

A population-based study of paediatric emergency department and office visits for concussions from 2003 to 2010

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BACKGROUND: There is a paucity of information regarding descriptive epidemiology of paediatric concussions over time, and few studies include both emergency department (ED) and physician office visits.

OBJECTIVE: To describe trends in visits for paediatric concussions in both EDs and physician offices according to age and sex. A secondary objective was to describe the cause of concussion for children treated in EDs.

METHODS: A retrospective, population-based study using linked health administrative data from all concussion-related visits to the ED or a physician office by school-age children and youth (three to 18 years of age) in Ontario between April 1, 2003 and March 3, 2011 was conducted.

RESULTS: The number of children evaluated in both EDs and a physician offices increased between 2003 and 2010, and this linear trend was statistically significant ($P=0.002$ for ED visits and $P=0.001$ for office visits). The rate per 100,000 increased from 466.7 to 754.3 for boys and from 208.6 to 440.7 for girls during the study period. Falls accounted for approximately one-third of the paediatric concussions. Hockey/skating was the most common specific cause of paediatric sports-related concussions.

CONCLUSIONS: The increasing use of health care services for concussions is likely related to changes in incidence over time and increased awareness of concussion as a health issue. Evidence-based prevention initiatives to help reduce the incidence of concussion are warranted, particularly in sports and recreation programs.

Key Words: Concussion; Concussion-related injury; Epidemiology; Paediatric

Unintentional injuries are common among children and youth; among these injuries, traumatic brain injuries (TBIs) are a cause for concern. According to the 2009-2010 Canadian Community Health Survey, 23% of the adolescent population reported having sustained a head injury within the previous year (1). Mild TBIs (mTBIs), commonly referred to as concussions, may lead to impaired neurological functioning, including chronic headaches and memory deficits, making this an important public health problem (2).

Within the paediatric population, the association between age and concussion may vary, with one study reporting a peak at approximately 10 years of age and subsequent decline, while other studies reported that children >10 years of age were at increased risk for head injury (2-4). The reported causes of concussion vary

Une étude en population d'âge pédiatrique sur les visites à l'urgence et en cabinet en raison d'une commotion cérébrale entre 2003 et 2010

HISTORIQUE : On possède peu d'information sur l'épidémiologie descriptive des commotions cérébrales en pédiatrie au fil du temps, et rares sont celles qui portent à la fois sur les visites à l'urgence et au cabinet du médecin.

OBJECTIF : Décrire les tendances des visites à l'urgence et au cabinet du médecin par une population d'âge pédiatrique en raison de commotions cérébrales, en fonction de l'âge et du sexe. Un objectif secondaire consistait à décrire la cause des commotions cérébrales chez les enfants traités à l'urgence.

MÉTHODOLOGIE : Des chercheurs ont mené une étude rétrospective en population reliant les données administratives en matière de santé de toutes les visites d'enfants d'âge scolaire et d'adolescents (de trois à 18 ans) à l'urgence ou au cabinet du médecin en raison d'une commotion cérébrale en Ontario, entre le 1^{er} avril 2003 et le 3 mars 2011.

RÉSULTATS : Le nombre d'enfants évalués à l'urgence ou au cabinet du médecin a augmenté entre 2003 et 2010, et cette tendance linéaire était statistiquement significative ($P=0,002$ pour les visites à l'urgence et $P=0,001$ pour celles en cabinet). Pendant la période de l'étude, le taux sur 100 000 enfants est passé de 466,7 à 754,3 chez les garçons et de 208,6 à 440,7 chez les filles. Les chutes représentaient environ le tiers des commotions cérébrales en pédiatrie, tandis que le hockey ou le patin était la principale cause de commotions cérébrales liées au sport.

CONCLUSIONS : L'utilisation croissante des services de santé en raison d'une commotion cérébrale est probablement liée à l'évolution de leur incidence et à une plus grande sensibilisation à leurs conséquences sur la santé. Il faudra entreprendre des initiatives de prévention fondées sur des données probantes pour contribuer à réduire l'incidence des commotions cérébrales, notamment dans le cadre des programmes sportifs et de loisirs.

according to age. Among them, falls are the most common cause of injury in younger children (3,5-8). Approximately 45% of the TBIs admitted to Canadian hospitals were fall-related. (6) Adolescents are more susceptible to sports-related injuries, which account for 30% of paediatric concussions (6,9-11). Sports-related concussions frequently occur in organized team sports such as hockey, basketball, soccer, football, baseball, etc (3,6,10-15). The rate of concussion in sports also varies according to sex. Boys are more likely to sustain a concussion while playing football or hockey, whereas girls are more likely to sustain a concussion while playing soccer (12,13). Snow sports, such as skiing, and combative sports, such as martial arts, have also been associated with an increased risk for concussion (3,10,16). Motor vehicle collisions are another major source of paediatric concussions (6,7). One study reported that 28% of

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TABLE 1
Total annual number of visits for paediatric concussions to an emergency department and physician office in Ontario, 2003 to 2010

Year	Emergency department	Physician office	Total number of visits	Rate per 100,000
2003	4180	4556	8736	340.5
2004	4791	4893	9684	378.5
2005	4701	4979	9680	379.8
2006	4847	4945	9792	386.1
2007	5252	5439	10,691	423.3
2008	5583	5968	11,551	460.0
2009	6443	7235	13,678	548.8
2010	6495	8391	14,886	601.3
Total	42,292	46,406	88,698	—

paediatric concussions that were examined in an emergency department (ED) were caused by road traffic collisions (7).

Previous studies have mainly focused on children who were evaluated in an ED. To date, no studies have described the incidence of paediatric concussions treated in both EDs and physician offices. In addition, few studies have examined population-based trends in paediatric concussions over time – they have focused solely on sports-related concussions and have shown an increase in incidence (17,18).

The primary objective of the present study was to describe trends in paediatric concussions in both EDs and physician offices according to age and sex. A secondary objective was to examine the causes of concussion among children treated in the ED.

METHODS

Selection and description of participants

A retrospective analysis of all visits related to a diagnosis of concussion in an ED or a physician office by school-age children and youth (three to 18 years of age) in Ontario between April 1, 2003 and March 3, 2011 was conducted. ED visit records with an *International Classification of Diseases, 10th Revision, Canada* (ICD-10-CA) diagnosis of S060 (concussion) were reviewed, as well as office visit records with an Ontario Health Insurance Plan diagnosis code of 850 or 854 (concussion or head injury). Multiple visits for the same patient were included; however, only one billing per patient per day was included. Duplicated, overlapping and transferred ED visits were excluded. Records with a missing or invalid health card number, age or sex were also excluded.

Technical information

Unique anonymized encrypted identifiers were used to link multiple population-based health administrative databases routinely collected by the Institute for Clinical Evaluative Sciences (Toronto, Ontario), which contain information on all medically necessary services received by publicly insured residents of Ontario. These included the National Ambulatory Care Reporting System for ED visits, a database maintained by the Canadian Institute for Health Information (Toronto, Ontario); the Ontario Health Insurance Plan for physician billings including physician visits, diagnosis codes and procedures; and the Registered Persons Database for patient demographic information. For ED patients, the most common causes of injury were identified; however, this information was not available in the physician office data. The broad causes that were evaluated in the present study included falls, exposure to force, motor vehicle crashes and being struck by another person. The specific causes that were examined were identified based on availability of data and

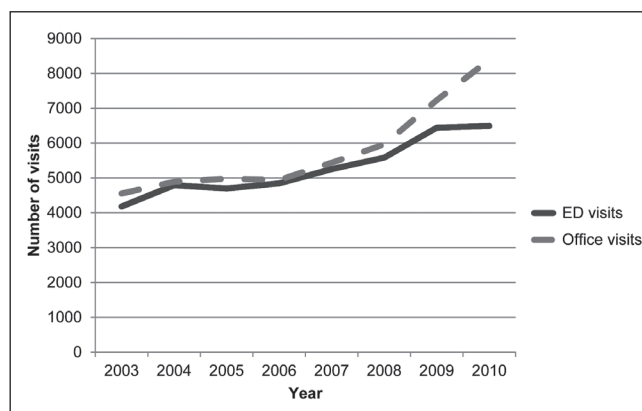


Figure 1) Total number of annual visits for paediatric concussion to an emergency department (ED) and physician office in Ontario, 2003 to 2010

previous identification of common concussion risk factors. These were hockey/skating, motor vehicle occupant, football/rugby, snow sports, cycling, baseball, soccer, falls from playground equipment, inline skating or skateboarding, and pedestrian injury.

Statistics

The total number of ED and physician office visits for concussion according to sex and age group from the fiscal years 2003 to 2010 were identified. A χ^2 test for trends was used to assess the change in the rates over the seven-year period.

All calculations were performed using SAS version 9.2 (SAS Corporation, USA). Rates were calculated using the number of visits as the numerator and the appropriate population, according to the Registered Persons Database, with age and sex as the denominator. Research Ethics Board approval was obtained from Sunnybrook Health Sciences Centre (Toronto, Ontario).

RESULTS

Between 2003 and 2010, a total of 88,688 paediatric concussions were treated in either an ED or a physician office, and there was a significant trend over time in both locations ($P=0.002$ and $P=0.001$, respectively). In 2003, there were 8736 concussions treated in either an ED or a physician office, compared with 14,886 in 2010 (Table 1). Figure 1 shows an increasing trend, with a growth in office-based visits in later years. In addition, the rate per 100,000 increased from 340.5 in 2003 to 601.3 in 2010 (Table 1).

Boys were more likely to be treated for concussions than girls, and this difference was consistent over the study period (Figure 1). For both boys and girls, the number of visits for concussion increased until 15 years of age, then decreased until 18 years of age (Figure 2). The rate per 100,000 increased from 466.7 to 754.3 for boys, and from 208.6 to 440.7 for girls between 2003 and 2010 (Table 2).

When the broad causes of concussion were examined, falls were found to be the most common cause of concussion in an ED, representing 34% of all ED visits, followed closely by exposure to force (25.5%) and motor vehicle collisions (12.3%). When specific causes were examined in more detail, hockey/skating was the most common cause of concussions that were treated in an ED (Figure 3).

DISCUSSION

Our main finding was that the use of health services for concussion increased from 2003 to 2010 in Ontario, Canada's largest province. Our study revealed an increase in office visits for concussions

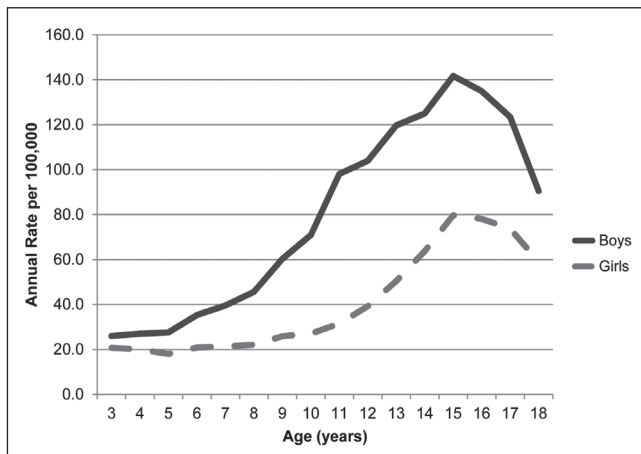


Figure 2) Paediatric emergency department and physician office visit annual concussion rate among boys and girls per 100,000 population according to age, 2003 to 2010

over this period of time. Given that the Zurich guidelines suggest that patients be diagnosed and subsequently cleared to return to activity by a physician, it is encouraging to observe more patients being evaluated for concussion in physician offices rather than EDs (19).

The variation in concussions according to age is not consistent in the literature, although most studies support our findings of increased concussions in adolescence (3,7-10). Only two studies reported that children <6 years of age were more likely to sustain a concussion than those >6 years of age (13,16).

The findings in our study are consistent with the majority of other studies reporting the major causes of paediatric concussions. Previous injury studies have reported the importance of falls as a cause of concussions in children (3,5-7,16). The Canadian Institute for Health Information analysis on national injury hospitalizations found falls to be one of the leading causes of injury hospitalizations in Canada (6). Previous studies of sports-related concussions involving children identified football and hockey as the sports that were associated with the highest number of concussions (3,10-12). Our findings reinforced that falls in general are the most common cause of paediatric concussions and, in terms of sports-specific causes, hockey/skating – a sport commonly played in North America – was associated with the greatest number of paediatric concussions.

Harris et al (17) conducted a population-based study of sport and recreation-related head injuries and reported that the rate of these injuries per 100,000 decreased from 99.4 in 1997/98 to 93.3 in 2007/2008. In contrast, Selassie et al (18) found that the rate of head injuries per 100,000 related to sports and recreation increased from 19.7 in 1998 to 45.6 in 2011. Our study showed that the rate of concussions per 100,000 for both sexes increased between 2003 and 2010; however, these rates are based on all causes and are not specific to sports.

Several interventions have been shown to reduce concussions. Sports-related concussions can be minimized by taking preventive action such as reducing body checking in hockey or wearing a helmet while cycling. Warsh et al (20) conducted a systematic review investigating the association between body checking and injury in youth ice hockey, and reported that the relative risk associated with body checking was between 0.63 and 39.79. The authors concluded that to decrease the burden of injury in hockey, body checking needs to be introduced at an older age. In addition, other prevention measures, such as wearing a helmet while cycling, have been shown to reduce the risk of head injury among youth. Macpherson

TABLE 2
Total annual number of visits for paediatric concussions to an emergency department and physician office according to sex in Ontario, 2003 to 2010

Year	All visits		Rate per 100,000	
	Boys	Girls	Boys	Girls
2003	6121	2615	466.7	208.6
2004	6817	2867	521.1	229.3
2005	6671	3009	511.8	241.7
2006	6604	3188	508.9	257.4
2007	7258	3433	561.4	278.4
2008	7659	3892	595.8	317.5
2009	8830	4838	692.0	397.8
2010	9563	5323	754.3	440.7
Total	59,523	29,165	–	–

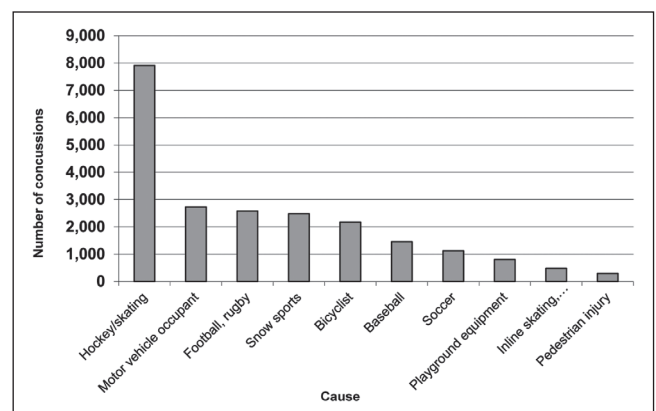


Figure 3) Emergency department visits for paediatric concussion according to selected causes in Ontario, 2003 to 2010

and Spinks (21) conducted a systematic review of bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. They reported that there is positive evidence to suggest that bicycle helmet legislation increases bicycle helmet use and decreases bicycle-related head injuries.

Strengths and limitations

The present study was the first to examine paediatric concussions evaluated in an ED and those evaluated in a physician office. By examining all of the paediatric concussions evaluated in multiple facilities, we were able to overcome the issue of under-reporting and obtain a more accurate number of concussions treated in Ontario. In addition, we collected data for a seven-year period; this enabled us to examine the changing trends over time.

The major limitation to our study was that not all concussions are treated in EDs or physician offices; therefore, we could not capture data regarding children who were evaluated by other medical professionals such as athletic therapists. In addition, the Institute for Clinical Evaluative Sciences only captures information for ED and physician visits in Ontario; therefore, our study may not be generalizable to other populations. We were also unable to discern whether the increase in visits for concussions were due to an increase in incidence, or an increase in awareness of concussion and the need for treatment. Finally, some children may have been seen in an ED initially and subsequently followed in a physician's office, and may, therefore, be counted more than once in the present study.

CONCLUSION

The number of children and youth treated for concussions in both EDs and physician offices increased between 2003 and 2010 in Ontario, Canada. However, over the years, more children were being evaluated in physician offices than EDs. Falls were the greatest broad cause of paediatric concussions, alongside more specific causes such as hockey/skating. Evidence-based prevention programs, including helmet use, fall prevention and recent changes to limit body checking in hockey, may help to reduce the incidence of concussion. Ongoing epidemiological studies can attempt to differentiate between the true incidence of concussion and an increase in health service utilization associated with increased awareness of concussion and subsequent health consequences.

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