NeuroRehabilitation 22 (2007) 191–198
IOS Press

Use of the ICECI and ICD-10 E-Coding structures to evaluate causes of head injury and concussion from sport and recreation participation in a school population

Karl F. Kozlowski[a,*], John J. Leddy[b], Machiko Tomita[c], Anne Bergen[d] and Barry S. Willer[e]
[a]*Department of Exercise and Nutrition Sciences-Program in Athletic Training, State University of New York at Buffalo, Buffalo, NY, USA*
[b]*Department of Orthopedics, State University of New York at Buffalo, Buffalo, NY, USA*
[c]*Department of Rehabilitation Sciences, State University of New York at Buffalo, Buffalo, NY, USA*
[d]*Department of Psychology, University of Guelph, Guelph, Ontario, Canada*
[e]*Department of Psychiatry, State University of New York at Buffalo, Buffalo, NY, USA*

Abstract. The purpose of this study was to identify the most common causes of head injury and associated symptoms of concussion in a population of school children ($n = 1,372,979$). Using standardized injury report forms, we identified the mechanisms of head injury associated with various sports/recreation activities and assessed each injury for the presence of concussion symptoms. Head injury reports ($n = 7,765$) were coded using the WHO's ICECI and ICD-10 E-codes. 1,338 Cases reported symptoms of concussion. The majority of head injuries occurred during School Free-Play/Recess (59.8%). Combative Sports and Wheeled Non-Motored Sports were the activities most often associated with concussion symptoms (rate of concussion (*RC*): 48.3% and 44.4%, respectively, $p < 0.001$). School Free-Play/Recess and Physical Education Classes were significantly less likely to have head injuries associated with concussion (RC: 16.0%, $p < 0.001$, and 12.4%, $p = 0.034$, respectively). The most common causes of head injury were (1) Struck by an Object (24.9%) and (2) Falling on the Same Level (22.8%). Falling from a Transport was the only etiological code significantly associated with concussion symptoms after head injury (RC: 28.7%, p<.001). Results were similar when using the two coding structures in combination. Prevention efforts should focus on activities where children are moving at high speeds since these are more likely to cause a concussion when a head injury occurs.

Keywords: Concussion, sports, ICECI, ICD-10

1. Introduction

Approximately 20 million children in the United States are injured each year at an estimated cost in excess of $347 billion dollars US [9]. Nineteen percent of these injuries occur at school and there are over 2.2 million school days lost annually due to childhood injury [4] with an estimated yearly cost of $47 billion US [9].

Injuries are caused by many factors including falls, being struck by objects, and collisions. Falls have been shown to be responsible for 16% to 55% of all injuries in children [7,10,11,13,14,17,20,21,24,27]. The number of injuries associated with falls peaks in younger children and decreases with maturation [17,19]. Most head injuries are caused by falls [17]. Collisions or contact with an object have been reported to cause 26.8%

*Address for correspondence: Karl F. Kozlowski, Department of Exercise and Nutrition Sciences, Kimball Tower, Room 214A, University at Buffalo, Buffalo, NY 14214, USA. Tel.: +1 716 829 2941, Ext. 282; Fax: +1 716 829 2428; E-mail: kfk@buffalo.edu.

ISSN 1053-8135/07/$17.00

to 43% of injuries [7,13,27].

Childhood injuries are often associated with various modes of transportation, i.e., motor vehicles, bicycles, roller skates, in-line skates, scooters, and skateboards. Some studies have shown that transportation-related mechanisms are second only to falls in terms of contributing to childhood injury [5,24]. Bijur et al. [14], for example, showed that over 48% of childhood injuries were related to the use of bicycles, skates, or skateboards.

Participation in athletic activity is most frequent during the first two decades of life and sports participation is often viewed as an important risk factor for pediatric head injury. Studies have examined both the overall effect of sport and recreation participation on injury as well as from specific sports. A US study of 11,840 children (aged 5–17 years) showed that 36% of all childhood injuries occurred from sport and recreation participation and that injury rates increased with age [5]. Other studies have reported rates of injury from sport and recreation ranging from 10% to 45.5% [7–10, 13–15,19,24].

The settings in which childhood injury occur include the home, schools, playgrounds, and sports arenas/fields. While the home environment is a common site of childhood injury [19,21], several studies have shown that injury is also common in the school setting. Using data from the National Health Interview Survey (NHIS), 19% [1] to 50% [15] of childhood injury has been shown to occur in schools. In other studies, sports facilities have been the reported setting in 9% to 36% of pediatric injury [4,25].

Head trauma and concussions are injuries of great concern in a pediatric population. In their review of the NHIS, Conn et al. [15] found that there were 1.1 million childhood injuries to the head and neck, 17% of which were internal head injuries. Body et al. [3] reported a head injury incidence rate of 13.6% in children ages 14 to 15. Using retrospective maternal injury recalls, Kohen et al. [10] reported head and neck involvement in 9% to 18% of injuries. LaForest et al. [22] reported that 12% of all childhood injuries in a playground setting were concussions, skull fractures, or contusions. In another study, 18% of school based injuries responded to by EMS were to the head, with sports participation being the most frequent contributing factor [20]. Symptoms of concussion have been reported to be present in 13.5% of all school related head injuries [28]. In a study by DiScala et al. [4], 39% of injuries were to the head and neck with 62% of these being classified as concussions.

While multiple studies have reported on the prevalence and incidence of pediatric head injury, little is known about the actual mechanisms of head injury that result in childhood concussions. Identifying which sport activities and what mechanisms within those activities most commonly contribute to head injury and concussion will aid in establishing preventive measures to reduce incidence.

Identifying mechanisms of head injury depends upon how the circumstances of injury are recorded at the time of the incident. Both the International Classification of Diseases External Causes (ICD-10 E-codes) and the International Classification of External Causes of Injury (ICECI) have been used to more accurately describe injury mechanism. The ICECI was drafted in 1999 in response to a call from researchers that the ICD-9 and ICD-10 E-codes on external causes lacked the requisite breadth and depth for designing injury prevention measures [1,5,16]. For example, a report of hospital discharge data on youth injury revealed that there were insufficient data to effectively code using ICD-9 E-codes and that it was difficult to determine the extent and type of sports injuries using the E-codes [2]. Bijur et al. [14] used ICD-9 E-Codes and reported in a sample of 5 to 17 year-olds that almost 30% of sports and recreational injuries were to the head but called for changes in the ICD-9 E-coding scheme because of difficulties determining the extent and type of injury. Furthermore, the two most recent revisions do not specify injury cause to mutually exclusive codes and so may unintentionally "hide" the significance of some mechanisms of injury [23].

Conn et al. [15] studied the Current Population Survey and was one of the first to use the ICECI coding procedure. They found that the ICECI did not have codes for 5.6% of injuries identified in the NHIS. They opined that the current state of research on the utility of these coding schemes is limited and that there should be research on using the ICD-10 E-codes and ICECI in combination [6].

In a prior study, Willer et al. [19] reported a population based study of the incidence of head injuries in a large school age population. The study provided limited information on the cause of injury simply citing whether the injury occurred during a sporting event or from falls etc. The current study uses the same population based data on injuries of children in schools but includes more precise information on the mechanism of injury through the use of ICD-10 E-codes and ICECI codes. One purpose of this study is to describe the mechanisms of head injury and concussion associated with certain types of school related sports and recreational activities. A second purpose of the study was a comparison of the ICD-10 E-codes and ICECI codes to document the mechanism of injury. Past research has shown that injury mechanism is a good indicator of injury severity [12] and that injuries can be prevented with a better understanding of their cause [14].

2. Methods

Injuries were recorded in the year 2000 from a population of Ontario School children aged 6 to 16 years ($n = 1,372,979$). This amounts to 79.5% of all Ontario children aged 6 to 16 years. Census data shows Ontario, as a Canadian province is 78.9% Caucasian with a mean household income of $66,836. Prominent minority group are South Asian, Chinese, and Black at 4.9%, 4.3% and 3.6% of the provincial population respectively. (Adapted from Statistics Canada [http://www.statcan.ca], extracted April 15, 2007) [26].

Evaluating the total number of head injuries reported in this population ($n = 11,068$), 7,765 were related to sports and recreation. The schools involved in this study used the Ontario School Boards Insurance Exchange (OSBIE) as their liability insurer. OSBIE requires the submission of a report to describe each incident, however minor, when a child becomes injured in a school or school related activity. The reports provided the name and demographics of the injured party as well as a narrative description of the injury and its cause including date, time, and location within the school or school property. These narratives were evaluated for the presence of key words representing symptoms of concussion [28]: nausea, memory difficulties, fatigue, dizziness, vision difficulties, ringing in the ears, unconsciousness, incoherence, headache, vomiting, incoordination, disorientation, emotion(al) and convulsion. Each injury report was then coded according to both the ICD-10 E-codes and the ICECI.

Prior to the establishment of the ICD-10 E-codes, the ICD-9 had external cause E-codes as a supplemental entity but these codes were not mutually exclusive. The ICD-10 E-codes are now included in the main body of the coding structure and include the nature and external cause of injury. The pattern of the current E-codes is an alphanumeric combination of a single letter followed by up to three numbers (Ex. W02.03 codes for "fall involving skateboards"). Each cause is based on two axes of code: intent (such as accidental, self-harm, or assault) and mechanism. The mechanism of each injury is coded within each intent category. This is an inherent weakness of the ICD-10 E-codes as it limits the utility of the mechanism as a primary code. After coding according to the major axis, the cause of injury can be additionally coded by activity (sport, leisure, working, vital activities, etc.) and location (home, school, institution, sports area, etc.).

The ICECI has been designed as a "pick and choose" multi-axial hierarchical taxonomic system to be used as a companion to the ICD-10. The intent behind the use of the ICECI is its ability to explain, evaluate, and scrutinize the occurrence of injuries [1]. Used in conjunction, these matrices are designed to code injury causes in very specific terms. The ICECI coding system is comprised of one core module and 5 additional modules. The core module is divided into the following data sets: role of human intent, mechanism of injury, object/substance producing injury, place of occurrence, activity when injured, use of alcohol, and use of other drugs or substances. The five additional modules and their respective number of data sets are comprised of: transport (4 sets), violence (7 sets), place (7 sets), sport (4 sets), and occupational (2 sets) modules. The number of data elements and modules used can be selected depending on the local needs and the resources available, making the ICECI easily adaptable to many data collection opportunities. Using sections as a "pick and choose" matrix the ICECI is considered to be a valid and reliable instrument for coding external causes of injury [3]. The present study focuses on the module and data set dealing with sport.

The ICD-10 E-codes and ICECI codes assigned to each injury were collected into larger coding categories for data analysis purposes. This combination left nine related categories of ICD-10 E-Codes and 16 categories of ICECI codes. The sports of basketball and ice hockey were isolated due to the high number of head injuries in each ($n = 444$ and 219, respectively). Coding groups containing a small number of head injuries ($n < 20$) were excluded from statistical analysis. As a result, the number of head injuries with an ICD-10 E-code ($N = 7765$) and an ICECI code ($N = 7510$) are different.

Descriptive statistics were used to describe the total number of head injuries, total number of those injuries with concussive symptoms, and the rate of concussion for each code. Rate of concussion was calculated as: (Number of injuries with concussive symptoms)/(Number of head injuries) x 100. Chi-square was used to calculate the association between occurrences of the head injury and the concussive symptoms for each code category. Significance of the chi-square statistic meant that the concussion rate for the head injuries of the code being evaluated is significantly higher than for head injuries from all other codes in question. Subsequent standard residuals identified the cells that contributed to the statistical significance. Significance level was set at $p < 0.05$.

After analyzing both coding schemes individually, Chi-square values were calculated for the ICECI codes for basketball and ice hockey, combined with the respective ICD-10 E-codes, and the occurrence of concussion symptoms. Total head injuries and those accompanied by concussion symptoms for each sport were analyzed using the corresponding ICD-10 E-codes for each injury event. Basketball and ice hockey were chosen for this analysis because they contained the largest sport-specific numbers of head injuries. The combination of coding schemes provided a more detailed description of both the activity and mechanism of injury.

3. Results

Using the ICD-10 E-codes, 17.2% of head injuries were accompanied by symptoms of concussion (Table 1). The three leading codes associated with head injury were: being struck by an object (sports equipment and being struck while participating in a variety of activities), falling on the same level (including striking an object with a subsequent fall), and collisions (accidental striking, bumping and kicking with no subsequent fall, not including assaults or intentional contact.). The greatest rate for concussion symptoms was identified in the codes relating to falling from a transport (skateboards, scooters, sleds, snowboards, etc.), unspecified/overexertion categories, and falling from a different level (from chairs, furniture, stairs, playground equipment, etc.). Being struck by an object ($p = 0.038$), falling from ice or snow ($p = 0.043$) and falling from a transport ($p < 0.001$) were the categories that demonstrated an increased risk of having a subsequent concussion when suffering a head injury.

Consistent with the ICD-10 E-codes, the ICECI codes indicated that 16.9% of head injuries were accompanied by symptoms of concussion. As previously noted, a small percentage (3.3%) of head injuries were excluded due to the criteria of requiring a minimal number of head injuries per code (>20) for data analysis. As shown in Table 2, the largest numbers of head injuries were specified by the codes for free play/recess (including non-organized sports activity), other ball sports (American football, soccer, rugby, and volleyball, excluding basketball), basketball, and school physical education class (including non-organized sports activity). The greatest rates for concussion involved the following codes: combative sport (wrestling, self-defense, etc.), wheeled non-motored sports (cycling, rollerblading, roller skating, skateboarding, scooter riding, etc.), acrobatic sports (cheerleading and gymnastics), and other ball sports. Other ball sports ($p = 0.022$), combative sports ($p < 0.001$), and wheeled non-motored sports ($p < 0.001$) were significantly associated with having concussion symptoms with a head injury. Free play/recess ($p < 0.001$) and school physical education class ($p = 0.017$) were negatively correlated with the occurrence of concussion symptoms after head injury (standard residuals $= -1.9$).

An analysis of the basketball ICECI code (1.01) combined with the corresponding ICD-10 E-codes identified 444 head injuries, 19% of which were accompanied by concussion symptoms (Table 3). The top three causes of head injury were identical to those identified by the overall ICD-10 E-codes, i.e., struck by an object, fall on the same level, and collision. The top codes for concussion symptoms were similar to those reported for number of head injuries but in altered order: fall on the same level, struck by an object, and collision. However, no ICD-10 E-code for basketball was associated with a significantly increased risk of concussive symptoms after sustaining a head injury.

Analysis of the hockey ICECI code (2.03) combined with the corresponding ICD-10 codes identified 219 head injuries, 17% of which were accompanied by concussion symptoms (Table 4). The top three causes of head injury were identical to what the ICD-10 codes alone had identified. The highest rates of concussion symptoms were seen in unspecified cause/overexertion, assault, and collisions. The only categories of causation that attained statistical significance for the presence of concussion symptoms after head injury were the unspecified cause/overexertion code ($p = 0.019$) and falling from a transport ($p = 0.036$).

4. Discussion

We found that the rates of children with symptoms of concussion after sustaining a head injury were similar in both coding structures. It was shown that these rates as identified by both the ICD-10 E-codes and ICECI coding systems were 17.2% and 16.9%, respectively.

Table 1
Injuries by ICD-10 E-code

ICD-10 E-Code	Head Injuries (n)	% of Total	Concussions (n)	Concussion Rate (%)	Rank by Symptoms	p-value
Struck by an Object	1930	24.86	307	15.91	8	**0.038**
Fall from Same Level	1769	22.78	305	17.24	6	0.495
Collisions	1266	16.30	230	18.17	4	0.168
Struck by a person	914	11.77	148	16.19	7	0.188
Fall from a Level	791	10.19	144	18.20	3	0.222
Fall from Ice or Snow	543	6.99	79	14.55	9	**0.043**
Assaults	236	3.04	42	17.80	5	0.408
Fall from a Transport	233	3.00	67	28.76	1	**<0.001**
Unspecified/Overexertion	83	1.07	16	19.28	2	0.31
Totals	7765		1338			

Table 2
Injuries by ICECI code

ICECI Code	Head Injuries (n)	% of Total	Concussions (n)	Concussion Rate (%)	Rank by Symptoms	p-value
Free-Play/Recess	4489	59.77	720	16.04	12	**<0.001**
Other Ball Sports	1045	13.91	203	19.43	4	**0.022**
Basketball	444	5.91	83	18.69	5	0.201
Phys-Ed Class	266	3.54	33	12.41	16	**0.017**
Other Specified Sport/Exercise	262	3.49	46	17.56	9	0.444
Ice Hockey	219	2.92	38	17.35	10	0.481
Unspecified Sport/Exercise	203	2.70	29	14.29	13	0.13
Other Stick Bat Sports	186	2.48	32	17.20	11	0.496
Individual Athletic Activity	168	2.24	31	18.45	6	0.336
Acrobatic Sport	47	0.63	10	21.28	3	0.231
Ice Snow Sports	45	0.60	6	13.33	14	0.244
Racquet Sport	34	0.45	6	17.65	8	0.475
Combative Sport	29	0.39	14	48.28	1	**<0.001**
Wheeled Non-motor sport	27	0.36	12	44.44	2	**<0.001**
Aesthetic Activity	24	0.32	3	12.50	15	0.27
Power Sport	22	0.29	4	18.18	7	0.453
Totals	7510		1270			

These results are similar to the 17.2% internal head injury rate previously described by Conn et al. [15] in a study of sports related injuries using the NHIS. It is also comparable to the 14.1% traumatic brain injury rate Hostetler et al. [18] reported in their analysis of brain injury in ice hockey.

The ICD-10 E-codes alone revealed that when a child falls from a transportation device, such as roller skates, skateboards or scooters, there is a much greater chance of sustaining a concussion with head injury (29%). This risk may be explained by considering the increased speed involved with using a transportation device. For example, a child on a skateboard is typically moving faster when compared with walking or running. Head injury is more likely to result in concussive symptoms when contact to the head follows the child moving at high speed as opposed to smaller projectiles moving at high speeds. The ICD-10 E-codes revealed that being struck by an object caused the greatest number of head injuries ($n = 1,930$) yet it had one of the lowest rates of concussion (16%, $p = 0.038$). Ice and snow related falls also showed increased chance of sustaining a concussion ($p = 0.043$). It is postulated that this is from the use of sleds, toboggans, and ice skates on these surfaces which again lead to increased velocity of the child.

The ICECI codes alone identified three activities associated with a significantly greater chance for developing concussion symptoms when a child sustains a head injury: combative sports (boxing and wrestling), wheeled non-motored sports (using a scooter or skateboard), and other ball sports (football, soccer, rugby and volleyball). Consistent with the results using the ICD-10 E-codes, wheeled non-motored transportation based activities with their related increased speed have a greater incidence of head injury with concussion symptoms. Combative sports also have a high velocity component in the speed generated either during a strike or when a person is forcefully thrown to the ground.

Table 3
Basketball Head Injuries and Concussions by ICD-10 E-codes

ICD-10 E-Code	Head Injuries (n)	% of Total	Concussions (n)	Concussion Rate (%)	Rank by Symptoms	p-value
Struck by an Object	141	31.76	28	19.86	2	0.19
Fall from Same Level	111	25.00	23	20.72	1	0.154
Collisions	91	20.50	17	18.68	3	0.283
Struck by a person	87	19.59	14	16.09	4	0.15
Unspecified/Overexertion	8	1.80	1	12.50	5	0.271
Fall from a Level	3	0.68	0	0.00	6	0.269
Fall from Ice or Snow	2	0.45	0	0.00	6	0.331
Assaults	1	0.23	0	0.00	6	0.407
Totals	444		83			

Table 4
Ice Hockey Head Injuries and Concussions by ICD-10 E-codes

ICD-10 E-Code	Head Injuries (n)	% of Total	Concussions (n)	Concussion Rate (%)	Rank by Symptoms	p-value
Struck by an Object	97	44.29	13	13.40	4	0.058
Fall from Same Level	46	21.00	6	13.04	5	0.132
Collisions	43	19.63	10	23.26	3	0.089
Struck by a person	23	10.50	3	13.04	5	0.204
Unspecified/Overexertion	5	2.28	3	60.00	1	**0.019**
Fall from a Transport	3	1.37	2	0.00	6	**0.036**
Assaults	2	0.91	1	50.00	2	0.159
Totals	219		38			

The category of "other ball sports" was one of the most frequent settings for both sustaining a head injury and having a concussion. This suggests a variety of potential injury prevention strategies that can be instituted. These strategies include increased endorsement of the benefits of protective equipment, new rule development and enforcement, and assurance of proper training techniques for those participating in ball sports. A reduction in the number of head injuries from this activity could well reduce the overall severity of head injuries sustained in a pediatric population.

The ICECI codes related to free-play/recess and physical education classes were significantly negatively associated with the development of concussion symptoms after a head injury. It may be that the unstructured nature of these sport/play experiences reduces the intensity of the activity and concurrently reduce the risk for head injury and concussion. It may be that children choose safer activities, or choose to partake in activities they feel most comfortable with, when left to their own devices.

The ICECI codes for basketball and ice hockey were isolated from their nested groups on the basis that these codes provided a large number of injuries within each of their categories. Basketball was originally included in the ball sport group and ice hockey in the stick/bat sport group. After considering the popularity of ice hockey in Canada, it may seem odd that the incidence of head injury and concussion for basketball was higher than for ice hockey. When considering a Canadian youth population, however, it is important to understand that although ice hockey is popular in Canada it is commonly played within community based organizations other than schools.

The proposition that the ICD-10 E-codes and the ICECI could be used in conjunction to identify particular causes of injury with greater specificity is worthy of investigation. After identifying the two ICECI codes for basketball and hockey, the ICD-10 E-codes were applied to that data. No significant trends were identified when we combined the codes, however, and the rates were similar to the overall ICD-10 E-code rates presented previously. The ICD-10 E-codes that were significantly associated with an increased occurrence of concussion symptoms were the unspecified/overexertion mechanism and falling from a transport within ice hockey. Not much can be extracted from this result based upon the fact that these codes were responsible for describing a very small number of head injuries and concussions.

The utility of using the ICD-10 E-codes and ICECI codes in combination requires further study. As causes of injury are classified with increasing specificity within individual coding structures, identification measures will require larger populations to demonstrate statistical significance. It is conceivable that coding injuries by both mechanism (ICD-10 E-codes) and activity (ICECI) will, however, mitigate the need for larger sample sizes while simultaneously increasing the specificity of identification. Such a coding strategy could provide valuable information in terms of injury prevention and cost reduction, especially among a pediatric population. This approach has the potential to identify injury mechanisms operative in other activities and in other populations to see if there are mechanisms unique to the school sport and recreation setting.

An inherent weakness in the present work concerns the use of the injury reports. The reports were originally submitted by a faculty or staff member from the child's school. These individuals may not have the training to correctly and completely record all the pertinent information needed for injury diagnosis and causation coding. Thus each report had to be reviewed retrospectively for diagnostic and coding purposes. Improved reporting at the school level could help to identify more symptoms and decrease the number of injuries coded within unspecified categories.

In conclusion, we have shown that there are certain aspects of sport and recreation participation in schools that are responsible for increasing the potential for concussion after pediatric head injury. Activities involving high speed impacts are more likely to cause symptoms of concussion whereas allowing children their own choice of activity is less likely to produce concussion symptoms after head injury. School officials and medical personnel should be aware of and be careful to appropriately evaluate head injuries in children, especially when the injuries occur in activities that are more likely to cause a cerebral concussion.

References

[1] International Classification of External Causes of Injuries (ICECI) version 1.1a Volume 1: Tabular Lists. Amsterdam Adelaide: Consumer Safety Institute AIHW National Injury Surveillance Unit, 2003.

[2] P.F. Agran, D. Winn, C. Anderson, R. Trent and L. Walton-Haynes, Rates of pediatric and adolescent injuries by year of age, *Pediatrics* **108**(3) (Sep. 2001), E45.

[3] J.L. Annest and C.L. Pogostin, *CDC's Short Version of the ICECI: International Classification of External Causes of Injuries: A pilot test*, Atlanta: Centers for Disease Control and Prevention; 2000.

[4] C. Ardern, W. Pickett, M.A. King and W.F. Boyce, Injury in Canadian youth: a brief report from the Health Behaviour in School-Aged Children Survey, *Canadian Journal of Public Health* **92**(3) (May-Jun. 2001), 201–203.

[5] P.E. Bijur, A. Trumble, Y. Harel, M.D. Overpeck, D. Jones and P.C. Scheidt, Sports and recreation injuries in US children and adolescents, *Arch Pediatr Adolesc Med* **149**(9) (Sep. 1995), 1009–1016.

[6] A. Bloemhoff and S. Mulder, *Testing ICECI: Review and Field Testing*, Amsterdam: Consumer Safety Institute; 2000.

[7] C. Body and J. Leathem, Incidence and aetiology of head injury in a New Zealand adolescent sample, *Brain Inj* **10**(8) (Aug. 1996), 567–573.

[8] J.M. Conn, J.L. Annest and J. Gilchrist, Sports and recreation related injury episodes in the US population, 1997–1999, *Inj Prev* **9**(2) (Jun. 2003), 117–123.

[9] E.R. Danseco, T.R. Miller and R.S. Spicer, Incidence and costs of 1987-1994 childhood injuries: demographic breakdowns, *Pediatrics* **105**(2) (Feb. 2000), E27.

[10] C. Di Scala, S.S. Gallagher and S.E. Schneps, Causes and outcomes of pediatric injuries occurring at school, *J Sch Health* **67**(9) (Nov. 1997), 384–389.

[11] M.S. Durkin, S. Olsen, B. Barlow, A. Virella and E.S. Connolly, Jr. The epidemiology of urban pediatric neurological trauma: evaluation of, and implications for, injury prevention programs, *Neurosurgery* **42**(2) (Feb. 1998), 300–310.

[12] G.D. Evans and S.B. Sheps, The epidemiology of school injuries: the problem of measuring injury severity, *J Community Health* **12**(4) (Winter 1987), 246–256.

[13] H. Gibson and T.P. Klassen, How safe are our schools? *Can J Public Health* **87**(2) (Mar–Apr. 1996), 106–108.

[14] S.J. Hambidge, A.J. Davidson, R. Gonzales and J.F. Steiner, Epidemiology of pediatric injury-related primary care office visits in the United States, *Pediatrics* **109**(4) (April, 2002), 559–565.

[15] A. Hammarstrom and U. Janlert, Epidemiology of school injuries in the northern part of Sweden, *Scand J Soc Med* **22**(2) (Jun. 1994), 120–126.

[16] J. Harrison, Injury Classification: Balancing Continuity and Utility (ICECI and its Compatibility with ICD-10), in: *Organization* W.H., ed., Cardiff, Wales 1999.

[17] E.B. Hendrick, D.C. Harwood-Hash and A.R. Hudson, Head injuries in children: a survey of 4465 consecutive cases at the hospital for sick children, Toronto, Canada, *Clin Neurosurg* **11** (1964), 46–65.

[18] S.G. Hostetler, H. Xiang and G.A. Smith, Characteristics of ice hockey-related injuries treated in US emergency departments, 2001–2002, *Pediatrics* **114**(6) (Dec. 2004), e661–666.

[19] M.A. King, W. Pickett and A.J. King, Injury in Canadian youth: a secondary analysis of the 1993–1994 Health Behaviour in School-Aged Children Survey, *Can J Public Health* **89**(6) (Nov–Dec. 1998), 397–401.

[20] S. Knight, D.D. Vernon, R.J. Fines and N.P. Dean, Prehospital emergency care for children at school and nonschool locations, *Pediatrics* **103**(6) (Jun. 1999), e81.

[21] D.E. Kohen, H. Soubhi and P. Raina, Maternal reports of child injuries in Canada: trends and patterns by age and gender, *Inj Prev* **6**(3) (Sep. 2000), 223–228.

[22] S. Laforest, Y. Robitaille, D. Dorval, D. Lesage and B. Pless, Severity of fall injuries on sand or grass in playgrounds, *J Epidemiol Community Health* **54**(6) (Jun. 2000), 475–477.

[23] J. Langley and D. Chalmers, Coding the circumstances of injury: ICD-10 a step forward or backwards, *Injury Prevention* **5** (1999), 247–253.

[24] P.M. Peloso, H. von Holst and J. Borg, Mild traumatic brain injuries presenting to Swedish hospitals in 1987–2000, *J Rehabil Med* (43 Suppl) (Feb. 2004), 22–27.

[25] W. Pickett, R.J. Brison, S.G. Mackenzie, M. Garner, M.A. King, T.L. Greenberg et al., Youth injury data in the Canadian Hospitals Injury Reporting and Prevention Program: do they represent the Canadian experience? *Inj Prev* **6**(1) (Mar. 2000), 9–15.

[26] Statistics Canada, 2003. Profile – Ontario(table). Provincial & Territorial Profiles. 2001 Census. Statistics Canada Catalogue no. 94F0046XIE Ottawa. http://www12.statcan.ca/english/census01/products/standard/prprofile/index.cfm (accessed April 15, 2007).
[27] A. Vorko-Jovic, M. Rimac, F. Jovic, M. Strnad and D. Solaja, Epidemiological investigation of school-related injuries in Koprivnica County, Croatia, *Croat Med J* **42**(1) (Feb. 2001), 58–63.
[28] B. Willer, J. Dumas, A. Hutson and J. Leddy, A population based investigation of head injuries and symptoms of concussion of children and adolescents in schools, *Inj Prev* **10**(3) (Jun. 2004), 144–148.