

Trends in Emergency Department Reported Head and Neck Injuries Among Skiers and Snowboarders

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ABSTRACT

Background: Reports from the U.S. suggest increases in the proportion and rate of head and neck injuries in skiers and snowboarders. It is important to determine if the same is true in Canada.

Methods: Skiers and snowboarders (<18 years) presenting to 16 selected emergency departments from 1991 to 1999 were assigned one body region of injury in the following order: i) brain and spine-spinal cord, ii) head and neck, iii) face, iv) other body region (i.e., controls). Crude and adjusted (age, gender, helmet use and hospital admission) odds ratios indicating the proportion of head, brain, face, and neck injury relative to controls by calendar year were estimated. Injury rates were examined for 12 to 17 year olds over the last 4 years of the study.

Results: Compared with 1997-1999, there was a lower proportion of skier head injuries from 1991-93 (adjusted odds ratio (AOR)=0.16; 95% Confidence Interval (CI)=0.09-0.30) and from 1995-97 (AOR=0.71; 95% CI=0.49-1.04). The proportion of skier brain injuries was lower from 1993-95 (AOR=0.69; 95% CI=0.44-1.07) and from 1995-97 (AOR=0.56; 95% CI: 0.35-0.91). In snowboarders, however, compared with 1997-99, there was evidence that although the proportion of head injuries was lower from 1991-93 (AOR=0.19; 95% CI=0.05-0.80), the opposite was true for facial injuries. For 12 to 17 year olds, skier brain and snowboarder head and neck injury rates increased from 1995-99.

Conclusions: The results suggest that head and brain injuries in skiers and head and neck injuries in snowboarders may be increasing, particularly in adolescents.

La traduction du résumé se trouve à la fin de l'article.

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Head and neck injuries in skiers and snowboarders can be a serious problem, particularly among younger participants.¹⁻⁵ Some evidence suggests these injuries may be increasing as a proportion of all injuries^{2,3,6} and in their rate of occurrence.^{3,6} However, none of the reports suggesting increasing trends have simultaneously accounted for changes in the age, sex, or activity distribution of injured participants, and thus the possibility of confounding by these factors remains.

To determine head and neck injury trends among young Canadian skiers and snowboarders, we examined data from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) surveillance system.

METHODS

The CHIRPP injury surveillance system began in 1990 at 10 children's hospitals, and 6 general hospitals joined the system between 1991 and 1994.⁷ Injury event information (e.g., where and when the injury occurred, what caused the injury) is self-reported by the individual or his/her parent on a standard form upon presentation to the emergency department. As many as 3 injury locations and diagnoses are recorded on the form by the attending emergency department physician. We restricted the age to those under 18. Early evaluations of CHIRPP suggested a case-capture rate between 30 and 91% at 4 hospitals⁸ while for the 14 hospitals with available data as of 1996, the median CHIRPP capture rate was 88% (range: 24%-100%).⁷ An evaluation of the CHIRPP system indicated that missed and captured individuals had similar demographic characteristics (e.g., age and sex) while missed individuals were more likely to be admitted to hospital and to present during the night.⁸

This investigation is characterized as a case-control study based on existing CHIRPP injury surveillance data. We defined 4 case groups comprised of skiers and snowboarders with a head, brain, face, or neck injury. Injuries involving the brain (i.e., concussion or worse) or cervical spine or spinal cord, were considered the most severe and were coded as brain and neck injuries, respectively. The sample was too small to separate cervical spine-spinal cord

TABLE I

Time Trends in the Proportion of Head, Brain, Face and Neck Injuries Relative to Control* Injuries in Skiers and Snowboarders Under Age 18

	Head Injuries		Brain Injuries		Face Injuries		Neck‡ Injuries		Control*
		OR (95% CI)		OR (95% CI)		OR (95% CI)		OR (95% CI)	
Skiers									
1991-92 and 1992-93	13	0.16§ (0.09,0.30) 0.16 (0.09,0.30)	48	0.86§ (0.56,1.32) 1.07 (0.69,1.66)	129	1.59§ (1.16,2.17) 1.57 (1.15,2.15)	42	0.80§ (0.51,1.26) 0.86 (0.55,1.35)	1308
1993-94 and 1994-95	94	0.93§ (0.67,1.30) 0.92 (0.66,1.28)	45	0.64§ (0.42,0.99) 0.69 (0.44,1.07)	139	1.36§ (1.0,1.85) 1.35 (0.99,1.84)	53	0.80§ (0.53,1.23) 0.84 (0.55,1.28)	1649
1995-96 and 1996-97	58	0.71§ (0.49,1.04) 0.71 (0.49,1.02)	30	0.53§ (0.33,0.86) 0.56 (0.35,0.91)	103	1.25§ (0.90,1.73) 1.24 (0.90,1.71)	45	0.85§ (0.55,1.32) 0.88 (0.57,1.35)	1326
1997-98 and 1998-99	69	1.0†	48	1.0†	70	1.0†	45	1.0†	1127
Snowboarders									
1991-92 and 1992-93	2	0.20§ (0.02,0.75) 0.19 (0.05,0.80)	8	1.34§ (0.58,2.98) 1.49 (0.68,3.27)	12	3.23§ (1.55,6.63) 3.25 (1.64,6.45)	4	0.96§ (0.25,2.72) 0.98 (0.34,2.79)	174
1993-94 and 1994-95	23	0.75§ (0.46,1.23) 0.75 (0.47,1.20)	19	1.06§ (0.60,1.85) 1.28 (0.74,2.22)	18	1.61§ (0.86,2.98) 1.61 (0.89,2.91)	15	1.20§ (0.62,2.27) 1.25 (0.67,2.31)	524
1995-96 and 1996-97	46	0.85§ (0.58,1.24) 0.83 (0.58,1.20)	34	1.06§ (0.67,1.68) 1.17 (0.74,1.83)	42	2.11§ (1.29,3.43) 2.12 (1.33,3.40)	13	0.58§ (0.29,1.14) 0.60 (0.31,1.13)	934
1997-98 and 1998-99	90	1.0†	53	1.0†	33	1.0†	37	1.0†	1545

* Control injuries include upper and lower extremity and trunk injuries only

† Reference category against which other levels of determinant are compared

‡ Neck, spine, and spinal cord injuries

§ Crude (unadjusted)

|| Adjusted for age (under 12; 12-17), gender, hospital admission (yes or no); and helmet use (yes or no)

injuries and other neck injuries. Injuries involving the head, head and face, or head and another body part (excluding the brain, neck, and spine or spinal cord) were coded as head injuries. Those with a head and neck injury (excluding the spine or spinal cord) were classified according to the more severe (the first listed on the CHIRPP form). Therefore, each case is represented only once in the database (i.e., by a single body region of injury).

Controls were skiers and snowboarders with any of an upper extremity (clavicle and scapula to hand), lower extremity (hip to foot), or trunk injury, without an accompanying head, brain, face or neck injury.

To measure rates, estimates of the number of skiers and snowboarders in Canada were obtained from the Canadian Ski Council (CSC) from 1995-96 through 1998-99. Since 1994, the CSC regularly contracts surveys by the Print Measurement Bureau (PMB) to estimate the characteristics of the Canadian ski and snowboard population.^{9,10} We used data from the 1994-96 survey to estimate the number of Canadian skiers and snowboarders (i.e., rate denominators) in the 1995-96 season. The next 3 surveys were conducted from October 1995 through September 1997 (1996-97 season rate denominators), October 1997 to September 1998 (1997-98 season rate denominators), and October 1997 to September 1999 (1998-99 season rate denominators).

Analysis

Using logistic regression, we modeled temporal changes in the odds of a head injury (i.e., 1 if head injured; 0 otherwise) relative to upper extremity, lower extremity, and trunk injuries. This analysis was repeated for brain, face, and neck injuries. The data were grouped into 4 two-year periods to examine trends. Crude and adjusted (age: <12, 12-17; gender, helmet use and patient disposition, i.e., admitted to hospital or treated and released) odds ratios (ORs) are presented comparing each two-year period with the reference period (1997-98 and 1998-99), separately for skiers and snowboarders, along with 95% confidence intervals (CIs). Odds ratios represent actual changes in the odds (or probability through the equation $\text{probability} = \text{odds}/(\text{odds} + 1)$) of head, brain, face, and neck injuries in a particular 2-year period relative to the reference period 1997-98 to 1998-99.

To examine changes in injury rates (i.e., injuries per 1000 participants), we compared the 1995-96 and 1996-97 seasons with the 1997-98 and 1998-99 seasons for skier and snowboarder head, brain, neck, face, and "control" (i.e., upper and lower extremity, and trunk) injuries. Rate ratios (RRs) with 95% CIs were used to estimate trends over the last 4 years of the study for the 12 to 17 age group, which is the youngest age grouping used by the CSC.

The study was approved by the McGill Institutional Review Board.

RESULTS

There were 6,562 injured skiers and 3,668 injured snowboarders under 18 captured by the CHIRPP system from October 1991 to July 1999. Over 80% of snowboarders were between 12 and 17 and 79% were male. Fifty-four percent of skiers were between 12 and 17 years and 55% were male. Four percent of skiers and 3% of snowboarders wore helmets. Approximately 12% of both skiers and snowboarders were hospitalized.

Trends in proportions

Table I examines the trends in the odds of a head, brain, face, and neck injury with calendar time for skiers and snowboarders. In skiers, the odds of a head injury increased after the 1992-93 season, decreased after 1994-95, and then increased again after 1996-97. The adjusted odds of a head injury was 29% lower in 1995-97 compared with 1997-99 (adjusted odds ratio (AOR): 0.71; 95% Confidence Interval (CI): 0.49-1.02). The odds of a skier brain injury steadily decreased through 1997 and then increased. The odds of a skier brain injury was significantly lower in 1995-97 compared with 1997-99 (AOR: 0.56; 95% CI: 0.35-0.91). The odds of a skier facial injury steadily decreased over the 1990s. There was little evidence of a trend in the odds of a skier neck, spine and spinal cord injury, but the odds were lower in all years prior to 1997-99.

TABLE II

Comparison of 1995-96 and 1996-97 with 1997-98 and 1998-99 Body Region-specific Incidence Rates for Skiers and Snowboarders in the 12 to 17 Year Age Group

Activity and Body Region	1995-96 and 1996-97 Injuries (i.e., rate numerator)	1995-96* and 1996-97† Estimated Participants (i.e., rate denominator)	1995-97 Rate Per 100,000 Participants	1997-98 and 1998-99 Injuries (i.e., rate numerator)	1997-98‡ and 1998-99§ Estimated Participants (i.e., rate denominator)	1997-99 Rate Per 100,000 Participants	Rate Ratio (95% CI) (1997-99 / 1995-97)
Skiers							
Head	32	1,436,000	2.23	34	1,114,000	3.05	1.37 (0.85,2.22)
Brain	21	1,436,000	1.46	31	1,114,000	2.78	1.90 (1.09,3.31)
Face	49	1,436,000	3.41	37	1,114,000	3.32	0.97 (0.64,1.49)
Neck¶	23	1,436,000	1.60	24	1,114,000	2.15	1.35 (0.76,2.38)
Control**	690	1,436,000	48.05	543	1,114,000	48.74	1.01 (0.91,1.14)
Snowboarders††							
Head	39	697,000	5.60	71	801,000	8.86	1.58 (1.07,2.34)
Brain	30	697,000	4.30	45	801,000	5.62	1.31 (0.82,2.07)
Face	29	697,000	4.16	21	801,000	2.62	0.63 (0.36,1.10)
Neck¶	8	697,000	1.15	31	801,000	3.87	3.37 (1.55,7.34)
Control**	791	697,000	113.49	1268	801,000	158.30	1.39 (1.28,1.52)

* Canadian Ski Council Print Measurement Bureau Survey for 1995-96 based on approximately 20,000 homes and completed over the time period October 1994 through September 1996

† Canadian Ski Council Print Measurement Bureau Survey for 1996-97 based on approximately 22,000 homes completed over time period October 1995 through September 1997

‡ Canadian Ski Council Print Measurement Bureau Survey for 1997-98 based on approximately 20,000 homes completed over the time period October 1997 through September 1998

§ Canadian Ski Council Print Measurement Bureau Survey for 1998-99 based on approximately 24,000 homes completed over time period October 1997 through September 1999

|| Canadian Ski Council Print Measurement Bureau data estimates 1,436,000 Canadian skiers for the two seasons 1995-96 and 1996-97 and 1,114,000 Canadian skiers for the two seasons 1997-98 and 1998-99

¶ Neck, spine, and spinal cord injuries

** Upper extremity, lower extremity, and trunk injuries only

†† Canadian Ski Council Print Measurement Bureau data estimates 697,000 Canadian snowboarders for the two seasons 1995-96 and 1996-97 and 801,000 Canadian snowboarders for the two seasons 1997-98 and 1998-99

The odds of a snowboarder head injury steadily increased through 1998-99 although only the 1991-93 with 1997-99 comparison confidence limits excluded the null value (AOR: 0.19; 95% CI: 0.05-0.80). There was a steady decline in the odds of a snowboarder brain injury, but none of the 2-year point estimates were statistically significant. The odds of a snowboarder facial injury declined after the first 2-year period, increased after 1994-95, and then decreased in the final 2-year period. There was no monotonic trend in the odds of a snowboarder neck, spine and spinal cord injury evident in the 2-year period comparisons, although the odds were lower in 1995-97 compared with 1997-99 (AOR: 0.60; 95% CI: 0.31-1.13).

Trends in rates

Table II provides information on changes in the rate of body region-specific injuries for 12 to 17 year old skiers and snowboarders from 1995-96 through 1998-99. The rates of skier brain (Rate Ratio (RR): 1.9; 95% CI: 1.09-3.31) and snowboarder head (RR: 1.58; 95% CI: 1.07-2.34) injury increased, as did the rates of snowboarder neck, spine, and spinal cord (RR: 3.37; 95% CI: 1.55-7.34) and snowboarder other (RR: 1.39; 95% CI: 1.28-1.52)

injuries. The confidence limits for other estimated changes included the null value of 1.0.

DISCUSSION

These results raise concern over the proportion and rate of skier and snowboarder head, brain, and neck injuries, particularly in adolescents. Although many of the trends were not monotonic over the entire period, the consistency of the logistic regression and rate analyses indicate a significant increase in head, brain, and neck injuries over the last 4 years of the investigation.

Evidence from the United States^{2,3,6} also suggests the proportion and rate of head and neck injuries may be increasing among skiers and snowboarders. Diebert et al. found an increase in the proportion of head injuries in child and adolescent skiers comparing 1981-87 with 1987-1994,³ as did the US Consumer Product Safety Commission (CPSC) between 1993 and 1997 for skiers and snowboarders of all ages combined.² The Diebert et al. data also indicate that the rate of skier head and spine injuries per 1000 skier visits increased in both children and adolescents when comparing 1972-73 with 1993-94.³

Similarly, Davidson and Laloties noted that the rate of ski patrol reported head, neck, and facial injuries increased from 1983 to 1992 for all ages combined.⁶ Our results echo the U.S. findings.

Data from many investigations suggest an association between collisions and head injuries in snowboarders¹¹ and skiers.¹²⁻¹⁹ With the greater acceptance of snowboarders at ski areas through the 1990s, skier-snowboarder interactions might have resulted in more collisions. Burtscher and Philadelphia found that 80% of snowboarders involved in collisions resulting in injury were "collision causers".¹²

Run grooming allows faster speeds and subsequent high energy impact injury.^{20,21} A strong, inverse correlation has been found between grooming hours and skier injuries in a Norwegian study.²⁰ Thus, run grooming may also contribute to the trends found in our investigation.

The increasing rate of neck, spine, and spinal cord injuries among adolescent (12 to 17 years) snowboarders may be the result of changes in the characteristics of participants. Inexperienced child snowboarders at the beginning of the 1990s may now be more daring, experienced adolescents. The increase in these injuries may thus be the result of a shift over the course

of the decade toward more advanced ability snowboarders attempting dangerous maneuvers. This is consistent with the findings of Tarazi et al. suggesting a link between jumping and spinal injuries in snowboarders,²² as well as work demonstrating an association between higher ability and injury severity in snowboarders under age 18.⁴

Limitations

For a change in the proportion of head injuries to indicate a change in the rate, we made the assumption that the rate of other injuries did not decrease over time. If the rate of other injuries decreased, this could account for the increasing trends in the proportion of head and neck injuries. Our comparisons, however, indicate no change in the rate of non-head, non-neck, spine and spinal cord injuries in skiers, and an actual increase in the rate of these injuries for snowboarders over the last 4 years of the study. Other investigators have also found no decline in the rate of skier lower leg injuries over an 11-year period ending in 1998.²³ It is unlikely then that changes in the rate of other injuries account for the reported trends.

Many injuries are reported only to the ski patrol, others to walk-in clinics or private physician offices. Still others are admitted directly to hospital, by-passing the emergency departments where CHIRPP data are collected. For these reasons, the absolute rates are surely underestimated as they reflect only those injuries presenting to 1 of 16 emergency departments across Canada. It is unlikely, however, that a failure to identify all cases each year or the hills at which they were injured, would influence trends over time.

Although some factors (e.g., age) related to CHIRPP case-capture have been identified,^{8,24} it is unlikely that these factors influenced temporal trends. In addition, we adjusted for the effect of age and hospital admission, making case-capture an unlikely explanation for the results.

The unadjusted odds ratios changed little when adjusted for age, gender, helmet use, and patient disposition. The rate comparisons were adjusted for activity and age through stratification and restriction, respectively. Other unmeasured factors such as ability, skiing or snowboarding frequency (e.g., skier or snowboarder visits),

as well as environmental factors, that may have changed with calendar year, however, cannot be excluded as possible explanations for the trends.

CONCLUSIONS

Our results call attention to the problem of skier and snowboarder head and neck injuries, particularly in adolescents. Irrespective of the trends noted, the proportion of head, brain, and face injuries is unacceptably high – from 11.4% to 17.5% in skiers and from 8.9% to 13.7% in snowboarders. As these injuries often have serious consequences, including death^{11,13,14,18,19,22,25-27} or permanent disability,^{11,15,19,22,28} additional preventive measures are urgently needed.

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RÉSUMÉ

Contexte : Des études américaines ont relaté une augmentation du taux de blessures à la tête et au cou chez les skieurs ainsi que chez les surfeurs des neiges. La présente étude tente de savoir s'il en est de même au Canada.

Méthode : Des skieurs et des surfeurs des neiges (<18 ans) provenant d'une des 16 urgences sélectionnées pour la période allant de 1991 à 1999 ont été classés d'après les blessures corporelles suivantes : i) au cerveau et à la colonne vertébrale, ii) à la tête et à la nuque, iii) au visage et iv) à d'autres parties du corps (population témoin). Les rapports de cotes bruts et ajustés (âge, sexe, port du casque, hospitalisation) indiquant la proportion de blessures à la tête, au cerveau, au visage et à la nuque en comparaison de la population témoin ont été estimés par année civile. Les taux de blessures ont été suivis pendant les quatre dernières années de l'étude pour le segment des 12 à 17 ans.

Résultats : Par rapport à la période 1997-1999, on retrouvait une moindre proportion de blessures à la tête chez les skieurs en 1991-1993 (rapport de cote (RDC) = 0,16; intervalle de confiance [IC] de 95 % = 0,09-0,30) et en 1995-1997 (RDC = 0,71; IC de 95 % = 0,49-1,04). La proportion de blessures au cerveau chez les skieurs était la plus faible pour les périodes de 1993-1995 (RDC = 0,69; IC de 95 % = 0,44-1,07) et de 1995-1997 (RDC = 0,56; IC de 95 % = 0,35-0,91). Pour le groupe des surfeurs des neiges, par contre, en comparaison de la période 1997-1999, malgré qu'une proportion plus faible de blessures à la tête ait été observée en 1991-1993 (RDC = 0,19; IC de 95 % = 0,05-0,80), on constate les résultats inverses quant aux blessures faciales. Chez les 12-17 ans, les taux de blessures au cerveau chez les skieurs, et à la tête et la nuque chez les surfeurs des neiges, ont augmenté de 1995 à 1999.

Conclusions : Ces résultats suggèrent que le nombre de blessures à la tête et au cerveau chez les skieurs, de même que les blessures à la tête et à la nuque chez les surfeurs des neiges, sont en hausse, particulièrement chez les adolescents.

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