ARTICLE

Injuries in Canadian Youth Ice Hockey: The Influence of Relative Age

Nick Wattie, BPHE, BSc\*, Stephen Cobley, BSc, MA\*, Alison Macpherson, PhD\*, Andrew Howard, MD, MSc, FRCCSd,e, William J. Montelpare, PhDf, Joseph Baker, PhD\*b

\*Lifespan Health and Performance Laboratory, School of Kinesiology and Health Science, York University, Toronto, Ontario, Canada; \*Carnegie Research Institute, Leeds Metropolitan University, West Yorkshire, United Kingdom; \*Institute for Clinical Evaluative Sciences, Toronto, Ontario, Canada; \*Division of Orthopaedic Surgery, Hospital for Sick Children, Toronto, Ontario, Canada; \*Population Health Sciences, Hospital for Sick Children Research Institute, Toronto, Ontario, Canada; \*School of Kinesiology, Lakehead University, Thunder Bay, Ontario, Canada

The authors have indicated they have no financial relationships relevant to this article to disclose.

ABSTRACT

OBJECTIVE. The purpose of this study was to investigate the relationship between relative age and injury prevalence in Canadian youth ice hockey.

METHODS. In study 1, youth ice hockey–related injuries (among children 10–15 years of age) collected by the Canadian Hospitals Injury Reporting and Prevention Program between 1995 and 2002 were analyzed. The relative ages of injured children were compared across different age groups and injury characteristics (mechanism of injury and severity of injury). In study 2, injuries reported in the Hockey Canada Insurance Database were analyzed. The relative ages of injured children at different levels of play (ie, representative versus house league teams) were compared.

RESULTS. In study 1, the majority of injured players were of older relative age. However, relative age was not related to mechanism of injury or severity of injury. In study 2, 70% to 80% of injured players at the highest level of play were relatively older, whereas only 50% to 55% of house league injured players were relatively older.

CONCLUSION. Relatively older children within ice hockey age groups are at increased risk of injury compared with their younger peers. Furthermore, the risk of injury for relatively older players is greater at more-competitive levels of play. This study proposes that the relative age advantage associated with selection to Canadian youth ice hockey teams is accompanied by an increased risk of injury.
AT FIRST GLANCE, annual age-grouping strategies in both sports and education seem to be a developmentally appropriate way to distribute children. This has been achieved by establishing “cutoff” date criteria, which ensure that children have turned a specific age before being placed in a certain grade for education or being eligible to participate on certain sports teams. For example, with a cutoff date of September 1, only children who had turned 6 years of age before September 1 of the current academic year would be allowed to enter first grade. However, there are problems with such an age-grouping strategy, as exemplified by relative age effects (RAEs). RAEs describe the potential advantages (or disadvantages) that result from age differences between peers within an annually age-grouped cohort. From the previous example, someone born shortly after September 1 would be almost 1 year older than someone born on August 30, but both would be in the same grade.

In sports, the consequences of such relative age differences suggest that relatively older members of a cohort are more likely to be selected for local junior teams1,4 and representative teams6,8 and to attain elite professional status,2,7,8 which highlights participation and attainment inequality. RAEs have been identified in many sports (eg, baseball,4 ice hockey,5 swimming,9 and basketball11) and across cultural contexts (eg, in Belgium, Holland, and France,12 England,13 and Australia,14 Brazil, Germany, and Japan14).

Regardless of alterations in cutoff dates or climatic seasonal variations, age-grouping RAEs persist.15 To date, physical maturational,17 experimental,18 and psychological16 hypotheses have been presented to account for RAE prevalence. Specifically, relative age differences, especially in prematurity stages, may create significant height and weight differences among youths participating in sports. This may confer specific physical performance advantages for relatively older players,19,20 leading to identification and selection for higher levels of competition. With the amount of time spent in sport-specific practice being closely related to attainment11 and there being variability of lived experience between relatively older and younger players, the amount of potential practice and game experience may result in a skill acquisition disadvantage for relatively younger players. Relatively younger players may not display the equivalent skills and competencies, compared with their relatively older peers. The psychological hypothesis suggests that personal perceptions of ability and competence directly influence behavior and participation.22 Positive competence is thought to reinforce and to maintain motivation for a given behavior (eg, sports participation), whereas negative perceptions, including affect, emotion, and stress, may lead to cessation. Therefore, relatively younger players may develop low perceived competence when skills or performance are not equivalent to those of their relatively older counterparts.18 Such perceptions may lead to reductions in effort, interest, and investment and ultimately to termination of sports participation.23

Separately or possibly in combination, these hypotheses suggest how age-grouping systems can lead to selection and attainment discrepancies in sports. To date, most relative age research has focused on simply identifying selection and attainment advantages associated with relative age differences. However, these may not be the only unintentional outcomes of age grouping; other implications may be evident but as yet not identified. For instance, in sports (eg, ice hockey) in which physical factors such as height, weight, speed, power, and coordination underlie performance, it is plausible that such differences may lead to discrepancies in injury incidence according to relative age in physically aggressive sports. Currently, research has not examined intra-age group (ie, relative age) patterns of injury.

The purpose of the present study was to examine whether relative age was related to physical injury as a result of participation in youth ice hockey (a physical-contact, high-strategy, team sport) and whether the proportions of relative age injuries changed across youth development phases (ie, inter-age group). Furthermore, given the physical contact inherent to ice hockey and the hypothesized influence of physical size and strength on creating RAEs, a secondary purpose of the current study was to examine whether players of different relative ages were more or less likely to be injured as the result of body contact or body checking and more or less likely to incur severe injuries. This secondary purpose was of interest because previous research identified body checking as being associated with injury severity.24

Previous research on the influence of relative age found advantages exclusively for relatively older children, compared with their younger peers.16 It has been hypothesized that relatively younger players are at a physical disadvantage with respect to size and strength and that this disadvantage, compared with their older peers, results in less selection to youth ice hockey teams. We hypothesized that these maturational physical discrepancies between players of different relative ages would result in a greater proportion of injured players being relatively younger. Similarly, because relatively older players are thought to be larger and stronger than their younger peers, we hypothesized that relatively younger injured players would have incurred a greater proportion of their injuries through physically aggressive contact (ie, body checks). Because body checks have been related to more-severe injuries, we also hypothesized that relatively younger players would incur a greater proportion of severe injuries.

Level of play (or competition level) was identified previously as an important covariate in relative age research, and this is particularly true of relative age research on youth ice hockey. Barnsley and Thompson17 observed that the RAE in youth hockey was more pro-
nounced at higher tiers in all age groupings. It was even observed that the lowest tiers of competition demonstrate a significant excess of relatively younger children. If level of play can influence the magnitude and existence of RAEs in a sport, then due consideration of this covariate is necessary. The purpose of the second study was to examine a secondary hockey-injury data source that contained information on level of play, in addition to information on age group and relative age.

**METHODS**

**Study 1**

**Sample**

The study sample consisted of boys 10 to 15 years of age (n = 4736) who visited pediatric emergency departments participating in the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP). The CHIRPP is an injury surveillance program conducted in certain pediatric emergency departments. All participating hospitals in Ontario and Quebec (excluding the Children’s Hospital of Eastern Ontario) were included. All ice hockey–related injuries reported by the CHIRPP between September 1995 and August 2002 were included. CHIRPP data include demographic variables and numerous variables pertaining to injuries. Specific injury information, such as injury type and severity, were reported by the treating physician, whereas information on how the injury was sustained was provided by the patient and parents.25

**Measures**

The primary independent measure was the relative age of the injured ice hockey players, as reported by the CHIRPP. Consistent with previous relative age research, players’ birth dates were grouped into monthly quartiles starting from the selection date criteria (in this case, starting on January 1 and ending on December 31 of the same calendar year). For example, quartile 1 included January, February, and March birth dates and quartile 4 included October, November, and December birth dates. Subjects born in quartile 1 were therefore relatively older than their peers born in quartile 4.

Several moderating variables were examined, to ascertain their interactions with relative age and subsequent RAEs. From 1995 to 2002 (7 ice hockey seasons), the youth ice hockey age groups dictated by Hockey Canada were Atom (10–11 years), Peewee (12–13 years), and Bantam (14–15 years). To determine whether relative age injury proportions were moderated by age groups, the proportions of relative age injuries were compared at different age groups.

Another moderating variable of interest was the mechanism factor, reported as “how the injury occurred” on the CHIRPP form.25 Injury was dichotomized as either resulting from a body check or not resulting from a body check. Hockey Canada defines body checking as the “physical extension of the body toward the puck carrier moving in an opposite or parallel direction.”26 Methods for classifying injuries as checking related or not checking related were consistent with previous use of this CHIRPP data set for examination of youth ice hockey–related injuries.24

In light of the previously identified relationship between injuries resulting from body checks and the severity of injuries,24 a measure of injury severity was included in the analyses. Injuries were categorized as severe if the athlete was admitted to the hospital and nonsevere if the athlete was not admitted.

**Analyses**

Statistical analyses were conducted by using SPSS 15.0 for Windows (SPSS, Chicago, IL). Frequencies of relative age (ie, quartile of birth) and age group (Atom, Peewee, or Bantam) were used to describe the study sample; χ² statistics (significance of P < .05, assuming equal distribution) were used to compare the observed versus expected proportions of relative age injuries in each of the age groups (Atom, Peewee, and Bantam). Logistic regression analyses were used to examine whether relative age was associated with (1) the risk of being injured in different age groups, (2) the risk of being injured by a body check, and (3) the risk of incurring a severe injury. The aforementioned risks (odds ratios [ORs]) were calculated by comparing the proportion of quartile 1 injured players with that of quartile 4 injured players (using 95% confidence intervals [CIs]).

**Study 2**

**Sample**

The Hockey Canada National Insurance Program provides financial resources to help compensate players and families that have experienced financial loss as the result of hockey participation in Canada.27 The study sample consisted of hockey injuries reported to the Hockey Canada National Insurance Program between September 1998 and August 2003. Each claim made to the Hockey Canada Insurance Database (HCID) contained information on the date of injury and how the injury occurred, as well as each player’s date of birth, age group, and level of play.

**Measures**

The primary independent measure of this study was the relative age of the injured athletes. Players’ birth dates were grouped into monthly quartiles (quartile 1: January to March; quartile 2: April to June; quartile 3: July to September; quartile 4: October to December).

A moderating variable of interest included in analyses was the age group of the injured players. The age groups included in the HCID were Peewee (12–13 years) and
Bantam (14–15 years). Within each of the age groups, there were 10 level-of-play tiers, including AAA (the highest, competitive-level tier), AA, A, B, C, CC, D, DD, E, and house league (the lowest tier). For the purpose of analysis, the “intermediate” B, C, CC, D, DD, and E tiers were combined into 1 group, to maintain disclosure confidentiality of players. Therefore, in the analyses, 5 levels of play were examined as potential moderating variables (AAA, AA, A, intermediate tiers, and house league). Because the purpose of this study was to examine how the level of play influences the proportion of relative age injuries, all cases that contained no information on the level of play were excluded from analyses.

Information on how the injury occurred was used to create a “mechanism of injury” variable. Twelve descriptors were used throughout the HCID to express how injuries occurred, of which 10 were used to create the mechanism of injury variable. Injuries that had no information on how the injured occurred, as well as injuries that were the result of a fight, were not included in the analyses. The descriptors of “blindsiding,” “checked from behind,” “collision with opponent,” and “collision on open ice” were categorized as injury resulting from a body check. Conversely, the descriptors of “collision with boards/net,” “fell on ice,” “hit by puck/stick,” and “noncontact injury” were categorized as injury that did not result from a body check.

Analyses
Statistical analyses were conducted by using SPSS 15.0 for Windows. Frequencies and percentages of injuries according to relative age category (quartile of birth), age group (Peewee or Bantam), and level of play were used to describe the study sample. To test for injury asymmetries according to quartile of birth, χ² analyses were conducted; χ² tests (significance of P < .05, assuming equal distribution) were conducted for all levels of play and both age groups. Logistic regression analyses were used to examine (1) the risk of injury for those of different relative ages at different levels of play and (2) the risk associated with mechanism of injury (body checked versus not body checked) for those of different relative ages. For all logistic regression analyses, risks (ORs) were calculated by comparing the proportion of quartile 1 injured players with that of quartile 4 injured players (using 95% CIs).

RESULTS
Study 1
There were 4736 ice hockey injuries reported by the CHIRPP between 1995 and 2002. Overall, the proportion of injuries varied significantly according to age group. Of the overall sample, 18% were children in the Atom (10–11 years) age group, 37% in the Peewee (12–13 years) age group, and 46% in the Bantam (14–15 years) age group (χ² = 591.13; P < .001). The proportions of injuries according to relative age category are presented in Table 1. A RAE was found within each of the 3 age groups. Birth dates (by quartile) were distributed unevenly, with a greater-than-expected number of injuries sustained by quartile 1 players and a less-than-expected number of injuries sustained by quartile 4 players (Atom: χ² = 11.20; P = .001; Peewee: χ² = 32.57; P < .001; Bantam: χ² = 42.04; P < .001).

Quartiles 2 and 3 did not differ significantly from each other or from expected values and were excluded from analyses; however, parallel analyses were conducted with those quartiles included, and the direction and significance of the observed RAEs were not affected.

Although a RAE was observed within each of the 3 age groups, regression analyses suggested that the risk of injuries according to relative age did not change from one age group to another. More specifically, on the basis of a comparison of the risk of injury for relatively older players versus relatively younger players in the Atom age group, the risk of injury for relatively older players (quartile 1) did not increase or decrease in the Peewee (OR: 1.05; 95% CI: 0.82–1.34) and Bantam (OR: 1.05; 95% CI: 0.83–1.33) age groups.

Neither older (quartile 1) nor younger (quartile 4) relative age was associated with a disproportionate risk of being injured as the result of a body check in any of the age groups (Atom: OR: 0.83; 95% CI: 0.53–1.31; Peewee: OR: 0.95; 95% CI: 0.71–1.25; Bantam: OR: 1.05; 95% CI: 0.82–1.34). Furthermore, neither older nor younger relative age was found to be a significant risk factor for incurring severe injuries in any age group (Atom: OR: 1.79; 95% CI: 0.47–6.80; Peewee: OR: 1.08; 95% CI: 0.43–2.72; Bantam: OR: 0.73; 95% CI: 0.37–1.45).

Study 2
Of the 6864 (Peewee and Bantam) injuries reported by the HCID, 5681 had information on the variables of interest in this study and were retained for additional analyses. Of the final study sample, a greater proportion of injured players were in the Bantam age group (58%) than in the Peewee age group (χ² = 144.16; P < .001).

The proportions of relative age injuries (quartile 1 versus quartile 4) for the Peewee and Bantam age groups are presented in Figs 1 and 2. The χ² analyses revealed...
that, within both the Peewee and Bantam age groups, RAEs existed at various levels of competition. Within the Peewee age group (Fig 1), greater proportions of injuries were incurred by players born in quartile 1 than in quartile 4 for the AAA, AA, and A levels of play ($\chi^2 = 21.05-36.16; P < .001$) but not the for the intermediate level of play ($\chi^2 = 1.01; P = .31$) or the house league level of play ($\chi^2 = 2.05; P = .15$). The same was true within the Bantam age group (Fig 2); greater proportions of injured players were born in quartile 1 than in quartile 4 for the AAA, AA, and A levels of play ($\chi^2 = 10.65-73.59; P < .01$) but not for the intermediate level of play ($\chi^2 = 1.45; P = .70$) or the house league level of play ($\chi^2 = 0.01; P = .89$). As in study 1, quartile 2 and quartile 3 were excluded from analyses because they did not differ significantly from each other or from expected values.

Results from the logistic regression analysis showed that there were intra-level-of-play variations in the proportions of relative age injuries in both the Peewee and Bantam age groups (Table 2). More specifically, the magnitude of the injury RAE varied according to the level of play. For example, Bantam AAA injured players were 3.21 times more likely to be relatively older (ie, born in quartile 1, rather than in quartile 4) than Bantam house league injured players. In both age groups, the risk of injury for relatively older players increased as the level of play increased from least competitive to most competitive. Logistic regression analyses revealed that differences in relative age (in both age groups and all levels of play) did not result in disproportionate risk of being injured as the result of a body check.

**DISCUSSION**

**Study 1**

Results of this study suggest that there are both inter-age group patterns of injury, with overall injury prevalence increasing progressively from Atom to Bantam age groups, and intra-age group patterns of injury. Within the Atom, Peewee, and Bantam age groups, greater proportions of children (26%–29%) were born in quartile 1, compared with quartile 4 (18%–20%), and thus were of older relative age. Therefore, whereas relatively older children are more likely to be selected for youth hockey teams, they are also more likely to present to hospital emergency departments with hockey-related injuries. Within the scope of relative age research, these findings are decidedly atypical; previous research in both education and sports found consistent advantages in attainment for relatively older children, compared with their relatively younger peers. Interestingly, these results suggest that the advantage in selection and attainment for relatively older players is accompanied by the disadvantage of increased proportion of injuries. The overall prevalence of injury increased progressively from Atom to Bantam age groups but the risk of injury for relatively older players did not change, which suggests that the injury disadvantage for relatively older players is stable.

Although it showed surprising results, this study did have limitations. First, the study was not population based. Although the CHIRPP has been found to be a valid indicator of overall youth injury patterns in Canada, ideally the relative age of injured children would have been compared with that of children who were not injured. Second, the nature of the data collected by the CHIRPP did not provide information on the children’s level of play (ie, competitive versus recreational/house leagues) within each age grouping. Previous research found the RAE in youth hockey to be more pronounced at higher levels of play (ie, more-competitive hockey) and nonexistent, or even reversed, at lower levels of play. Because level of play has been identified as a major covariate of the RAE, failure to control for level of play represents a major limitation of this study and may
even account for the atypical direction of the RAE observed for youth ice hockey injuries. We focused on this limitation in study 2.

**Study 2**

The results of study 2 suggest that the prevalence of injuries increases from younger age groups to older age groups (ie, from Peewee to Bantam) and that, within each age group, relatively older players experience a greater proportion of injuries than do their relatively younger peers. Like study 1, study 2 presented both inter-age group patterns of injury and intra-age group patterns of injury. Furthermore, as in study 1, relative age was not related to mechanism of injury (ie, being injured by a body check or not). However, the addition of level of play as a covariate in study 2 demonstrated that the relationship between relative age and youth hockey injury was more dynamic than revealed previously. The addition of level of play as a covariate suggested that the proportion and risk of injury increased for relatively older players as the level of play became more competitive (Table 2).

Like study 1, this study was limited by the fact that it was not population based. Future research would benefit from examination of both injured and noninjured players when injury RAEs are considered. Although this study did control for level of play, the HCID did not provide a measure of injury severity. Although there was no relationship between relative age and mechanism of injury, as in study 1, it cannot be assumed that level of play does not interact with relative age and severity of injury.

**General Observations**

Both study 1 and study 2 support the notion that relatively older players at the highest levels of competition are at increased risk of injury. Although at first it might seem counterintuitive that these children, with more experience and skill, would be at greater injury risk, it is possible that they are actually playing more, playing at higher competitive levels, or both and thus are more likely to be injured because of greater exposure. Research investigating the RAE in soccer not only found a relative age advantage for selection to soccer teams but also found that relatively older players had more playing time in games, compared with their younger peers. Because relatively older participants are selected because of their greater physical maturity, skill, and experience, it seems reasonable that these individuals would play longer and more often. If the same disproportionate amount of playing time is present for relatively older children in Canadian youth ice hockey, then these players would have increased exposure to the inherent risks associated with playing the game. Researchers should

![FIGURE 2](image_url)

Percentages of injuries in older (quartile 1) and younger (quartile 4) relative age categories for different levels of play in the Bantam age group. Q1 indicates quartile 1, Q4, quartile 4.

<table>
<thead>
<tr>
<th>Age Group Level of Play</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peewee (12–13 y)</strong></td>
<td></td>
</tr>
<tr>
<td>AAA</td>
<td>3.53 (1.90–6.56)</td>
</tr>
<tr>
<td>AA</td>
<td>1.78 (1.24–2.56)</td>
</tr>
<tr>
<td>A</td>
<td>1.42 (1.00–2.01)</td>
</tr>
<tr>
<td>B/C/D/E</td>
<td>0.93 (0.66–1.32)</td>
</tr>
<tr>
<td>House league</td>
<td>1</td>
</tr>
<tr>
<td><strong>Bantam (14–15 y)</strong></td>
<td></td>
</tr>
<tr>
<td>AAA</td>
<td>3.21 (2.18–4.73)</td>
</tr>
<tr>
<td>AA</td>
<td>2.23 (1.58–3.14)</td>
</tr>
<tr>
<td>A</td>
<td>1.45 (1.03–2.06)</td>
</tr>
<tr>
<td>B/C/D/E</td>
<td>1.06 (0.75–1.50)</td>
</tr>
<tr>
<td>House league</td>
<td>1</td>
</tr>
</tbody>
</table>

The risk of injury for relatively older players (quartile 1), compared with relatively younger players (quartile 4), at different levels of play within the Peewee and Bantam Age Groups.
consider differences in exposure time as a possible explanatory factor in this unusual disadvantage for relatively older players.

Our results suggest that the profile of RAEs is more complex than considered previously. In addition to the selection and attainment advantages noted consistently for relatively older players in a range of sports, these participants are at increased risk of injury.

Implications for Coaches and Athletes
The nature of the data in study 2 did not make it possible to examine the interaction between relative age, level of play, and injury severity. Such research would benefit from consideration of injury severity when relative age and level of play are examined, because this might provide a more-compelling view of the implications of relative age injuries. Similarly, information regarding how relative age differences affect the length of time an injured athlete is away from play or participation may be more tangible to coaches, parents, and athletes. It is noteworthy that increased injuries have been identified as one of the reasons why, as a result of decreased fun and performance, youths drop out of sports.11

There has been a great deal of debate regarding strategies and rule changes aimed at decreasing the risk of injury in Canadian youth ice hockey.12,32 The results from this study suggest that, regardless of the strategy adopted, coaches, parents, and athletes should be cognizant of the potential factors leading to increased injury risk for relatively older ice hockey players, particularly at higher levels of competition.

REFERENCES