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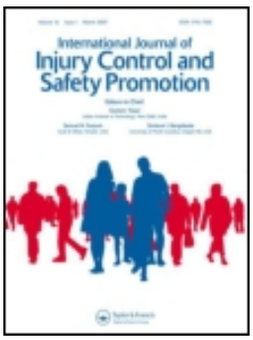

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Comparing the characteristics of snowboarders injured in a terrain park who present to the ski patrol, the emergency department or both

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Ski patrol report forms are a common data source in ski/snowboard research, but it is unclear if those who only present to the emergency department (ED) are systematically different from those who see the ski patrol. To determine the proportion and characteristics of injured snowboarders who bypass the ski patrol before presenting to the ED, three groups of injured snowboarders were compared: presented to the ED only, ski patrol only and ski patrol and ED. Data were collected from ski patrol Accident Report Forms (ARFs), ED medical records and telephone interviews. There were 333 injured snowboarders (ED only: 34, ski patrol only: 107, both: 192). Ability, time of day, snow conditions or drugs/alcohol predicted ED only presentation. Concussions (RRR: 4.66; 95% CI: 1.83, 11.90), sprains/strains (RRR: 4.22; 95% CI: 1.87, 9.49), head/neck (RRR: 2.90; 95% CI: 1.48, 5.78), trunk (RRR: 4.17; 95% CI: 1.92, 9.09) or lower extremity (RRR: 3.65; 95% CI: 1.32, 10.07) injuries were significantly more likely to present to ski patrol only versus ski patrol and ED. In conclusion, snowboarders who presented to the ED only had similar injuries as those who presented to both.

Keywords: snowboard; data quality; injury

1. Introduction

Ski patrol Accident Report Forms (ARFs) are a common data source in ski and snowboard injury research (Davidson & Laliotis, 1996b; Goulet, Hagel, Hamel, & Legare, 2007; Greenwald, Nesshoever, & Boynton, 2000; Hagel, Goulet, Platt, & Pless, 2004; Hagel, Meeuwisse, Mohtadi, & Fick, 1999; Hagel, Pless, Goulet, Platt, & Robitaille, 2004; Macnab, Smith, Gagnon, & Macnab, 2002; Shealy, Ettlinger, & Buonomo, 1997); however, they may introduce bias for a variety of reasons and underestimate the rate of injuries. Identifying injured skiers and snowboarders who bypass the ski patrol and present to only the emergency department (ED) is a labour-intensive process, particularly, if the hospital is the catchment area for several nearby resorts and not all resorts are included in the research. Snowboarders who present to the ED only may be systematically different than those who first present to the ski patrol and if they are, a selection bias could be introduced and the study findings may not be valid. It is unclear whether there is an inherent difference between snowboarders presenting to the ED only and those presenting to ski patrol, which could introduce a selection bias if only data from ski patrol were used to identify skiers and snowboarders for injury research.

Snowboarding is a popular winter sport among adolescents (Emery, Meeuwisse, & McAllister, 2006). Risk factors for snowboard injuries include beginner ability (Boldrino & Furian, 1999; Lamont, 1995; Langran & Selvaraj, 2004; Ronning, Ronning, Gerner, & Engebretsen, 2001), participation in competitive events (Torjussen & Bahr, 2006) and suboptimal environmental conditions (Hasler et al., 2010). Wrist and upper extremity injuries account for approximately 35–45% of all injuries (Made & Elmqvist, 2004; Matsumoto, Miyamoto, Sumi, Sumi, & Shimizu, 2002; Pigozzi, Santori, Di Salvo, Parisi, & Di Luigi, 1997). Other commonly injured body regions include the head (Emery et al., 2006; Hagel et al., 2004) and ankle (Bridges, Rouah, & Johnston, 2003; Ekeland, Sulheim, & Rodven, 2004; Shealy & Sundman, 1989).

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Injury prevention methods have primarily focused on the use of protective equipment (Russell, Christie, & Hagel, 2010; Russell, Hagel, & Francescutti, 2007).

Snowboarding has evolved to include terrain parks (TP), which contain man-made features used for jumping or performing aerial manoeuvres and appear to increase the risk and/or severity of snowboarding injuries (Brooks, Evans, & Rivara, 2010; Goulet et al., 2007; Moffat et al., 2009). Few papers are available on the nature of injuries sustained in TPs, and currently there is no information regarding the proportion and characteristics of snowboarders injured in the TPs who bypass the ski patrol (i.e. present only to ED). The objective of this study was to determine the proportion and characteristics of snowboarders injured in the TPs who bypass the ski patrol and present to the ED only.

2. Methods

2.1. Setting and definition of treatment groups

The study was conducted at a TP at a ski resort in Alberta, Canada, during the 2008–2009 and 2009–2010 ski seasons. The TP consisted of the following man-made features that supported aerial tricks and manoeuvres: half-pipe, jumps, kickers, rails, boxes, quarter-pipes and a mushroom. There were three groups: (1) snowboarders who were injured in the TP and presented to one of the two local EDs without first being examined by the ski patrol, (2) snowboarders who were injured in the TP and presented only to the ski patrol and (3) snowboarders who were injured in the TP and presented to the ski patrol followed by the ED.

2.2. Data collection

Data were collected from ski patrol ARFs during the season when the terrain park was open (Season 1: beginning of January until the end of March; Season 2: beginning of January until mid-April). Among consenting snowboarders, follow-up telephone interviews were conducted and the ED medical records were reviewed for those who presented to a participating ED. Primary data collection was performed for a study (reported elsewhere) examining injury rates and risk factors on terrain park features (Russell, 2011).

For those who presented to the ski patrol, data were collected from ARFs and telephone interviews. The ARFs contained contact information and demographics (e.g. age, sex, ability), environmental conditions (e.g. temperature, snow conditions, light) and injury characteristics (e.g. injured body region and injury type). An ARF was completed whenever a snowboarder was injured in the TP and presented to the ski patrol (operating daily from 9:00–21:00 on weekdays and 09:00–17:00 on the weekend). Using the telephone number provided on the ARF, the snowboarder was contacted to collect information about additional potential risk factors. A maximum of six attempts were made to contact the snowboarder to obtain verbal consent for study participation. Additional potential risk factor data collected included features used at time of injury (e.g. jump, kicker, half-pipe, mushroom, rail, box or quarter-pipe), snowboarding and TP experience (years), listening to music, wearing wrist guards at the time of injury, previous snowboarding injury and recent drug or alcohol use (asked among snowboarders 18 years or older) within the last 12 hours.

To identify snowboarders who bypassed the ski patrol, the Regional Emergency Department Information System at the two closest tertiary hospitals (one adult and one paediatric) was searched for those who presented with a snowboarding injury. These snowboarders were then telephoned to confirm they were injured at the TP of interest and did not present to the ski patrol. They were then asked the same potential risk factor information that was collected on the ARF and the additional risk factor questions.

For snowboarders who presented to the ED (with and without ski patrol presentation) and consented, their injury type(s) and injured body region(s) were extracted from the ED medical record. If a snowboarder presented to the ski patrol and reported during their telephone interview that they had presented to a non-participating ED, the diagnosis they provided over the phone was included and the snowboarder was classified as having presented to both the ski patrol and ED. If a snowboarder presented to the ski patrol but could not be contacted or did not consent, the data were extracted from their ARF, and the injury assessment on their ARF was included.

Ethical approval for the study was granted by the University of Calgary Conjoint Health Research Ethics Board.

2.3. Analysis

All snowboarders who were injured in the TP and part of the larger study were included (Russell, 2011). We compared the distribution of injuries and risk factors among the three groups: snowboarders who presented only to the ED, those who presented only to ski patrol and those who presented to both ski patrol and ED.

The distributions of injured body regions and injury types among the three groups were tabulated, and 95% confidence intervals (CIs) for the proportions were calculated using the Agresti–Coull interval (Agresti & Coull, 1998), which provides better coverage than the standard Wald interval (Brown, Cai, & DasGupta, 2001). Multinomial logistic regression was used to examine the characteristics associated with presentation to one of the three groups. Relative risk ratios (RRR) with 95% CI

were reported for the comparison of characteristics between those who only reported to the ski patrol or only to the ED with those who presented to both as baseline.

To determine if the occurrence of multiple injuries versus only one injury predicted who bypassed the ski patrol, the RRRs were calculated where presenting to the ski patrol and ED was the base outcome. However, to determine if specific injured body regions or injury types predicted bypassing the ski patrol, those with multiple injuries were excluded in order to determine which injury resulted in the choice to seek ski patrol and/or ED treatment. Had snowboarders with multiple injuries been included, it would be unclear which injury motivated them to present to the ski patrol and/or ED resulting in an unclear clinical picture of snowboarders who chose to bypass the ski patrol. While creating one model with individual variables for each exposure (sprain, bruise, concussion, etc.) would have been ideal, there were too few complete cases who presented to ED only with each type of injury to add the required number of variables to the model, and thus separate models were constructed that compared one injury type versus fracture (reference injury type) (Harrell, Lee, & Mark, 1996). The same challenge existed for injured body region, and therefore, separate models were built that compared one injured body region with upper extremity injury (reference injured body region). Models were built using forward-selection techniques; potential confounders (age, sex, ability, listening to music, wearing wrist guards, previous snowboarding injury, temperature, light, snow and aerial (jumps, kickers, half-pipe, mushroom) versus non-aerial feature (rail, box, quarter-pipe)) were individually added to a crude model on the polytomous outcome (presentation to ED only, ski patrol only or both) and containing exposure (injured body region or injury type). Whichever confounder changed the injured body region or injury-type RRRs by more than 15% was retained in the model (Mickey & Greenland, 1989). This process was considered complete once no potential confounder changed the RRR by more than 15% or once there was more than one variable for every 10 complete cases in the least frequent outcome category (Harrell et al., 1996). The base outcome category was presentation to ski patrol and ED.

3. Results

There were 333 snowboarders injured in the TP included in the study (Figure 1). There were 34 who presented to the ED only, 192 who saw ski patrol and ED and 107 who saw ski patrol only. The consent rate was 85% for snowboarders recruited through ski patrol and 71% for snowboarders recruited at the EDs. Few snowboarders injured in the TP were not assessed by the ski patrol and presented directly to a study ED (10.2%).

The 333 snowboarders sustained a total of 379 injuries. Snowboarders who presented to the ED only or to both the ski patrol and ED had a greater proportion of fractures than those who only presented to ski patrol (Table 1). Snowboarders who only presented to the ski patrol had greater proportions of concussions, sprains/strains, bruises/abrasions/lacerations or symptom-only reporting (i.e. pain or swelling). There were also greater proportions of trunk and head/neck injuries among snowboarders who only saw ski patrol, compared with a greater proportion of upper extremity injuries among those who presented to the ED.

Compared with those presenting to both ski patrol and ED, injured snowboarders who were self-rated experts versus intermediates, recently used drugs or alcohol, or injured in the evening versus sunny daytime were significantly more likely to present to the ED only, while snowboarding on un-groomed snow versus groomed snow was associated with not presenting to the ED only (Table 2).

Multinomial logistic regression compared the three groups (Table 3). Compared with snowboarders who presented to the ski patrol and ED, the occurrence of multiple injuries versus only one injury was not significantly associated with presenting to the ED only (RRR: 2.04; 95% CI: 0.79, 5.23) or the ski patrol only (RRR: 1.14; 95% CI: 0.54, 2.38). Compared with upper extremity injuries, snowboarders with lower extremity, trunk and head/neck injuries all had a higher relative risk of seeking an assessment from the ski patrol only compared with the ski patrol and ED. There were no significant differences in the RRRs of presenting to the ED only versus ski patrol and ED for any of the injured body regions. Snowboarders who presented to the ED were more likely to have a fracture than any other type of injury, and those with fractures were less likely to present to the ski patrol only. Because of the limited number of injured snowboarders in each of the three groups, the RRRs for all associations could not be adjusted for any potential confounders and only the crude RRRs were presented, except for the association between ED presentation and lower extremity injury, which was adjusted for previous injury (Harrell et al., 1996).

4. Discussion

Using comprehensive data from local EDs and ski patrols, this study identified that approximately 89% of all TP-injured snowboarders were assessed by ski patrol staff, assuming that few missed snowboarders also bypassed the ski patrol and presented to a non-participating ED. Snowboarders who saw only the ski patrol were significantly more likely to have a concussion, bruise/abrasion/laceration or sprain/strain than a fracture than those who presented to both the ski patrol and ED. This indicates that those who only presented to the ski patrol were less

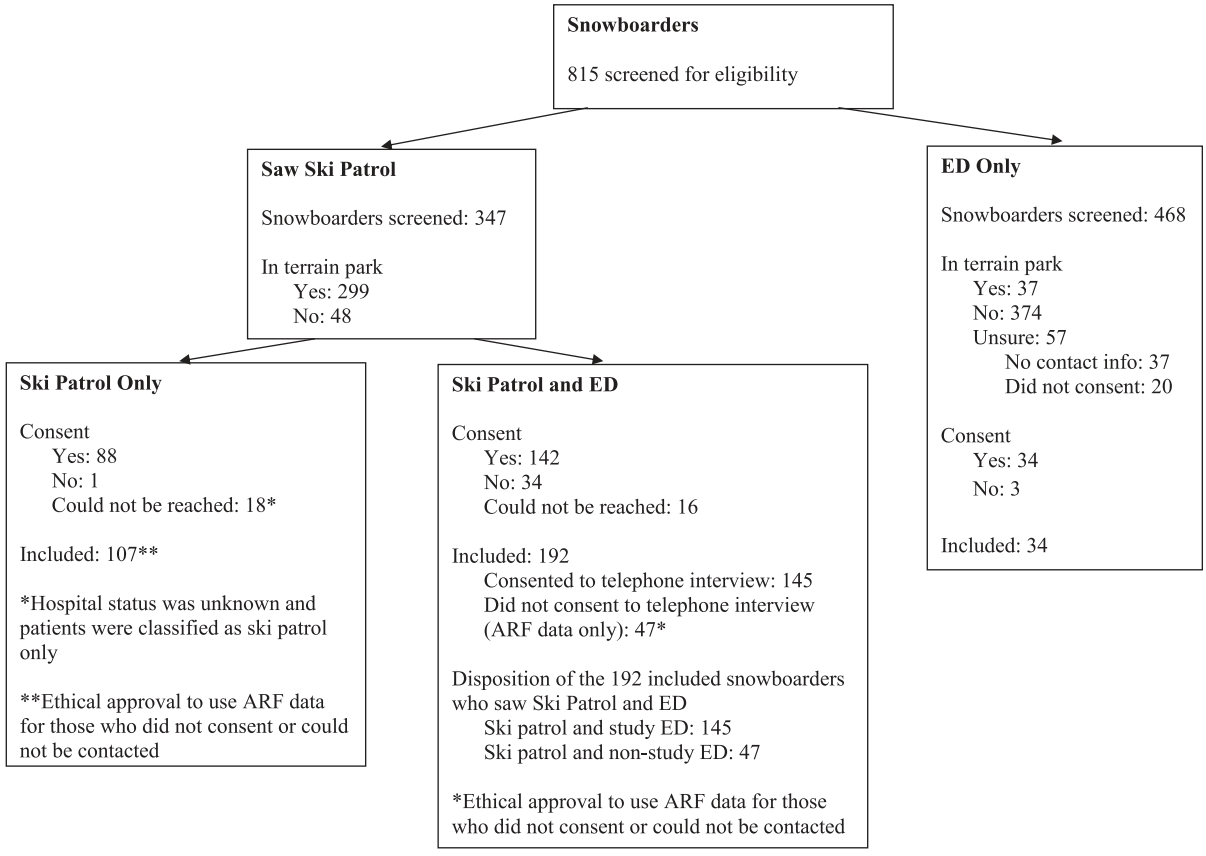

Figure 1. Patient flow.

Table 1. Injury characteristics of snowboarders who bypassed ski patrol, presented to ski patrol and ED or presented to ski patrol only (proportions and 95% CI) during 2008–2009 and 2009–2010 seasons.

		ED only $N = 43^{*}$ (%) (95% CI)**	ED and ski patrol $N = 216^{*}$ (%) (95% CI)**	Ski patrol only $N = 120^{*}$ (%) (95% CI)**
Injured body region	Upper extremity	53.5 (38.9, 67.5)	58.0 (51.4, 64.3)	32.5 (24.8, 41.3)
	Head/neck	16.3 (7.9, 30.4)	18.3 (13.7, 24.0)	28.3 (21.0, 37.0)
	Trunk	14.0 (6.3, 27.8)	13.7 (9.7, 19.0)	20.8 (14.5, 29.0)
	Lower extremity	14.0 (6.3, 27.8)	9.6 (6.3, 14.3)	17.5 (11.7, 25.4)
	None	2.3 (0, 13.4)	0.9 (0, 3.5)	0
	Missing	0	0	1.6 (0.4, 4.7)
Injury type	Fracture	41.9 (28.4, 56.7)	48.0 (41.4, 54.5)	12.5 (7.7, 19.8)
	Sprain/strain	14.0 (6.3, 27.8)	16.0 (11.7, 21.5)	20.8 (14.5, 29.0)
	Bruise/abrasion/laceration	14.0 (6.3, 27.8)	9.6 (6.3, 14.3)	26.7 (19.6, 35.3)
	Concussion	7.0 (1.8, 19.5)	9.1 (6.0, 13.8)	14.2 (9.0, 21.7)
	Soft tissue	18.6 (9.6, 33.0)	6.9 (4.1, 11.1)	0.8 (0, 5.1)
	Pain/sore/swelling	0	0.9 (0, 3.5)	20.0 (13.8, 28.1)
	Dislocation	0	5.0 (2.8, 8.9)	3.3 (1.1, 8.6)
	Other	2.3 (0, 13.4)	3.7 (1.7, 7.2)	0
	None	2.3 (0, 13.4)	0.5 (0, 2.2)	0
	Missing	0	0	1.6 (0.4, 4.7)

Note: ED, Emergency Department; *N*, number.
*Number of total injuries sustained by snowboarders.
**For variables with more than two levels, the CIs are calculated based on a Binomial distribution 'per row', that is taking the characteristic in the row versus all others collapsed into the other category.

Table 2. Summary of baseline and environmental characteristics of snowboarders who presented to ED only, ski patrol and ED or ski patrol only (RRR and 95% CI) during 2008–2009 and 2009–2010 seasons.

		ED only $N = 34$ (%)	Ski patrol only $N = 107$ (%)	ED and ski patrol $N = 192$ (%)	ED only RRR (95% CI)*	Ski patrol only RRR (95% CI)*
Number of injuries	Total	43	120	218		
	No injury	1 (2.9)	0	1 (0.5)	5.78 (0.35, 94.72)	N/A
	1 injury	26 (76.5)	93 (86.9)	169 (88.0)	1.00	1.00
	>1 injury	7 (20.6)	13 (12.2)	22 (11.5)	2.00 (0.78, 5.14)	1.08 (0.52, 2.24)
	Missing	0	1 (0.9)	0		
Aerial feature use	Yes	22 (64.7)	59 (55.1)	123 (64.1)	1.00 (0.47, 2.14)	0.70 (0.43, 1.14)
	Missing	0	2 (1.9)	2 (1.0)		
Age (years)	Mean (SD)	16.62 (0.62)	17.03 (0.53)	17.16 (0.40)	0.98 (0.91, 1.05)	1.00 (0.95, 1.04)
	Missing	0	0	0		
Sex	Female	5 (14.7)	12 (11.2)	25 (13.0)	1.15 (0.41, 3.25)	0.84 (0.41, 1.76)
	Missing	0		0		
Self-reported ability	Beg/novice	2 (5.9)	8 (7.5)	10 (5.2)	1.67 (0.31, 8.84)	1.43 (0.52, 3.90)
	Intermediate	9 (26.5)	42 (39.3)	75 (39.1)	1.00	1.00
	Advanced	12 (35.3)	40 (37.4)	74 (38.5)	1.35 (0.54, 3.40)	0.97 (0.56, 1.65)
	Expert	10 (29.4)	15 (14.0)	24 (12.5)	3.47 (1.26, 9.54)	1.12 (0.53, 2.36)
	Missing	1 (2.9)	2 (1.9)	9 (4.7)		
Snowboarding experience (years)	Mean (SD)	5.74 (0.72)	5.55 (0.52)	5.75 (0.31)	1.00 (0.91, 1.10)	0.99 (0.91, 1.07)
	Missing	3 (8.8)	43 (40.2)	41 (21.9)		
Terrain park experience (years)	Mean (SD)	4.34 (0.68)	3.40 (0.34)	4.06 (0.29)	1.02 (0.92, 1.13)	0.94 (0.85, 1.03)
	Missing	3 (8.8)	43 (40.2)	45 (23.4)		
Listening to music	Yes	9 (26.5)	15 (14.0)	45 (23.4)	1.09 (0.47, 2.52)	0.71 (0.36, 1.37)
	Missing	2 (5.9)	33 (30.8)	22 (11.5)		
Wrist guards	Yes	2 (5.9)	3 (2.8)	11 (5.7)	0.94 (0.20, 4.44)	0.61 (0.17, 2.27)
	Missing	1 (2.9)	33 (30.8)	21 (10.9)		
Previous snowboarding injury	Yes	17 (50.0)	29 (27.1)	73 (38.0)	1.51 (0.71, 3.21)	0.92 (0.52, 1.61)
	Missing	2 (5.9)	36 (33.6)	22 (11.5)		
Alcohol or drug use within 12 hours	Yes	4 (11.8)	4 (3.7)	5 (2.6)	6.93 (1.45, 33.09)	2.45 (0.59, 10.17)
	N/A (child)	23 (67.7)	67 (62.6)	123 (64.1)		
	Missing	1 (2.9)	19 (17.8)	12 (6.3)		
Temperature (°C)	Above 10	0	6 (5.6)	17 (8.9)	**	0.57 (0.21, 1.55)
	0 to 10	11 (32.4)	51 (47.7)	83 (43.2)	1.00	1.00
	−10 to 0	18 (52.9)	46 (43.0)	76 (39.6)	1.79 (0.79, 4.03)	0.99 (0.59, 1.63)
	Below −10	5 (14.7)	4 (3.7)	16 (8.3)	2.36 (0.72, 7.71)	0.41 (0.13, 1.28)
	Missing	0	0	0		
Light	Sunny	12 (35.3)	63 (58.9)	111 (57.8)	1.00	1.00
	Cloudy	7 (20.6)	20 (18.7)	42 (21.9)	1.54 (0.57, 4.18)	0.84 (0.45, 1.55)
	Night	14 (41.2)	24 (22.4)	35 (18.2)	3.70 (1.57, 8.74)	1.21 (0.66, 2.21)
	Missing	1 (2.9)	0	4 (2.1)		
Snow	Not groomed	6 (17.7)	9 (8.4)	9 (4.7)	0.24 (0.08, 0.72)	0.55 (0.21, 1.43)
	Missing	0	1 (0.9)	6 (3.1)		
Time of injury	Morning	3 (8.8)	17 (15.9)	23 (12.0)	0.98 (0.26, 3.67)	1.28 (0.64, 2.58)
	Afternoon	15 (44.1)	65 (60.8)	113 (58.9)	1.00	1.00
	Evening	14 (41.2)	22 (20.6)	47 (24.5)	2.24 (1.00, 5.01)	0.81 (0.45, 1.47)
	Missing	2 (5.9)	3 (2.8)	9 (4.7)		
Proximity to hospital (km)	Mean (SD)	16.82 (2.25)	N/A	24.95 (3.28)	0.99 (0.97, 1.01)	N/A
	Missing or N/A	2 (5.9)	107 (100.0)	30 (15.6)		

Note: ED, Emergency Department; C, Celsius; km, kilometres; RRR, relative risk ratio.
*Compared with those who went to the ski patrol and ED.
**No one presented to the ED only when the temperature was above 10 °C.

Table 3. Association between injury and ED only versus went to ski patrol only versus both ski patrol and ED (RRR and 95% CI) during 2008–2009 and 2009–2010 seasons.

		ED only RRR (95% CI)	Ski patrol only RRR (95% CI)	Ski patrol and ED RRR (95% CI)
Injured body region*	Head/neck	0.25 (0.03, 1.95)	2.90 (1.45, 5.78)	1.00
	Trunk	0.83 (0.17, 3.94)	4.17 (1.92, 9.09)	1.00
	Lower extremity***	1.15 (0.33, 4.04)	3.65 (1.32, 10.07)	1.00
Injury type**	Sprain/strain	0.62 (0.17, 2.30)	4.22 (1.87, 9.49)	1.00
	Bruise/abrasion/laceration	0.97 (0.20, 4.76)	11.39 (4.62, 28.07)	1.00
	Concussion	0.36 (0.04, 2.94)	4.66 (1.83, 11.90)	1.00
	Soft tissue	2.90 (0.87, 9.68)	0.62 (0.07, 5.24)	1.00
	Dislocation****	N/A	2.49 (0.68, 9.03)	1.00
	Other****	N/A	N/A	1.00

Note: ED, Emergency Department; CI, confidence interval; RRR, relative risk ratio.
*Compared with upper extremity.
**Compared with fracture.
***Adjusted for previous injury.
****No one with a single dislocation or 'other' injury presented to the ED only.

likely to have a fracture, and those with fractures were more likely to present to the ED. Snowboarders who only saw the ski patrol were also significantly more likely to have injured the lower extremity, trunk and head/neck compared with the upper extremity. Injury type and injured body region did not predict who presented to the ED only.

These results suggest that some snowboarders are not heeding the advice of the ski patrol; however, non-ED care was not assessed and some may have delayed treatment and sought care at clinics, primary care providers and/or other health professionals. Overall, 7 of the 107 snowboarders who saw the ski patrol only were assessed with a suspected fracture, and based on our follow-up telephone interview, these snowboarders did not present to an ED to confirm the diagnosis. Another two did not consent to being interviewed and their ARF indicated that they went home or returned to snowboarding; it is unknown if they presented to a non-participating ED. The ARF for five snowboarders stated that they left for the hospital but did not present to a participating ED and could not be contacted by telephone to determine if they had presented to a non-participating ED. Many sprain/strain injuries (38%) presented to ski patrol only, even though the severity of sprain injuries can range from minor to severe requiring surgical intervention(s). It is unclear if snowboarders with severe sprain/strain injuries were those who presented to the ED. Also, 43% of all concussions were seen by the ski patrol only. The importance and long-term consequences of concussions are often underappreciated and misunderstood (Echlin, 2010). Moreover, formal medical documentation and neuropsychological testing may be required in baseline and future assessments. Finally, current evidence suggests that concussions and repeated concussions can have important long-term consequences (Collins et al., 2002; Iverson, Gaetz, Lovell, & Collins, 2004) and one concussion increases the risk of sustaining a second (Guskiewicz et al., 2003). Snowboarders may need further education regarding the seriousness of concussions, including signs and symptoms, appropriate rest periods and the importance of seeing a physician. While return-to-play guidelines exist for a variety of sports (McCrory et al., 2009), ski- and snowboard-specific guidelines do not exist and could be an important hill-side intervention.

Few sports have on-site first-aid treatment services and few studies have evaluated how such services are utilised. Pelletier, Anderson, and Stark (1991) examined sport and leisure injuries presenting to six EDs in Canada over a week-long period. Of the 244 respondents, 62% of injuries occurred during supervised sports and only 7% received on-site first-aid treatment. Similar findings of on-site first-aid treatment were observed in a Scottish ED treating sports injuries (Pickard, Tullett, & Patel, 1988). While it is unknown if our findings can be generalised to snowboarders on the regular slope or skiers, our study adds to the body of knowledge on on-site treatment services by providing a better understanding of who uses the services in relation to the nature of their injuries. This information could help improve the services provided to more accurately address patient needs or to improve patient understanding of what to do if they are injured (e.g. see the ED, rest, return to sport, etc.).

4.1. Limitations

All eligible snowboarders were unlikely captured, introducing a possible selection bias. Only snowboarders who presented to either of the two closest EDs to the ski area were captured; however, of those injured snowboarders who attended the ski patrol, only 14% indicated that they presented to a non-participating hospital. Therefore, the

majority of injured snowboarders were likely captured even though the study was limited to the two closest hospitals.

There were 33 snowboarders who went to the ski patrol but did not consent to the telephone interview or did not have contact information and did not present to either of the study EDs. According to the ARF, 2 of these 33 snowboarders left the ski resort in an ambulance and must have been diverted to another hospital. It is unclear if the remaining 31 snowboarders presented to a non-participating hospital. Therefore, these snowboarders were classified as 'ski patrol only' cases, although there is a chance of misclassification if these snowboarders were treated at a non-participating ED. There was likely a differential misclassification of injury type among snowboarders where only a ski patrol diagnosis was available (Davidson & Laliotis, 1996a; Russell et al., 2013). For example, if a ski patroller was unclear if a wrist injury was a sprain or a fracture, they may have classified it as a fracture to encourage the snowboarder to seek a diagnosis from a physician. This would result in a higher proportion of fractures than sprain injuries among ski patrol only snowboarders.

Although many potential confounders relating to personal, environmental and injury characteristics were collected, others may have been missed. For example, triage systems categorise pain on a visual or verbal analogue scale, and perhaps, pain intensity predicts who presents to the ED only. Only 34 snowboarders were presented to the ED only and they had a variety of injury types and injured body regions. Therefore, the role of multiple confounders could not be simultaneously evaluated as there were too many potential confounders compared with the number of cases (Harrell et al., 1996).

4.2. Conclusions

Snowboarders who presented to the ED only were significantly more likely to rate themselves as experts, report recently using drugs or alcohol, or report being injured in the evening. Snowboarders who presented to the ED only were significantly less likely to be snowboarding on ungroomed snow. There was no difference by injured body region or injury type among those who presented to the ED only compared with those who presented to both ski patrol and ED. However, snowboarders presenting to the ED were more likely to have more severe injuries (e.g. fractures). Until further evidence is available, it seems appropriate to assume that snowboard research using ski patrol ARF data is capturing the majority of injured snowboarders, and those who only present to the ED are similar to those who see the ski patrol. Further research is needed to determine if concussed snowboarders understand the severity of their injury and are treated accordingly.

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