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ORIGINAL RESEARCH

Hospital-Treated Snow Sport Injury in Victoria, Australia: A Summary of 2003–2012

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Introduction—To determine the incidence rate and changes over time for ice and snow sports injury in Victoria, Australia, from 2003 to 2012 and describe the most common types and causes of these injuries.

Methods—Retrospective data from the Victorian Injury Surveillance Unit describing hospital admissions and emergency department presentations were extracted for the 10-year period of 2003 to 2012 for all ice- and snow-related injury. Descriptive injury data and participation-adjusted trend analyses using log-linear regression modelling of data (statistical significance, $P<0.05$) from the Exercise, Recreation and Sport Survey 2003 to 2010 are presented.

Results—Overall, there were 7387 ice- and snow-related injuries, with a significant increase in hospital-treated snowboard injuries and a (nonsignificant) decline in hospital-treated ski injuries over the 10 years. Skiing (39%) and snowboarding (37%) had the highest incidence of hospital-treated injury, with males aged 15 to 24 years injured most frequently in both sports. Falls were the most common cause of injury in both skiing (68%) and snowboarding (78%).

Conclusions—Patterns of snow sports injury in Australia during 2003 to 2012 remain similar to findings of national studies conducted decades earlier. More importantly, however, Australian injury patterns are comparable to international statistics and thus may be generalizable internationally. Head injuries, although infrequent, are associated with great injury severity due to a high frequency of hospitalization. Furthermore, research into the use of personal protective equipment and other injury prevention measures among Australian participants, particularly by young, male snowboarders, is required. Given the similar injury patterns, injury prevention measures implemented internationally could reasonably translate to an Australian setting.

Keywords: recreation, sports medicine, epidemiology

Introduction

Snow sports, including skiing (eg, alpine and Nordic), snowboarding, and recreational snow play, are popular winter activities, with 70 million people participating worldwide.[1] Australian snow resorts, which are predominantly located in the southeastern states of New South Wales and Victoria, record an estimated 3 million visitor-days per year. Approximately 2 million of these visits involve resort-lifted activities, such as downhill skiing and snowboarding.[2] The Australian ski industry attracts a large number of national and international visitors and makes a significant economic contribution to Australian tourism each year.[2] Given the popularity of snow sports, obtaining an understanding of the injury risks involved in these activities and developing strategies to minimize them would have benefits for the individual and for the broader snow sports industry.

Although published studies describing snow sports injury are common in other regions, such as the United States,[3] Canada,[4] Japan,[5] and Europe,[6,7] these studies may be unlikely to be generalizable to Australia because of the less challenging skiable environments in Australia,

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which are predominantly beginner and intermediate level, as well as the difference in Australian population snow sports exposure and skill level in comparison to North American or European countries.[1] Few Australians live near ski resorts; thus, recreational, weekend, and day-pass visitation is common.[8] Previous evidence suggests that less experienced skiers and snowboarders have a higher risk of injury,[9] so it is possible that the sporadic nature of Australian snow sport participation could have a greater risk of injury and thus could be a target group for injury prevention strategies.

Generally, skiing is the most common snow activity worldwide, although snowboarding has grown in popularity, particularly among younger participants.[10] Internationally, these 2 sports are associated with relatively high injury incidences.[11] In Australia, there has been little research examining injury from snow sports, with some previous studies only targeted to 1 specific group (eg, risk in children,[12] Nordic skiing injury,[13] and ski-related deaths[14]), and results are now quite dated. More recent studies have investigated injuries sustained during snowboarding and ski-based snow sports, more specifically, providing greater depth of knowledge of injury occurrence, including common types of injuries sustained for each activity, body regions injured, and severe snow sports–related injuries.[15,16] However, despite the detail provided in these studies, the data are dated and may not accurately reflect injury occurrence in the past 10 to 20 years when considering possible changes over time in factors such as participant numbers, protective equipment use (eg, helmets), style of riding (eg, freestyle [involving tricks] vs free ride [involving backcountry]), and terrain/conditions encountered (eg, groomed runs, terrain parks, off-piste).[11]

An understanding of the common types of injuries sustained in the unique setting of Australian snow resorts will help to determine the types of injury prevention initiatives that are required. Comparing these injury findings with those of global studies may also inform the translation of international prevention measures for implementation in an Australian setting, if injury patterns can be generalized. Furthermore, an evaluation of injury trends can provide insight into possible factors affecting injury occurrence and how these factors can be addressed in future prevention strategies. Therefore, the purpose of this research was to investigate snow sports injury over a 10-year period (2003–2012) for the Victorian region, where 5 skiable mountains and at least 3 of Australia's larger ski resorts are located. The specific aims were to determine the incidence rate of snow sports injury in Victoria, consider changes in incidence rate over time, and determine the most common types and causes of snow sports injury.

Methods

Retrospective data were obtained from the Victorian Injury Surveillance Unit (VISU) covering hospital admissions (Victorian Admitted Episodes Dataset [VAED]) and emergency department presentations (Victorian Emergency Minimum Dataset [VEMD]) in the 10-year period of January 1, 2003 to December 31, 2012. The Victorian Department of Health and Human Services supplies the VISU with a deidentified subset of injury admissions and emergency department presentations annually for the purposes of injury surveillance and injury-related research. Research using data collected by VISU has approval from the Human Research Ethics Committee at the Victorian Department of Health and Human Services.

INJURY DATA

The VAED is a statewide collection of data on all admissions to Victorian hospitals (public and private) and was established in July 1987. Data are coded to the International Classification of Diseases, Australian Modification (ICD-10-AM).[17] For the main analysis, cases recorded in the VAED were extracted if they had a principal diagnosis recorded as an injury (ICD-10-AM code in the range S00–T98) and an activity code as an ice or snow sport (U550–U559). These codes include snow skiing, snowboarding, bobsledding, ice skating, ice dancing, snowmobiling, speed skating, tobogganing, curling, and other specified and unspecified ice or snow sport. Transfers within and between hospitals were excluded to avoid double counting in the estimation of the incidence of cases.

The VEMD, which commenced in October 1995, is an ongoing surveillance dataset of injury presentations to Victorian public hospitals that have a designated emergency department service. Cases recorded in the VEMD were extracted using text narratives that indicated that a person was injured while engaging in an ice or snow sport (activities searched were the same as those listed for VAED cases). Emergency department cases that were subsequently admitted to hospital were excluded in the VEMD dataset to avoid double counting with the VAED cases.

For both the VEMD and VAED, data are presented for body region, injury type, and cause of injury, based on the first occurring injury diagnosis recorded (ie, the number of injuries is equal to the number of injured persons).

PARTICIPATION DATA

Victorian data from the 2003 to 2010 Exercise, Recreation and Sport Surveys (ERASS)[18] were used to calculate participation-adjusted trends for adults (aged ≥15 years) for the injury data covering the 8-year period of 2003 to 2010. The ERASS was an annual survey conducted between 2001 and 2010 that collected information on the frequency, duration, nature, and type of physical activities participated in for recreation, exercise, or sport by individuals aged ≥15 years during the 12 months before the interview. Random computer-assisted phone survey interviews were conducted quarterly, and the aggregated results of the 4 survey periods were compiled and extrapolated into national estimates. Ice/Snow sports were defined by the ERASS as participation in blade skating, ice hockey, ice skating, snowboarding, skeleton, snow skiing, and any other ice and snow sports, excluding wheelchair ice hockey.

DATA ANALYSIS

The number of injuries, injury type, body part injured, and cause for hospital-treated injuries were determined for children (aged ≤14 years) and adults for the decade 2003 to 2012, separated by sport (skiing, snowboarding, ice skating/dancing, and tobogganing). χ^2 tests were used to identify differences between sex and age for skiing and snowboarding injuries. Trends in hospital-treated injury rates (per 100 000 participants) (adjusted for participation) were calculated for persons aged ≥15 years for all ice and snow sports combined for the 8-year period 2003 to 2010, along with 95% CIs. Trends in rates could not be assessed for the whole time period of the VAED and VEMD data or for all ages because ERASS participation data are limited to persons aged ≥15 years and data collection ceased in 2010. Trends in the frequency and rate of cases were analyzed using a log-linear regression model of the rate data assuming a negative binomial distribution of cases, with 95% CIs calculated. The statistics relating to the trend curves, slope, and intercept and the P value were calculated using the regression model in SAS 9.3. Differences were considered to be statistically significant if the P value of the slope of the regression model was <0.05.

Results

During the 10-year period from 2003 to 2012, 7387 ice- and snow-related, hospital-treated injury cases were reported in Victoria. Skiing and snowboarding had the highest frequency of hospital-treated injury (2894 skiing cases [39%] and 2728 snowboarding cases [37%]). Table 1 presents the number of hospital-treated injury cases by sex and age. Male participants were injured more frequently than females for both sports (57% skiing and 73% snowboarding, respectively), representative of their frequently higher participation in snow sports overall, as shown in the ERASS data, with significantly more males injured during snowboarding ($\chi^2[1]=344.7$, $P<0.001$). Compared with all other age groups, participants aged 15 to 24 years were injured most frequently during skiing and snowboarding, respectively, with significantly more 15 to 24 year olds injured during snowboarding ($\chi^2[5]=1603.3$, $P<0.001$).

Table 2 summarizes the annual injury frequency and injury rates per 100,000 participants for all sports combined and separately for select activities. The rate of adult hospital-treated ice and snow sport injury fluctuated annually during the 8-year period (2003–2010) for which participation data were available; however, there was an overall (nonsignificant) increase

Table 1. Hospital-treated injury cases by sex and age group, 2003–2012

	Skiing		*Snowboarding*		*Other ice and snow sports*		*All activities combined*	
Variable	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Sex								
Male	1642	56.7	1982	72.7	807	45.7	4431	60.0
Female	1252	43.3	746	27.3	958	54.3	2956	40.0
Age group (y)								
≤14	356	12.3	205	7.5	575	32.6	1136	15.4
15–24	767	26.5	1364	50.0	458	25.9	2589	35.0
25–34	555	19.2	928	34.0	272	15.4	1755	23.8
35–44	540	18.7	166	6.1	254	14.4	960	13.0
45–54	455	15.7	51	1.9	149	8.4	655	8.9
55+	221	7.6	14	0.5	57	3.2	292	4.0
Total	2894	100.0	2728	100.0	1765	100.0	7387	100.0

Table 2. Trends in frequency and incidence rate of hospital-treated ice and snow sports-related injuries

Variable	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*% Change 2003–2012 (95% CI)*
All activities combined	698	742	597	416	752	717	706	1007	869	883	52.8 (1.9–121.9)[a]
Child[b] (n)	112	87	99	74	123	93	103	170	145	130	66.0 (9.0–142.7)[a]
Adult (n)	586	655	498	342	629	624	603	837	724	753	50.7 (−1.2 to 122.4%)
Adult injury rate (injuries per 100 000 participants)	827	725	610	801	1426	967	777	1161	n/a	n/a	58.0 (−15.8 to 176.8)
Skiing											
All ages	315	388	284	176	330	290	259	287	262	303	−14.2 (−43.5 to 28.6)
Child	31	42	46	21	48	26	27	48	24	43	−2.0 (−51.0 to 87.3)
Adult	284	346	238	155	282	264	232	239	238	260	−15.8 (−44.9 to 26.2)
Snowboarding											
All ages	206	260	218	136	304	274	291	354	324	361	91.0 (24.2–177.6)[a]
Child	15	14	19	13	26	13	22	31	24	28	117.9 (32.1–232.2)[a]
Adult	191	246	199	123	278	261	269	323	300	333	89.1 (21.4–178.3)[a]
Ice skating and dancing											
All ages	128	50	60	77	78	111	121	315	242	180	290.8 (63.2–645.1)[a]
Child	50	21	29	30	37	45	41	75	85	49	145.2 (23.4–334.2)[a]
Adult	78	29	31	47	41	66	80	240	157	131	407.3 (83.4–927.0)[a]
Tobogganing											
All ages	37	29	24	16	27	28	24	37	32	18	−12.3 (−51.4 to 53.0)
Child	14	8	5	7	11	8	12	14	12	5	2.5 (−55.1 to 119.8)
Adult	23	21	19	9	16	20	12	23	20	13	−19.7 (−57.7 to 46.2)

N/A, ERASS data not available.

[a] Significant change.

[b] ≤14 y.

of 58% (95% CI to 15.8 to 176.8%). In the 2 most popular sports of skiing and snowboarding, the number of hospital-treated snowboarding injury cases increased significantly from 206 in 2003 to 361 in 2012, an overall increase of 91% (95% CI 24.2–177.6%). The number of hospital-treated skiing injury cases for the same period decreased from 315 in 2003 to 303 in 2012, a nonsignificant decrease of 14.2% (95% CI −43.5 to 28.6%).

Across all ice/snow sports, the most commonly injured body regions were the upper and lower limbs (42.3% and 31.1%, respectively) with the frequency of these injuries varying for different activities (Table 3). Skiers were mostly treated for lower extremity injuries (46.2%), whereas snowboarders were mostly treated for upper extremity injuries (54.5%). Injuries of the head and neck were the third most commonly treated at hospitals for all sports (13.7%).

Fractures were the most common hospital-treated injury type overall (43.1%) (Table 4). Fractures made up almost half of all hospital-treated injury cases (47.7%) for snowboarders and 39.3% for skiers. Dislocation and soft tissue injury was the second most frequent hospital-treated injury type for both sports (36% of skiers and 25.3% of snowboarders).

More specifically, among skiers the most common lower extremity diagnoses were dislocations, sprain and strain of joints and ligaments of the knee (n=620, 45.1% of lower extremity injury), and fractures of lower leg, including ankle (n=416, 30.3%). For snowboarders, the upper extremity injuries were mostly fractures to the forearm (n=399, 29.2% of upper extremity injury) and wrist and hand (n=341, 24.9%). Overall, skiing cases had the highest number of hospital admissions (55.7%) and the longest average mean length of stay of 2.3±6.2 days (Table 4). Although intracranial injuries, injuries to the nerves/spinal cord, and injury to internal organs occurred relatively infrequently, these injuries resulted in high incidences of hospitalization (70.1%, 83.8%, and 84.5% of cases, respectively) and a higher mean length of stay in hospital (3.5±17.7 days, 5.1±8.3 days, and 4.9±8.3 days, respectively). The most common cause of injury recorded for all sports was falls at 72.6% (67.6% of skiing, 78.4% of snowboarding).

Discussion

This study describes changes in injury incidence over time using hospital treatment data from a large geographic region in Victoria, Australia. From 2003 to 2010, there were fluctuations in annual injury incidence rates, with an overall, but not significant, increase in injury incidence. These fluctuations may be explained by the changes in participation; however, the exact nature of snow sports participation over the 8-year period in terms of number of people undertaking skiing, snowboarding, or snow play cannot be determined due the combined nature of the participation data used. It is likely that snow depth changes accounted for year-to-year variations in participation across the study period; it has been previously shown that snow depth is a key factor influencing lift ticket sales and thus the number of people participating in lifted activities such as skiing and snowboarding,[19] which would affect the population-level exposure to injury. This may explain injury occurrence during the 2006 season, when injury numbers were at their lowest, as snow depth only reached approximately 30% of the average maximum depth[20] and, perhaps accordingly, participation was also at its lowest with only approximately 42,000 people reporting snow sports activity in Victoria during that year.[18]

Across 2003 to 2012, the frequency of injuries significantly increased for snowboarding, with no increase in ski injuries. Many studies have reported that snowboard injuries occur more frequently than injuries during skiing.[4,11] This finding, as with the present study,

Table 3. Hospital-treated ice and snow sports-related injury by body region injured, 2003−2012

	Skiing		*Snowboarding*		*Other ice and snow sports*		*All activities combined*	
Body region	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Head/Face/Neck	318	11.0	333	12.2	362	20.5	1013	13.7
Trunk	296	10.2	342	12.5	120	6.8	758	10.3
Upper extremity	875	30.2	1488	54.5	765	43.3	3128	42.3
Lower extremity	1336	46.2	492	18.0	470	26.6	2298	31.1
Multiple body regions	29	1.0	32	1.2	21	1.2	82	1.1
Unspecified body region	40	1.4	41	1.5	27	1.5	108	1.5
Total	2894	100.0	2728	100.0	1765	100.0	7387	100.0

Table 4. Hospital-treated ice and snow sports-related injury by injury type

	Skiing				Snowboarding				Other ice and snow sports				All activities combined			
Injury type	*Hospital-treated cases (%)*	*Admitted cases (%)*	*Mean LOS (days) [SD]*	*Range*	*Hospital-treated cases (%)*	*Admitted cases (%)*	*Mean LOS (days) [SD]*	*Range*	*Hospital-treated cases (%)*	*Admitted cases (%)*	*Mean LOS (days) [SD]*	*Range*	*Hospital-treated cases (%)*	*Admitted cases (%)*	*Mean LOS (days) [SD]*	*Range*
Fracture	39.3	67.3	2.8 [2.8]	18	47.7	53.7	1.8 [1.6]	12	42.2	54.3	2.2 [1.9]	13	43.1	58.7	2.3 [2.3]	18
Dislocation, sprain, or strain	36.0	49.9	1.4 [1.1]	13	25.3	20.3	1.2 [0.5]	3	22.3	10.7	1.2 [0.7]	4	28.8	33.0	1.4 [1.0]	13
Injury to muscle and tendon	6.7	29.2	1.4 [0.7]	3	5.6	17.5	1.8 [1.4]	6	4.6	14.8	1.0 [0.0]	0	5.8	22.3	1.5 [0.9]	6
Intracranial injury	4.0	77.4	5.0 [24.5]	218	4.7	71.7	2.7 [13.4]	128	4.3	56.6	1.9 [2.6]	13	4.3	70.1	3.5 [17.7]	218
Superficial injury	3.2	22.8	1.2 [0.5]	2	4.3	13.6	1.4 [1.1]	4	5.9	8.6	1.1 [0.3]	1	4.3	14.6	1.3 [0.7]	4
Open wound	1.6	48.9	2.0 [1.8]	8	1.5	40.5	1.4 [0.8]	2	12.2	15.3	1.1 [0.2]	1	4.1	24.0	1.4 [1.2]	8
Injury to internal organs	1.2	91.2	4.6 [4.8]	21	1.9	82.7	4.5 [9.1]	60	0.6	72.7	8.0 [13.5]	40	1.3	84.5	4.9 [8.3]	60
Injury to nerves or spinal cord	0.7	85.7	2.8 [3.6]	12	0.5	78.6	9.5 [12.3]	40	0.1	100.0	1.0 [0.0]	0	0.5	83.8	5.1 [8.3]	40
Other or unspecified injury	7.3	42.2	1.2 [1.7]	4	8.4	34.1	1.3 [0.8]	4	7.8	32.6	1.4 [1.3]	7	7.8	36.7	1.3 [0.8]	7
All	100.0	55.7	2.3 [6.2]	218	100.0	41.1	1.9 [4.7]	128	100.0	33.9	2.0 [2.4]	40	100.0	45.1	2.2 [5.2]	218

LOS, length of stay.

is possibly reflective of a growing number of participants in the sports as their popularity and accessibility may have increased in Australia throughout the decade, as it has done internationally.[21,22] Injury increases may also be due to snowboarders' pursuit of more advanced-level riding, such as use of terrain parks, jumps, and off-piste areas,[11] which lead to greater injury risk.[8] Given that the overall snowboard injury trends showed a marked increase (91%) across the 10-year period, this group should be of particular focus with regard to targeted injury prevention strategies.

Across all ice and snow sports combined, males were injured more frequently than females, which is likely to be representative of the higher participation rates of males in all snow sports, as demonstrated within the 8-year period in which the ERASS data were available. Furthermore, males tended to be injured more frequently than females in the 2 most popular sports of skiing and snowboarding; males were overrepresented in both sports. There are varying reports of male sex as a risk factor for injury in skiing and snowboarding. Some studies report that females are injured most frequently[11,23]; however, it is more commonly illustrated that males tend to sustain greater numbers of injuries, as well as more severe injuries.[6,7] Again, this is likely due to greater male participant exposure and typically higher risk-taking behaviors.[24] The injured population in the present study comprised predominantly young males, which is also consistent with other Australian and international snow sports injury studies,[3,15,25] demonstrating a potential target group for injury prevention. The greatest number of injuries occurred among the 15 to 24 years age group for both popular sports, but particularly among those aged 15 to 24 years who participated in snowboarding. These findings support previously published studies, both in Australia and internationally, that have reported that young snowboarders are injured most frequently in comparison to other age groups.[11,15,23]

Consistent with both previous Australian and international research,[15,23,25] injuries to the lower limb were most common among skiers, whereas upper limb injuries were most frequent in snowboarding. Likewise, the most common mechanism for snow sports injury was falls, further confirming previous research across geographic locations.[15,23,25] The body regions injured were also reflective of the nature of the activities and the equipment used. For example, falls during skiing, when the feet are fastened separately into skies via a hard shell boot, tend to encourage twisting at the knee, which typically affects the cruciate and medial ligaments.[26] In the case of snowboarding, in which both feet are fastened onto a single board via either soft or hard

shell boots, falls are more likely to result in an injury to the wrist as the participant attempts to break a fall on an outstretched arm.[27]

Over the past several decades, measures have been introduced to reduce the impact of fall-related injury mechanisms, which has led to progressive declines in injury rates. The most prominent of the prevention measures includes modifications to boot and binding design.[26] This has seen ski boots evolve from leather alpine shoes to high-top, heavy-constructed plastic boots that provide protection and support to the lower leg and ankle, as well as multidirectional quick release bindings for skies[26] and wrist protection for snowboarders.[28] Although specific data on equipment use were not available in this study, the most common ski and snowboard injuries illustrated suggest that the mechanisms of these injuries have not changed and also correspond to the injury patterns seen globally, with falls remaining the most prevalent cause, and may imply that current injury prevention measures be reviewed in regard to effectiveness and/or implementation.

Consideration of the effectiveness of injury prevention initiatives in an Australian setting, such as actual use and attitudes toward use of protective equipment, as well as design components and structural effectiveness, may be of value. For instance, both Australian and international research has investigated wrist protection among snowboarders[28–30] and has found found reduced injury risk with wrist guard use. In addition, an Australian study has examined wrist guard protection and location of wrist fracture among snowboarders to assess design effectiveness.[29] Although the study found no association with wrist guards and fracture location, such research is useful in determining the appropriateness of specific personal protective equipment. Implementation of standards that wrist guard protection must meet may lead to fewer and less severe injuries,[31] standards which are not currently in place in Australia. Furthermore, global reviews of wrist guard use illustrate that use among snowboarders is low,[30] a finding that likely corresponds to an Australian setting, given the similar patterns of injury found in the present study. Therefore, factors found globally to be attributed to use/disuse, such as comfort, fit, social acceptance, and availability, should also be addressed in Australia accordingly to assist in the promotion and adoption of this injury prevention measure.

Research into design and structural effectiveness should also be considered with regard to helmet use in snow sports. Although injuries to the head, as well as those to the spine and internal organs, occurred relatively infrequently, these injuries resulted in the highest proportion of subsequent hospitalization, indicative of their severe nature. One previous Australian study in New South Wales documented similar findings of overall low injury rates to the head and spine (1.8 per 1,000,000 and 5.6 per 1,000,000, respectively).[16] Similarly, international research has found comparable head injury patterns with regard to low, but increasing, incidence and high severity[32]; given the severe nature of these types of injuries, they are presented as an important area to target for injury prevention.[16]

Helmets have been implicated in the effective reduction of the risk and severity of snow sports-related head injuries, without incurring greater numbers of neck/spinal injuries, nor enabling participant risk compensation.[33,34] However, helmet-associated reductions in catastrophic snow sports–related head injury leading to death remains unclear.[35] Despite a growing number of participants wearing helmets, both in Australia and internationally, research to establish appropriate sport-specific safety standards that ensure adequate protection is required.[36] Furthermore, consideration of factors contributing to head injuries, such as location (eg, off-piste or terrain parks), preinjury events (eg, jumping, colliding with a tree), and participant skill level, is required to gain full understanding of the potential ways to prevent them.[32] It should be noted that current helmet use mandates at Victorian ski resorts only extend to certain resort-organized programs, such as those for children (aged <18 years) or resort-organized competitions (for any age group). Helmet use is optional for all other activities/participants as per guidance from the Australian Ski Area Association.[37] Therefore, policies for mandatory use for all participants under the age of 18 years should be considered, as well as mandatory use for participants of any age who plan to enter areas, such as terrain parks, where the risk of head injury may be greater.[32] Again, given the present study found similarities to global findings of snow sports–related head injury incidence, helmet use mandates enforced across international locations may be of value for implementation in an Australian setting to enhance head injury prevention.

Reliable and accurate snow sports injury data are difficult to obtain in Australia; hence, the high-quality data in the present study provide a good representation of the snow sports injury context in Victorian hospitals for the past decade. Despite the extensive nature of the datasets, a number of limitations require consideration. Only hospital-treated injuries related to snow sports in Victoria are included, thereby potentially providing an underestimation of the overall injury incidence rate in Australia, as well as the possibility of coding issues, with some injuries being incorrectly categorized or omitted due to errors in collection, misspelling, or missing information. Case identification is reliant on good data

being provided. The VEMD is collected in the busy emergency department, so detailed data collection may not always be achieved; hence, these data may be an underestimate of the true number of cases. Furthermore, each record in the dataset represents an episode of care, not necessarily 1 incident.

It is also possible that some snow sports injuries occurring on mountains may be treated by a ski patroller or at a ski resort medical clinic. Similarly, there may be cases of injured individuals who do not seek treatment until after they leave the snowfields, particularly for overuse-type injuries in which the participant is not immediately limited in function or performance. Such cases are unlikely to attend a hospital as initial treatment, instead presenting to a general practitioner or community allied health professional, thereby leading to further underestimation of true injury rates. It is acknowledged that the most recent data used in the study are based on statistics from 2012, beginning from 2003. However, despite the dataset being at least 5 years old, the reporting of high-quality data in snow sport injury contexts is rare, and the present study still provides the most up-to-date statistics in Australia considering previous research was undertaken approximately 20 years ago.

Finally, the ERASS participation data came from a large nationwide survey. Although there were many strengths in the design of this data collection, the data were nevertheless based on self-reported participation in the previous 12 months and therefore present an estimate only. It should be noted that accurate snow sports participation data are also difficult to obtain, and although using ERASS data is sufficient to calculate an indicative injury rate, data that provide a correct representation of Australian snow sports participation would be valuable. Furthermore, participation-adjusted trends could not be calculated for participants aged 14 years and under, as ERASS does not collect data corresponding to this age group. It may be possible that younger children are also a high-risk group at which snow sport injury prevention measures need to be targeted.

Conclusions

This study has provided an update of hospital-treated snow sport–related injuries in Australia over the decade dating from 2003 to 2012. The injury patterns found in this study are similar to those in previous Australian research and demonstrate that Australian snow sports injury patterns are comparable, and perhaps generalizable, to international settings. Specifically, it is evident from this study that injury patterns, such as those related to upper/lower limbs and the head/neck, among skiers and snowboarders are similar to those found both nationally and internationally. Therefore, it is plausible that measures for prevention in Australia, such as wrist protection and helmets, could be promoted/implemented based on international recommendations and guidelines. The up-to-date findings presented also provide justification that injury in snow sports is a problem in Australia and evidence-based prevention efforts are required.

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