HEADING BEYOND THE GATES: WHO IS MOST AT RISK OF GETTING INVOLVED IN AVALANCHE INCIDENTS OUT-OF-BOUNDS?

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ABSTRACT: The popularity of out-of-bounds skiing and snowboarding has been growing steadily over the last decade despite the avalanche risk inherent to the activity. As a consequence, out-of-bounds skiers and snowboarders have become an important target audience for avalanche safety messages. The present research focuses on identifying and characterizing out-of-bounds skiers most at risk of involvement in an avalanche incident. An innovative multidimensional approach that integrates the three central dimensions of avalanche risk management (training and experience, risk mitigation practices and terrain choices) was used to assign a risk level to out-of-bounds skiers and snowboarders participating in an extensive online survey. Subsequently, high-risk and low-risk groups were compared with respect to motivations and attitudes, risk perception, sensations seeking, self-efficacy, and understanding of ski area out-of-bounds policies. The results of this study offer useful insights for the development of avalanche awareness messages specifically targeted at out-of-bounds skiers and snowboarders most at risk.

KEYWORDS: Out-of-bounds skiing, multidimensional risk assessment, sensation seeking scale, self-efficacy, risk communication.

1. INTRODUCTION

Out-of-bounds skiing and snowboarding (hereafter referred to as OB skiing) is the activity that skiers and snowboarders engage in when they leave official runs within a resort area to ski or ride terrain beyond the resort boundary. OB terrain is generally defined as the terrain adjacent to a ski resort that is primarily accessed through the use of the resort's lift system, though short sections of hiking may be required to reach the top of a run. OB ski runs typically lead participants back into the resort in order to facilitate continued use of the resort's lift system. These characteristics distinguish OB skiing, which is possible from many North American ski resorts, from the related activity of backcountry skiing where participants ascend wilderness slopes under their own power, rather than use a lift system.

Avalanches are the results of complex interactions between the seasonal snowpack, weather, terrain and backcountry use. While nature provides warning signs of increased avalanche hazard, the reliable recognition and interpretation of these signs requires formal training, experience and considerable preparation prior to a backcountry trip.

This stands in stark contrast to the fact that all that is required to engage in OB skiing is passing under a boundary rope. The general ease of access to OB terrain allows for spontaneous engagement without a substantial investment in time, effort or specialized equipment. As a consequence, skiers with a wide variety of preparation levels and ambitions can easily expose themselves to significant avalanche hazard.

During the six year period spanning the 2003/2004 to the 2008/2009 ski season, OB avalanche fatalities accounted for 23% (219 of 973) of the known avalanche related deaths in North America and Europe (IKAR-CISA, 2004-2009). In Canada, 19 people were killed while skiing OB or on closed resort terrain in the last 15 years, accounting for 8% of all avalanche fatalities. Given that OB skiers are viewed as one of the most quickly growing user group of avalanche terrain (Hägeli, 2005), it is reasonable to assume that the proportion of OB avalanche fatalities will likely increase further in the near future.

Due to the unique characteristics of the decision environment and participants of OB skiing, existing avalanche awareness initiatives originally developed for traditional backcountry skiers will most

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likely not provide the desired results among OB skiers and snowboarders. Instead, this group needs to be considered a distinct target group for avalanche safety initiatives. However, the development of evidence-based avalanche awareness programs that effectively use available OB skiing communication opportunities requires an in-depth understanding of this target audience.

While media sources covering OB avalanche incidents typically portray participants as a homogeneous group of risk taking adventure seekers, preliminary research indicates a more diverse and complex picture. Previous studies on OB skiing behavior have identified heterogeneity within the OB skiing population such as variation in training, experience, perception of exposure to risk and risk management behavior (e.g., Silverton, 2006; Björk, 2007).

McCammon (2009) conducted focus groups, expert interviews and site visits to develop a comprehensive picture of the influences on the decision process of OB skiers and snowboarders. Using a health behavior model approach, McCammon (2009) constructed an applied framework that indentifies five distinct stages of avalanche awareness and precautionary behavior among OB skiers (Unaware, Unengaged, Engaged, Emergent and Practitioner). The framework offers avalanche awareness educators and ski resorts tangible guidance for the design of avalanche messages and interventions as risk communications will be most effective when they are matched to the precautionary stage of the target audience (McCammon, 2009).

While the framework promoted by McCammon (2009) builds on the assumption that increased training and skill automatically results in safer behavior, an analysis of OB accidents in Canada and the U.S. shows that OB accidents involve individuals at all precautionary stages (McCammon, Haegeli and Gunn, 2008). This indicates that additional factors are at play when OB skiers and snowboarders make choices about exposing themselves to avalanche hazard.

The goal of this study is to offer an additional perspective by identifying and characterizing OB skiers and snowboarders that are particularly at risk of being involved in an avalanche accident. The results of this study offer interesting insights in the behavioural, motivational, perceptual and attitudinal characteristics characteristic of high-risk OB skiers. The resulting management implications nicely augment the framework of McCammon (2009) by providing the necessary background information for the development of avalanche safety messages and interventions that specifically target individuals most at risk.

2. METHOD

Experience shows that OB skiing is practiced safely by hundreds of skiers and snowboarders every winter. Avalanche risk can be managed by continuously monitoring avalanche conditions and making terrain choices that are appropriate for the current conditions. Avalanche safety equipment, such as beacon, shovel and probe, is carried to facilitate the timely rescue in case of an accident.

The multidimensional character of avalanche risk management is considerably more complex than other risky behaviors that are commonly studied in health research (e.g., unprotected sex, smoking, lack of physical exercise), While these activities are often identified by a single behavioural characteristic (‘Have you had unprotected sex within the last six months?’ or ‘How often do you exercise for longer than 30 minutes in a week?’), this one-dimensional approach is unable adequately capture risk taking in OB skiing.

To better accommodate the multi-dimensional character of avalanche risk management, a more comprehensive approach was developed that uses multiple indicators to segment OB skiers and snowboarders into different risk levels. The following section briefly outlines the approach used in this study, however a full discussion of the methodological approach is beyond the scope of this paper; a detailed description can be found in Gunn (2010).

Due to the distributed character of OB skiing and the significant spatial and temporal variations in avalanche hazard, monitoring campaigns or intercept surveys have significant limitation. To overcome these limitations, a comprehensive online survey was developed to broadly collect detailed information about OB skiing behavior, formal avalanche training, personal experience, motivations, risk perceptions, attitudes, and information about the characteristics of the most common OB skiing partners. In addition, a number of questions examined participants’ comprehension of resort boundary policies including responsibilities of avalanche control program, availability of rescue services in OB terrain, and the meaning of temporary and permanent closures.

To assess OB skiing behavior as a function of avalanche hazard, the survey included a discrete choice experiment (DCE) where survey participants were presented with hypothetical, but realistic OB decision situations (Figure 1). These decision situations consisted of an avalanche danger rating describing the current avalanche conditions and two possible OB runs that were characterized by slope character (open, trees or chute), slope size (small intermediate, or large), slope steepness (blue, black or double black), use (rarely, occasionally or regularly) and number of existing tracks (none, two or several). To make the scenarios as tangible as possible, the first three characteristics were presented combined in a terrain photo. In addition to the given OB runs, there was always also the option to stay inbounds. The task of survey participants was to choose the option they would most likely prefer to ski or snowboard with their most common OB partners under the given avalanche conditions. Each survey participant was presented with a different set of eight OB run choices with the avalanche danger ranging from low to high. In total, the survey consisted of 44 different choice situations that were designed and presented following a statistics design.

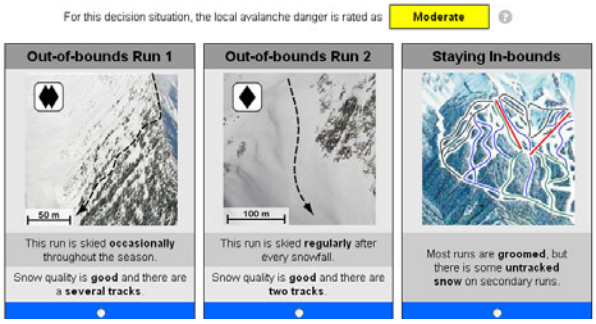


Figure 1: Screen shot of Discrete Choice Experiment for examination of terrain choice in online survey

Data from the discrete choice experiment were examined using multinomial logit models, which describe terrain preferences of the entire sample as a function of the avalanche danger and the various terrain characteristics. However, since we are interested in identifying individuals who exhibit particularly 'risky' behavior, the analysis of general choice preferences is only of limited interest.

Latent class analysis (LCA; Magidson and Vermunt, 2004) is a probabilistic clustering method that can be used for identifying subpopulations within a sample based on similarities in an unobservable (i.e., latent), aggregate variable from multivariate categorical data. The results of a LCA are probabilities of group membership for each individual in the dataset.

Using the software package Latent Gold Choice 4.0 © (Vermunt and Magidson, 2005), LCA was applied to examine the DCE data and segment survey participants into a finite number of classes characterized by similar choice behavior. The analysis produced a final model with three distinct, classes, which exhibited terrain preferences that could be associated to varying levels of risk taking (Gunn, 2010).

LCA was also used to segment survey participants according to the general training and experience level within their most common group of OB partners as well as risk mitigation practices regularly employed by this group. Both of these aspects of avalanche risk management are higher level concepts that are not directly measurable, but aggregates from a number of different related variables. For example, the risk mitigation practice aspect includes whether a the group checks the bulletin prior to going out of bounds, how often they talk about avalanche hazard during their outings, how the group makes travel decisions and whether the group carries avalanche safety equipment. Similarly, the training and experience aspect is an aggregate of a range of group characteristics related to training and experience. For both of these aspects, LCA identified three distinct, ordered classes that could be associated with increasing levels of risk.

The combination of the three individual latent class segmentations of the survey participants according to terrain choices, risk mitigation practices, and training and experience resulted in a total of 27 possible risk combinations. Based on expert opinion, an overall risk level of high, moderate or low was assigned to each of these combinations and therefore all survey participants. While over half of the online participants were categorized as low-risk OB skiers, slightly more than one quarter were classified as moderate risk OB skiers and only 8% were labeled as high-risk OB skiers.

To highlight the specific characteristics of the high-risk cohort, the responses of this group to the remaining survey questions was compared to the responses of the low-risk cohort. Pearson Chi-square tests were used for the comparison of nominal data, Kruskal-Wallis rank sum tests were applied to ordinal and non-normal numerical data. T-tests were used for the comparison of numerical

data that followed a normal distribution. The dimensionality of the Likert-scale motivation questions was reduced using principal component analysis prior to the comparison.

3. RESULTS

The focus of this paper is the comparison between the high and low-risk OB groups. Due to the limited space available, the following discussion only highlights characteristics where we were able to indentify significant differences (p-values < 0.05). The interested reader is referred to Gunn (2010) for a more in-depth discussion of the results of all analysis steps.

3.1 Demographics

Compared to the low-risk cohort, the high-risk cohort was significantly younger, had a lower level of completed education and a larger proportion of males. Over 70% of the high-risk segment was under 34 years old, and females were almost four times less likely to be classified as high-risk than low-risk.

3.2 Travel mode

Individuals classified as high-risk were significantly more likely to travel on downhill skis or snowboards than equipment designed specifically for backcountry travel.

3.3 Resort Policies Comprehension

High-risk OB skiers and snowboarders were significantly less likely to believe that they completely understand resort boundary policies. This perception was confirmed by the fact that they were less likely to believe that OB skiing is permitted under resort policies. High-risk OB skiers were also more likely to believe that ski resorts control avalanches in OB terrain and that rescuing injured skiers in OB terrain is part of their duty. However, no significant differences in perceptions of ski patrol attitudes towards OB skiing were observed between the high and low-risk cohorts.

3.4 Reported Past OB Behavior

Members of the high-risk cohort were less likely to report that they consider avalanche hazard when OB skiing than members of the low-risk cohort. They were also more likely to have skied in permanent and temporary closure areas. Members of the high-risk cohort were considerably less likely to report that they had been involved in an avalanche incident that could have injured or killed someone.

3.5 Risk Perceptions

No significant differences were observed regarding perception of avalanche likelihood between the two groups. Only, marginally significant differences were observed between the low and high-risk groups regarding acceptance of avalanche involvement consequences. High-risk OB skiers appear slightly more accepting of loss of gear, partial or complete burial, minor injuries and death.

3.6 Motivations

Differences in motivational factors suggest that high-risk OB skiers were more likely to be motivated by social and adventure factors and less likely to be motivated by nature experiences.

3.7 Sensation Seeking and Self-efficacy

The high-risk OB skier cohort scored significantly higher than the low-risk cohort on all four categories of the Brief Sensation Seeking Scale (BSSS–8; Hoyle et al., 2002). The largest observed difference between scores for the high and low-risk OB skiers was in the disinhibition category.

The high-risk cohort rated all three measures of avalanche skill self-efficacy (Bandura, 1997) significantly lower than the low-risk group:

- confidence in their ability to recognize situations when they are likely to trigger an avalanche;
- confidence in their ability to rescue a partner who is completely buried by an avalanche; and
- confidence in their ability to talk partners out of skiing a slope they think is dangerous.

It is worth noting that the assessments of the low and high-risk groups were closest in self-efficacy for avalanche assessment, the task that requires the highest level of avalanche expertise.

4. DISCUSSION

In this section, we expand on the characterization of the high-risk cohort by linking the results to existing research in risk communication and health interventions and highlighting important themes for the future development of effective avalanche ac-

cident prevention programs for OB skiers and snowboarders.

4.1 Salience of Avalanche Danger Rating

Several weaknesses identified in the knowledge base of high-risk OB skiers offer opportunities for improvement. An important distinction in the terrain preferences of high-risk OB skiers suggests that improving the salience of the danger rating would be a useful target for a future awareness campaign.

Most members of the high-risk OB cohort exhibited aggressive terrain choices despite higher avalanche danger ratings, which suggests a limited awareness of the extent that avalanche hazard increases with increasing avalanche danger ratings. While experts generally view the avalanche danger scale as increasing exponentially with each step (Haegeli *et al.*, 2010), the terrain choices of the high-risk group in the DCE suggest a linear perception of the danger scale. This confirms the results of previous studies (Björk, 2007; Haegeli *et al.*, 2010) that also indentified potentially dangerous misconception with respect to the avalanche danger scale. While the most recent revision of the North American danger scale (Statham et al. 2010) is a step in the right direction, a more explicit awareness campaign specifically targeted at OB skiers that strongly focuses on the consequence aspect will most likely be required to create the necessary shift in awareness.

While the avalanche danger rating is a key component of avalanche risk communication and considered an important aspect for assessing local avalanche danger (Jamieson *et al.*, 2009), results from the intercept survey that was conducted as in conjunction to the present online survey (see Gunn, 2010 for details) indicate that many OB skiers are unaware of the current danger rating. To address this deficiency, danger rating information should be made more prominent and accessible so that OB skiers are more likely to have this information when making OB terrain choices. Engaging in modern communication technologies such as smart phone applications, Facebook and Twitter might be crucial for connecting with this young target audience.

4.2 Resort Policies

OB policies vary widely between resorts and no clear standards exist (McCammon, 2009). This lack of consistency may contribute to poor comprehension of resort boundary policies. Since high-risk OB skiers generally exhibit worse comprehension than low-risk OB skiers, clarifying and potentially standardizing resort boundary policies and signage should be a part of any comprehensive OB management strategy. An example of a recent development in this aspect is the revised boundary and avalanche signage policy by the Canada West Ski Area Association (2009).

4.3 Attitude towards Ski Patrol

Both, high and low-risk OB skiers demonstrated generally positive perceptions of ski patrollers as approachable and reliable information sources. Given the importance of trust and credibility in risk communication (Covello and Sandman, 2001) the ski patrol should be used as an information channel and role model to reach OB skiers of all levels of experience and risk levels. With encouragement, it is possible that instruction passed from ski patrollers to experienced OB skiers can trickle through the OB community and be transmitted to less experienced OB skiers.

4.4 Beliefs Regarding Consequences

Our findings suggest that high-risk skiers do not perceive the implications of their behavior. No significant differences were observed between the high- and low-risk group in the perceived likelihood of triggering an avalanche, triggering an avalanche resulting in injury, or triggering an avalanche resulting in a fatality. Furthermore, marginally significant differences were observed in the acceptance of avalanche consequences with high-risk OB skiers more likely to accept negative avalanche related outcomes.

Avalanche safety campaign messages should therefore strongly highlight the potential consequences of high-risk behavior in avalanche terrain. It is one of the strongest and most robust findings in warning literature that warning effectiveness increases with the perceived hazardousness of the product (Dejoy, 1999). Campaigns employing vivid imagery as commonly used on cigarette packages (Hammond *et al.*, 2007, Fathelrahman *et al.*, 2009) will more likely be effective in conveying the severity of an avalanche involvement.

The effect of vivid experiences is strongly highlighted by the result that the high-risk group included a significantly lower percentage of individuals that had personal experience with a potentially serious avalanche involvement. The

goal of any awareness campaign should therefore be to recreate such personal experiences as vividly as possible. The video clip that shows a complete avalanche burial filmed with a helmet camera in real time (Chappy, 2009) is an excellent example for the type of powerful material.

4.5 Promotion of Self-Efficacy

Self-efficacy regarding avalanche assessment, rescue, and convincing partners not to ski a run they felt was unsafe was considerably lower among high-risk OB skiers than low-risk OB skiers. Research indicates that in situations where individuals exhibit low self-efficacy, behaviors may fail despite motivations to the contrary. Experimental manipulation of self-efficacy suggests that self-efficacy may be enhanced, and enhancement can be related to subsequent behavioural change (Strecher *et al.*, 1986; Bandura, 1997).

Existing avalanche awareness courses do a good job promoting the development of self-efficacy. 'Beacon practice fields' are examples for additional opportunities for self-directed promotion of self-efficacy in a safe environment. Our research suggests that in addition to the assessment and rescue skills traditionally covered in courses, communication skills are an additional aspect where high-risk OB skiers lack self-efficacy. Instruction in communication, negotiation and refusal skills might be an important addition to existing avalanche courses. Development of self-efficacy can be facilitated through rehearsing behaviors in situations where efficacy is low while being supported by counseling from credible sources (Strecher *et al.*, 1986). These strategies can be used in courses as well as in interactions of ski patrol staff with OB skiers and snowboarders.

Successful health behavior interventions tend to concentrate on reducing one or more behaviors and give a clear message about risk mitigation (McCammon, 2004). Increasing self-efficacy regarding decision-making by introducing simple decision tools for assessing avalanche conditions and making appropriate terrain choices (e.g., Avaluator; Haegeli, 2010) therefore also has great potential among OB skiers. In comparison to a general decision aid for backcountry skiers that needs to be applicable under all conditions, the possibility of direct involvement of the local ski patrol at a ski resort creates the potential for development of decision aids that can incorporate local expert input enabling them to more dynamically respond to local conditions.

4.6 A High-Sensation Seeking Audience

High-risk OB skiers scored significantly higher on total sensation seeking as well as all four subscales: thrill and adventure seeking, boredom susceptibility, experience seeking and disinhibition. According to Zuckerman (2007) sensation seeking is a basic personality trait and, as such, difficult to change. A review of different intervention approaches to address unprotected sex - a risky behavior commonly associated with sensation seeking characteristics - found that programs aimed at reducing unprotected sex were more successful than programs with only abstinence as a goal (Kirby, 2002). It might therefore be more effective to focus on providing OB skiers with tools to make safe OB decisions. Given the findings of this research, this approach is likely to be more effective than attempting to dissuade OB skiing entirely (see, e.g., Fowlie, 2009). Given that high-risk OB skiers are more likely to believe that OB skiing is against resort policies, attempts at discouragement do not seem promising.

The high sensation seeking characteristics of high-risk OB skiers indicates that particular styles of communication will be more effective than others. Communication should be dramatic, emotionally powerful or physically arousing, graphic, explicit and unconventional or suspenseful (Donohew *et al.*, 1991; Everett and Palmgreen, 1995; Lorch *et al.*, 1994; Palmgreen *et al.*, 1991; Palmgreen *et al.*, 2001). Given the importance of public avalanche bulletins and the inability of most OB skiers to accurately recall the danger rating (Gunn, 2010), novel and prominent methods should be explored to promote this information at multiple areas frequented by OB participants in order to elicit attention. While the typically text heavy posting of avalanche information found at many OB gates is an obvious area that has potential for considerable improvement, the same applies to many other avalanche awareness efforts (see recommendations of Kobe and Jenkins, 1990).

The use of dramatic and emotionally powerful messaging is further strongly supported by our observation that a personal avalanche experience seems to be one of the most powerful avalanche awareness teacher (see section 4.4).

An example of a targeted campaign that tries to apply considerable parts of this knowledge is the awareness brochure 'Out-of-Bounds' recently published by the Canadian Avalanche Centre (Turk, 2010; Figure 2).



Figure 2: Cover of an eye catching awareness booklet targeting OB skiers (Turk, 2010).

Written by an avid OB enthusiast herself, the brochure relies heavily on a dynamic and engaging design to draw the attention of OB skiers with limited avalanche awareness and plant an initial seed for the development of avalanche awareness. Attractive riding photos are interspersed with avalanche photos and quotes from professional free-riders about personal avalanche experiences to illustrate that avalanches matter to OB skiers and stress the seriousness of an involvement, Basic safety messages and links to information sources are provided as a first step in the development of personal avalanche skills.

5. CONCLUSION

When visitors to ski resorts cross area boundaries and venture beyond into uncontrolled terrain, they are exposing themselves, either wittingly or unwittingly, to the risk of involvement in a serious avalanche incident. With the current growth in OB skiing, and ongoing occurrences of heavily publicized avalanche fatalities, the need for an effective avalanche safety health behavior campaign is evident.

A solid evidence-based foundation is key to the development of successful health behavior interventions. The goal of this formative research was to better understand the characteristics, perceptions and motivations of OB skiers most at risk of being involved in a serious avalanche incident.

In a first step, survey participants were classified into high-, medium- and low-risk groups using an innovative approach that accounted for the multidimensional character of avalanche risk management. The subsequent extensive comparison between high and low-risk OB skiers and snowboarders provided a broad perspective on specific characteristics of those individuals most at risk of being involved in an avalanche incident.

While McCammon (2009) offers a useful framework for the development of avalanche awareness initiatives targeting of OB skiers and snowboarders at different awareness levels, this research further helps to develop messages that are most effective for affecting the behavior of individuals most at risk of being involved in an avalanche accident.

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