohort (13 players/team) was estimated based on an incidence rate ratio (IRR) of 0.5, concussion rate of 1.5/1000 player-hours in the body checking cohort, 75.5 hours of exposure, a team coefficient of variation of 0.58 and adjusting for cluster ($\alpha$=0.05, $\beta$=0.20). We expected a 5% drop-out rate and aimed for 49 teams in each arm (body checking permitted vs body checking prohibited).[16] The statistical software R (V.4.0.0) and STATA (release V.15) were used for all analyses.[26 27] Baseline player characteristics at time of recruitment into study (ie, city, year of participation, sex, anthropometrics, year of play in age group, position, previous injury/concussion history) were stratified by body checking cohort and by players sustaining one or more injuries in this study. When weekly game exposure was missing, it was imputed based on within participant weekly means or team information or within city and division and using methods recommended by Kang *et al*.[7 8 14–18 28] Crude game-related rates and absolute rate reductions (ARRs) were calculated for game-related injury, game-related injury (>7 days time loss), game-related concussion and game-related concussion (>10 days time loss) with 95% CIs account for clustering (team and subject level for injury and injury (>10 days time loss) and only team for concussion and severe concussion based on smaller number of outcomes), offset for exposure game-hours. IRRs (95% CIs) were estimated based on multilevel Poisson regression analysis offset for exposure game-hours, adjusted for clustering (as above).[29] The estimates for the number of injuries and concussions prevented in one season in Alberta and Canada if body checking was prohibited in the lowest 70% of divisions of play were calculated based on the ARR, using the average game-hours (36.52 game hours) of non-elite lower 70% of Midget players in one season in 2018–2019 (5266 players in Alberta, 43 556 players in Canada).[1]

For game-related injury and game-related concussion, separate multiple multilevel Poisson regression models were used to examine the association between each outcome and body checking cohort, adjusting for covariates including previous injury in the last year (for injury outcome), previous lifetime concussion (for concussion outcome), year of play (first, second or third), player weight, and position (forward, defence, goalie). Game-hours was used as an offset, and team level and subject level random effects were examined to account for clustering at each level. Missing covariate data were imputed using multiple imputation by chained equations.[30] Game-related injury rates by location and injury type were calculated with 95% exact Poisson

CIs (offset for exposure game-hours and adjusted for cluster by team).

## RESULTS

Midget ice hockey players in non-elite leagues were recruited from 96 teams (52 teams in body checking leagues and 44 teams in non-body checking leagues) in Calgary, Edmonton and Vancouver over three seasons (2015–2016, 2016–2017, 2017–2018) (table 1).

In total 120 players participated in more than one study season with all participating players contributing to 1127 player-seasons (674 player-seasons for body checking and 453 player-seasons for non-body checking leagues) (see table 1). The median number of players on each team was 13 on body checking and 13 on non-body checking teams. Cities contributing to 674 player-seasons in leagues permitting body checking included Calgary (n=181 in 2015–2016, n=126 in 2016–2017, n=193 in 2017–2018) and Edmonton (n=140 in 2015–2016, n=34 in 2016–2017) and cities contributing to 453 player-seasons in leagues prohibiting body checking included Vancouver (n=365 in 2015–2016), Edmonton (n=47 in 2016–2017) and Calgary (n=25 in 2016–2017 and n=16 in 2017–2018). Baseline characteristics by body checking group and injury category (at least one injury) are summarised in table 2.

Injury surveillance was executed for 8–33 weeks (median 19 weeks). The median proportion of weeks imputed was 13% (first quartile: 10%, third quartile: 20%). The median time loss following concussion was 13 days (first quartile—6, third quartile—32) in the body checking and 6.5 days (first quartile—3, third quartile—10) in the non-body checking group.

Policy prohibiting body checking in non-elite Midget leagues was associated with a 70% lower rate of all injury (IRR=0.30 (95% CI 0.19 to 0.46)) and a 93% lower rate of injury with time loss >7 days (IRR=0.07 (95% CI 0.03 to 0.17)) (table 3). Policy prohibiting body checking was associated with a 57% lower rate of concussion (IRR=0.43 (95% CI 0.24 to 0.76)) and 96% lower rate of concussion with time loss >10 days (IRR=0.04 (95% CI 0.01 to 0.30)) (see table 3).

**Table 2** Baseline characteristics comparing Midget (15–17 years) ice hockey players in Calgary, Edmonton and Vancouver over three seasons (2015–2016, 2016–2017 and 2017–2018)

| | Body checking permitted n=52 teams (n=674 plyers) | | Body checking prohibited n=44 team (n=453 players) | |
|---|---|---|---|---|
| Characteristic | Injured (n*=179) | Not injured (n*=495) | Injured (n*=39) | Not injured (n*=414) |
| City, No (%) | | | | |
| Calgary | 126 (70.39) | 374 (75.56) | 11 (28.21) | 30 (7.25) |
| Edmonton | 53 (29.61) | 121 (24.44) | 0 (0) | 47 (11.35) |
| Vancouver | 0 (0) | 0 (0) | 28 (71.79) | 337 (81.40) |
| Year, No (%) | | | | |
| 2015–2016 | 86 (48.04) | 235 (47.47) | 28 (71.79) | 337 (81.40) |
| 2016–2017 | 43 (24.02) | 117 (23.64) | 6 (15.38) | 66 (15.94) |
| 2017–2018 | 50 (27.93) | 143 (28.89) | 5 (12.82) | 11 (2.66) |
| Sex, No (%) | | | | |
| Male | 179 (100) | 490 (98.99) | 39 (100) | 410 (99.03) |
| Female | 0 (0) | 4 (0.81) | 0 (0) | 4 (0.97) |
| Preferred not to answer | 0 (0) | 1 (0.20) | 0 (0) | 0 (0) |
| Anthropometrics | | | | |
| Height, cm, median (Q1, Q3) | 177.8 (172.7, 180.3) | 177.8 (172.7, 182.9) | 178.9 (173.3, 180.3) | 177.8 (170.2, 182.9) |
| Missing data, No (%) | 49 (27.37) | 109 (22.02) | 9 (23.08) | 63 (15.22) |
| Weight, kg, median (Q1, Q3) | 67.3 (60.2, 74.2) | 68.0 (61.3, 77.1) | 63.5 (58.3, 77.1) | 65.8 (59.0, 74.6) |
| Missing data, No (%) | 47 (26.26) | 107 (21.62) | 12 (30.77) | 84 (20.29) |
| Year of play, No (%) | | | | |
| First | 51 (28.49) | 151 (30.51) | 15 (38.46) | 167 (40.34) |
| Second | 61 (34.08) | 151 (30.51) | 18 (46.15) | 209 (50.48) |
| Third | 26 (14.53) | 103 (20.81) | 2 (5.13) | 7 (1.69) |
| Missing data | 41 (22.91) | 90 (18.18) | 4 (10.26) | 31 (7.49) |
| Position, No (%) | | | | |
| Forward | 90 (50.28) | 226 (45.66) | 22 (56.41) | 209 (50.48) |
| Defence | 56 (31.28) | 121 (24.44) | 9 (23.08) | 109 (26.33) |
| Goalie | 7 (3.91) | 54 (10.91) | 3 (7.69) | 39 (9.42) |
| Missing data | 26 (14.53) | 94 (18.99) | 5 (12.82) | 57 (13.77) |
| Previous injury†, No (%) | | | | |
| No | 59 (32.96) | 231 (46.67) | 20 (51.28) | 298 (71.98) |
| Yes | 75 (41.90) | 144 (29.09) | 11 (28.21) | 77 (18.60) |
| Missing data | 45 (25.14) | 120 (24.24) | 8 (20.51) | 39 (9.42) |
| Previous concussion‡, No (%) | | | | |
| No | 62 (34.64) | 238 (48.08) | 12 (30.77) | 245 (59.18) |
| Yes | 102 (56.98) | 212 (42.83) | 24 (61.54) | 155 (37.44) |
| Missing data | 15 (8.38) | 45 (9.09) | 3 (7.69) | 14 (3.38) |

*Sum of n is 1127, given that it is player-season (120 players participated in more than one season).
†Previous injury history 12 months prior to baseline test.
‡Previous concussion (lifetime).

**Table 3** Game-related outcome variables for Midget (15–17 years) ice hockey injuries in Calgary, Edmonton and Vancouver (2015–2016, 2016–2017 and 2017–2018)

| | Injury | | More severe injury (time loss >7 days) | | Concussion | | More severe concussion (time loss >10 days) | |
|---|---|---|---|---|---|---|---|---|
| Outcome | BC permitted | BC prohibited | BC permitted | No BC prohibited | BC permitted | BC prohibited | BC permitted | BC prohibited |
| No of player-seasons | 674 | 453 | 674 | 453 | 674 | 453 | 674 | 453 |
| No of injuries or concussions | 213 | 40 | 131 | 5 | 69 | 18 | 41 | 1 |
| Player participation (hours) | 26 081.75 | 15 075.71 | 26 081.75 | 15 075.71 | 26 081.75 | 15 075.71 | 26 081.75 | 15 075.71 |
| Injury rate, injuries/1000 player-hours (95% CI)* | 8.17 (6.33 to 10.01) | 2.65 (1.27 to 4.03) | 5.02 (3.46 to 6.59) | 0.33 (0.00 to 0.86) | 2.65 (1.84 to 3.45) | 1.19 (0.49 to 2.24) | 1.57 (0.91 to 2.24) | 0.07 (0.00 to 0.25) |
| Incidence rate ratio (IRR), (95% CI)† | 1 (reference) | 0.30 (0.19 to 0.46) | 1 (reference) | 0.07 (0.03 to 0.17) | 1 (reference) | 0.43 (0.24 to 0.76) | 1 (reference) | 0.04 (0.01 to 0.30) |
| Absolute rate reduction (ARR) if BC were not permitted, injuries/1000 player-hours (95% CI)* | 5.51 (3.21 to 7.81) | | 4.69 (3.04 to 6.34) | | 1.45 (0.38 to 2.52) | | 1.51 (0.82 to 2.19) | |
| No of injuries prevented in one season in Alberta‡ | 1060 (618 to 1503) | | 902 (585 to 1219) | | 279 (73 to 485) | | 290 (157 to 422)§ | |
| No of injuries prevented in one season in Canada¶ | 8770 (5111 to 12429) | | 7462 (4837 to 10086) | | 2309 (607 to 4011) | | 2395 (1300 to 3490)§ | |

*Crude rates and ARRs (95% CI) with a design effect accounting for clustering team and subject level for injury and injury (>10 days time-loss), and only team for concussion and concussion (>7 days time-loss), offset for exposure game-hours.
†IRRs (95% CI) based on multilevel Poisson regression analysis offset for exposure game-hours, adjusted for clustering (by team and subject for injury and severe injury, and only by team for concussion and severe concussion).
‡The number of injuries prevented (rounded to the nearest integer) is estimated based on ARR and Alberta population participation of male Midget players. The population of male Midget players from Alberta in the 2018–2019 season is 7523. The sample proportion used in the estimation was identified as the lower 70% of 7523 (n=5266) and the average exposure game hours was estimated as 36.52 per player.
§Number of severe concussions saved can be greater than the number of concussions saved, given that severe concussions saved is not a subset of concussions saved. Those that still get injured (ie, not saved) may get less severely injured.
¶The number of injuries saved (rounded to the nearest integer) is calculated based on ARR and Canada population participation of male Midget players. The population of male Midget players from Canada in the 2018–2019 season is 62 224. The sample proportion used in the calculation was identified as the lower 70% of 62 224 (n=43 557) and the average exposure game hours was estimated as 36.52 per player.
.ARR, absolute rate reduction; BC, body checking; IRR, incidence rate ratio.

Based on ARR estimates and 70% of the total Midget male population reported in the 2018–2019 Hockey Canada Annual Report,[1] 8770 injuries (95% CI 5111 to 12429) would have been saved in Canada in one season of non-elite Midget ice hockey if body checking was prohibited nationally (see table 3).

The results of multilevel mixed-effects Poisson regression models to examining the association between body checking cohort and each outcome (game-related all injury and game-related concussion), adjusting for covariates, are summarised in table 4. Policy prohibiting body checking was associated with a 67% lower all injury rate (IRR=0.33 (95% CI 0.21 to 0.51)) and a 59% lower concussion rate (IRR=0.41 (95% CI 0.23 to 0.73)) (see table 4).

The most common body region of injury in both study groups was the head/face, accounting for 32.9% of injuries in body checking leagues and 45% of injuries in non-body checking leagues (see table 5). In body checking leagues, this was followed by shoulder/clavicle (17.8%), wrist/hand (9.9%) and knee injuries (9.4%). The most common injury type was concussion among both groups, accounting for 69/213 injuries (32.4% of all injuries) in body checking and 18/40 injuries (45% of all injuries) in non-body checking leagues.

## DISCUSSION

This is the first cohort study examining policy change prohibiting body checking in older adolescent (ages 15–17) non-elite ice hockey leagues compared with leagues where it was still permitted. Policy change prohibiting body checking in non-elite adolescent ice hockey was associated with a 67% lower rate (IRR=0.33 (95% CI 0.21 to 0.51)) of game-related injuries (59% lower game-related concussion rate, IRR=0.41 (95% CI 0.23 to 0.73)). Injury (>7 days time loss) rates were 93% lower and concussion (>10 days time loss) rates were 96% lower in leagues where body checking was prohibited.

Notably, in a preliminary complete case analysis (without imputation for missing covariates), IRRs previously reported

**Table 4** Results of multiple multilevel poisson regression models for game-related injury and concussion in Midget (15–17 years) ice hockey players in Calgary, Edmonton and Vancouver (2015–2016, 2016–2017, 2017–2018) in the lower 70% by division of play (with MICE Imputation)

| | Incidence rate ratio (95% CI) | |
|---|---|---|
| Covariate | All injurya | Concussionb |
| Body checking cohort | | |
| Body checking | 1 (reference) | 1 (reference) |
| No body checking | 0.33 (0.21 to 0.51) | 0.41 (0.23 to 0.73) |
| Year of play | | |
| First | 1 (reference) | 1 (reference) |
| Second | 0.90 (0.63 to 1.28) | 0.65 (0.35 to 1.19) |
| Third | 0.83 (0.64 to 1.08) | 0.65 (0.42 to 1.00) |
| Player weight | | |
| Previous injuryc | | |
| No | 1 (reference) | NA |
| Yes | 1.90 (1.37 to 2.62) | |
| Previous concussiond | | |
| No | NA | 1 (reference) |
| Yes | | 2.63 (1.62 to 4.26) |
| Position | | |
| Forward | 1 (reference) | 1 (reference) |
| Defence | 1.19 (0.86 to 1.64) | 1.32 (0.82 to 2.14) |
| Goalie | 0.62 (0.34 to 1.15) | 0.91 (0.39 to 2.12) |

*Incidence rate ratios and corresponding 95% CI based on Poisson regression analysis offset for exposure game hours, accounting for two levels of clustering: one at subject level and other at team level, and adjusted for covariates (body checking cohort, year of play, player weight, 1-year history injury and position).
†Incidence rate ratios and corresponding 95% CI based on Poisson regression analysis offset for exposure game hours, accounting for clustering by team, and covariates (body checking group, year of play, player weight, previous concussion and position).
‡The covariate 'previous injury in the last year' includes any injury that occurred in the last 1 year.
§The covariate 'previous concussion' includes any concussion (lifetime).
.MICE, multiple imputation by chained equations; NA, not applicable.;

**Table 5** Game-related injury rates per 1000 player-hours in Midget hockey players in body checking and non-body checking leagues in the lower 70% by division by location and type of injury

| Location and injury type | Rate per 1000 player-hours (95% CI)* | | | |
|---|---|---|---|---|
| | Body checking (n=213) | | No body checking (n=40) | |
| Location | N (/213) | Rate | N (/40) | Rate |
| Head/face† | 70 | 2.40 (1.76 to 3.26) | 18 | 1.05 (0.62 to 1.78) |
| Neck/throat | 3 | 0.12 (0.02 to 0.34) | 0 | 0.00 (0.00 to 0.24) |
| Shoulder/clavicle | 38 | 1.46 (1.03 to 2.00) | 2 | 0.13 (0.02 to 0.48) |
| Arm/elbow/forearm | 8 | 0.31 (0.13 to 0.06) | 1 | 0.07 (0.00 to 0.37) |
| Wrist/hand | 21 | 0.81 (0.50 to 1.23) | 2 | 0.13 (0.02 to 0.48) |
| Back/side | 9 | 0.35 (0.16 to 0.66) | 0 | 0.00 (0.00 to 0.24) |
| Chest/ribs/abdomen | 5 | 0.19 (0.06 to 0.45) | 0 | 0.00 (0.00 to 0.24) |
| Pelvis/hips/groin/upper leg | 6 | 0.23 (0.08 to 0.50) | 0 | 0.00 (0.00 to 0.24) |
| Knee | 20 | 0.77 (0.47 to 1.18) | 4 | 0.27 (0.07 to 0.68) |
| Lower leg/ankle/foot | 9 | 0.35 (0.16 to 0.66) | 2 | 0.13 (0.02 to 0.48) |
| Other | 0 | 0.00 (0.00 to 0.14) | 0 | 0.00 (0.00 to 0.24) |
| Missing/unknown | 24 | 0.92 (0.59 to 1.37) | 11 | 0.73 (0.36 to 1.31) |
| **Type** | | | | |
| Contusion | 13 | 0.50 (0.27 to 0.85) | 2 | 0.13 (0.02 to 0.48) |
| Concussion† | 69 | 2.36 (1.73 to 3.22) | 18 | 1.19 (0.71 to 1.89) |
| Joint/ligament sprain/dislocation | 41 | 1.57 (1.13 to 2.13) | 2 | 0.13 (0.02 to 0.48) |
| Fracture | 32 | 1.23 (0.84 to 1.73) | 3 | 0.20 (0.04 to 0.58) |
| Muscle strain/tendonitis | 19 | 0.73 (0.44 to 1.14) | 1 | 0.07 (0.00 to 0.37) |
| Abrasion/bleeding/burn/cut/blister | 2 | 0.08 (0.01 to 0.28) | 0 | 0.00 (0.00 to 0.24) |
| Other | 7 | 0.27 (0.11 to 0.55) | 0 | 0.00 (0.00 to 0.24) |
| Missing/unknown | 30 | 1.15 (0.78 to 1.64) | 14 | 0.93 (0.51 to 1.56) |

*Crude rates with 95% exact Poisson CIs.
†Rate and corresponding 95% CI are based on Poisson regression analysis, offset for exposure game hours and adjusted for clustering by team.

were similar for injury (IRR=0.29 (95% CI 0.20 to 0.43)) and concussion (IRR=0.41 (95% CI 0.24 to 0.70)).[31] The association of this policy change on overall injury and concussion rates in non-elite Midget ice hockey is similar to that found following national policy change prohibiting body checking in Pee Wee (2013), where a 50% lower game-related injury rate and a 64% lower concussion rate was seen in games.[17] Further, in non-elite Midget (ages 15–17) leagues the effect of such policy change was greater than seen previously in non-elite Bantam (ages 13–14) leagues, where a 55% lower injury rate and a 41% (not statistically significant) lower concussion rate was reported in non-body checking leagues.[8] Policy prohibiting body checking was associated with a 92% lower more severe injury rate (>7 days time loss) and 95% lower more severe concussion rate (>10 days time loss) in non-elite Midget players, a much greater impact than reported in Pee Wee (60% and 44%, respectively) or Bantam (61% for more severe injury and 45% but not significant for more severe concussion).[8 17] It is possible that the greater reduction seen in injury and concussion rates in older adolescent (ages 15–17) players compared with non-elite Bantam players (ages 13–14) may be related to the players generally being larger, faster, and more aggressive resulting in larger impact forces. The median weight for Midget players was 68 kg and for Bantam was 54 kg.[8] The point estimate for the injury rate (8.17 injuries/1000 game hours (95% CI 6.33 to 10.01)) in non-elite Midget body checking leagues in this study is higher than the recently reported rate in non-elite body checking leagues in Bantam (5.52 injuries/1000 game hours (95% CI 3.03 to 8.01)). The same is the case for non-body checking leagues where the injury rate was 2.65 injuries/1000 game hours (95% CI 1.27 to 4.03) in Midget and 3.66 injuries/1000 game hours (95% CI 0.20 to 4.80) in Bantam. It is also noted that there is considerable overlap of 95% CIs between Bantam and Midget in body checking and non-body checking leagues. The concussion rate of 4.2 concussions/1000 game hours (95% CI 1.84 to 3.45) in Midget body checking leagues is also similar to that reported in Bantam ((2.31 concussions/1000 game hours (95% CI 0.49 to 4.13)).[8]

Translating these findings to the entire non-elite Midget player population in Canada, approximately 8770 game-related injuries in Canada annually could be prevented if body checking were prohibited in non-elite Midget. This is a similar reduction as was seen in non-elite Bantam (4461 injuries) and all levels of Pee Wee (6388 injuries) in Canada.[8 17] The impact of these findings could also be considered in the context of reviewing tackle laws in other youth collision sports such as tackle football, rugby and lacrosse.

Limitations included that not all players with an identified suspected concussion followed-up after referral to a study physician (46/69 were assessed by study physician (66.7%) in body checking cohort and 12/18 (66.7%) in non-body checking cohort). Bias may have been associated with examining concussion (>10 days time loss) estimates, as return to play decisions may have been influenced if the player was returning to a body checking league. Other factors contributing to return to play decisions and influencing precision of equating time loss with severity include game importance, motivation, personality characteristics, parental influence and body checking policy. Return to play protocols were established based on the International Consensus Statement on Concussion in Sport and supported harmonisation for return to play decisions between physicians.[19] Non-differential measurement of concussion severity based on the 10-day time loss cut-point may have been introduced if there was a delay of greater than 3 days until the athlete had first seen a study physician and then progressed through the return to play protocol. Self-reporting of some covariates may have been influences by recall bias and player position, previous history of injury/concussion, and weight may not have been consistent for every game during the season for each player

## What are the findings?

- ⇒ Policy change prohibiting body checking in non-elite 15–17 years old adolescent ice hockey leagues resulted in a 67% lower rate of game-related injury.
- ⇒ Policy change prohibiting body checking in non-elite 15–17 years old adolescent ice hockey leagues resulted in a 59% lower rate of game-related concussion.
- ⇒ The public health impact of policy prohibiting body checking in non-elite 15–17 years old levels of play is substantial.

## How might it impact on clinical practice in the future?

This research will inform future body checking policy change in non-elite adolescent ice hockey leagues regionally, nationally, and internationally to have the greatest public health impact in the reduction of injuries and concussions in adolescent ice hockey players.

as reported at baseline. Non-participation was largely based on the failure to identify a team safety designate with willingness to support injury surveillance. Socioeconomic status data were not collected, however, the inclusive sampling strategy across city associations and study years should minimise any potential confounding effect. Teams in the body checking and non-body checking leagues participated for a differential number of weeks ranging from 8 to 33 weeks. While exposure and injury data were collected concurrently, it is possible that injury rates may have differed across the months of the season, however, this was the case for both the body checking and non-body checking cohorts. It is also acknowledged that the level of play in less-elite Midget leagues for which body checking was disallowed is regional and thus the non-body checking cohort ranges to include players in the lower 70% by level of play in some regions (British Columbia) and the lower 40% in other regions (Alberta). It should be noted that >80% of players in the non-body checking cohort were players in British Columbia (lower 70% by level of play).

## CONCLUSION

Introduction of policy prohibiting body checking regionally in Midget non-elite levels of play was associated with a 67% lower rate of injury and 59% lower rate of concussion. These findings highlight the significant public health impact of this policy change associated with reduced injury and concussion rates in older adolescent ice hockey players. Considerations for future research include the development of skills associated with body checking, years of body checking experience, coaching expertise, progression of body checking skills and the impact of body checking policy on player game behaviours and performance.

**Author affiliations**
[1]Sport Injury Prevention Research Centre, Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada
[2]Department of Pediatrics, Cumming School of Medicine, University of Calgary, Calgary, Alberta, Canada
[3]Department of Pediatrics, Faculty of Medicine, University of British Columbia, Vancouver, British Columbia, Canada
[4]British Columbia Injury Research & Prevention Unit, British Columbia Children's Hospital, Vancouver, British Columbia, Canada
[5]Department of Educational Psychology, University of Alberta, Edmonton, Alberta, Canada
[6]Glen Sather Sports Medicine Clinic, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Alberta, Canada
[7]Department of Family Medicine, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Alberta, Canada
[8]Department of Physical Education, Laval University, Quebec City, Quebec, Canada
[9]School of Kinesiology & Health SCience, Faculty of Health, York University, Toronto, Ontario, Canada

**Correction notice** This article has been corrected since it published. An author has been added and results in the tables have been corrected in the online version only and not in print.

**Twitter** Carolyn A Emery @CarolynAEmery, Amanda Marie Black @aacademic, Kathryn J Schneider @Kat_Schneider7 and Shelina Babul @cattonline

**Acknowledgements** The Sport Injury Prevention Research Centre (one of the International Research Centres for Prevention of Injury and Protection of Athlete Health supported by the International Olympic Committee). Carolyn Emery is supported by a Canada Research Chair (Tier 1) Concussion. This research was possible due to the support from Hockey Calgary, Hockey Edmonton, BC Hockey, Hockey Alberta, and Hockey Canada. This research would not have been possible without the support of many Midget players, parents, coaches, team designates, physiotherapists, athletic therapists, student therapists and study physicians.

**Contributors** CE, LP-D, AMB, PE, KJS, SB, MM, CL, CG, AM and BEH contributed to the study proposal development. CE, AMB, MK, NS and SK contributed to data collection, entry, and data cleaning. CE, LP-D, AMB, PE, BEH contributed to the data analysis and interpretation of study results. SB, MM and CB contributed to all aspects of data collection at study sites outside of Calgary. CE and BEH contributed to acquisition of funding, study design, and led all aspects of the cohort. All authors critically reviewed and edited the manuscript before submission.

**Funding** This study was funded by Alberta Innovates Health Solutions (Collaborative Research and Innovation Opportunities Program Grant # 3685), Canadian Institutes of Health Research (Institute of Neuroscience, Mental Health and Addictions Grant #293332), and the Hotchkiss Brain Institute (University of Calgary).

**Competing interests** None declared.

**Patient and public involvement** Hockey Canada, BC Hockey, Hockey Calgary and Hockey Edmonton were involved as knowledge brokers in 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 Hockey Canada, BC Hockey, Hockey Calgary, and Hockey Edmonton. Hockey players, parents, coaches and administrators in Hockey Canada, BC Hockey, Hockey Calgary 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 and parents and safety designates. Partners from Hockey Canada, BC Hockey, Hockey Calgary and Hockey Edmonton have received an executive report of the study findings based on preliminary results.

**Patient consent for publication** Not required.

**Ethics approval** Ethics approval was received from the research ethics boards at the University of Calgary (Ethics ID: REB14-0348 and REB14-2209), University of Alberta (Ethics ID: REB Pro00024093) and the University of British Columbia (Ethics ID: CW14-0304/H14-01894).

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

**Data availability statement** Data may be obtained from a third party and are not publicly available.

**ORCID iDs**
Carolyn A Emery http://orcid.org/0000-0002-9499-6691
Amanda Marie Black http://orcid.org/0000-0001-5668-9706
Brent E Hagel http://orcid.org/0000-0002-5530-0639

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