WHO IS INVOLVED IN AVALANCHE ACCIDENTS?

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ABSTRACT: Off-piste and backcountry skiers, snow-shoers, climbers, heli-skiers, hikers, ski patrollers and many more: The range of people who are involved in avalanche accidents is wide—and so are their avalanche knowledge, training and experience. Avalanche hazard information published in avalanche bulletins aim to reach all off-piste and backcountry enthusiasts as well as professionals. However, this can only be done effectively if the characteristics and needs of the target group are known (e.g., language, foreknowledge, the medium of information used and the main interest in the field of snow and avalanches). With that knowledge at hand, forecasters can design avalanche information products that are tailored and more effectively address the needs of the various user groups. In this paper, we investigate a 40-year dataset of the Swiss avalanche accident database and a recent online survey to provide detailed background information on who is involved in avalanche accidents in Switzerland. Our results confirm that most individuals involved in avalanches in Switzerland are men between 20 and 30 in non-guided groups of two to four people. Often groups have an informal leader even if they are not professionally organized. Our findings demonstrate that men show higher willingness to take a risk than women. Furthermore willingness to take a risk also increased with the self-declared level of experience. Travel motivation factors showed that off-piste skiers are more motivated by adrenalin rush than backcountry travelers who mainly enjoy being outdoors.

KEYWORDS: avalanche accidents, avalanche accident statistics, human factors

1. INTRODUCTION

More than 90% of fatal avalanche accidents (data from Switzerland 1987-88 to 1996-97) occurred during recreational activities in uncontrolled avalanche terrain (Schweizer and Lütschg, 2001). One of the primary goal of the daily avalanche bulletins is to reach recreationists and prevent these accidents. Originally recreational activities in avalanche terrain were dominated by classical mountaineering and backcountry skiing and the avalanche community had a good understanding of their perspectives and needs. Over the last decades, we have seen a general increase in the number of backcountry users (Zweifel et al., 2006) as well as the appearance of numerous new backcountry activities including off-piste skiing, ice climbing, snow-shoeing or speed flying. A detailed understanding of the perspectives and needs of these newer backcountry user groups is critical for the development of products and services that can reach them effectively and reduce their numbers of accidents and fatalities. However, this information currently does not exist.

The goal of the present study is to provide the foundation to guide future backcountry user group studies by providing an up-to-date perspective on who is involved in avalanche accidents in Switzerland.

2. PREVIOUS RESEARCH

Previous research has shown that there are common aspects in recreational avalanche accidents. In Europe, the groups most frequently involved in accidents are backcountry skiers, off-piste skiers and mountaineers (Etter et al., 2005; Jarry and Sivardière, 2001; Tschirky et al., 2001; Valt et al., 2009). Snowboarding and snowshoeing increasingly contribute to the number of accidents in Switzerland (Harvey and Zweifel, 2008). In the United States snowmobilers and backcountry skiers account for 79% of all avalanche fatalities between 1999-2000 to 2008-09 (Atkins, 2010). Avalanche accidents typically involve men (90%) with the most important common age range from 20 to 29 year (Atkins and Williams, 2001; Harvey and Signorell, 2002; Irwin and Owens, 2005; Jamieson et al., 2010). The highest number of fatal accidents occurred in groups consisting of

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two or three people (Atkins and Williams, 2001). In Switzerland, group size in avalanche accidents decreased significantly in recent years (Harvey and Zweifel, 2008). In Switzerland fatalities in guided groups showed a significant decreasing trend (Harvey and Zweifel, 2008).

It is difficult to gain more detailed insight from avalanche statistics as most avalanche databases do not record more details on groups or individuals. Another way to obtain information on group composition and behavior of people moving in avalanche terrain are survey studies, a relatively new area of avalanche safety research (Björk, 2007; Bright, 2010; Gleason et al., 2006; Gunn, 2010; Zgraggen, 2004). Even if the results of these studies are partly different mainly due to different group samples some common findings emerge: most people participating in the surveys were aware of the avalanche risk, informed about danger and used risk mitigation practices. People were equipped with avalanche beacon, shovel, probe and cell phone, only few people used further avalanche safety devices like avalanche airbag backpacks or AvaLung. These results based on self-declaration in online surveys do obviously not agree with what can actually be observed in the field. Percentage of individuals who are aware of the avalanche risk (and therefore also better equipped with avalanche safety gear) is lower in intercept surveys than in online survey (Björk, 2007; Gunn, 2010).

However, the topic of investigation is prone to fast changing behavior and previous research is partly based on old datasets or does not describe all characteristics of individuals and groups in avalanche accidents. Therefore, we conducted the investigation at hand which will be described in the following section.

3. DATA AND METHODS

We analyzed a dataset from the Swiss avalanche accident database and used data from an online survey.

3.1 Swiss avalanche accidents dataset

The dataset from Swiss avalanche accidents covers a 40-year period from 1970-1971 to 2009-2010 with 8130 avalanches recorded, including 2239 datasets from recreational avalanche accidents. In these 2239 avalanches, 4619 people were caught and 898 were killed. The data from the Swiss avalanche accident database were analyzed by decades. Monotonic trends in annual data were tested using the Mann-Kendall trend test, which is based on the Kendall rank correlation (Hipel and McLeod, 1994; Mann, 1945).

3.2 Online survey dataset

The second dataset used in this study was collected using an online survey. The first part of the survey included questions on backcountry experience, avalanche specific education, leading and deciding preferences, risk awareness, willingness to take risk as well as basic socio-demographics. Survey participants were asked to enter their personal information as well as the information for their typical backcountry companions. The second part contained questions on travel motivation, decision making approach during trip planning and during backcountry outings as well as potential human factors affecting the decision process. These questions were asked using 5-point Likert scales (Likert, 1932) with proposed factors as well as open text fields.

The online survey was open for participation between 31 May 2012 to 30 July 2012 and links to the survey were posted on websites giving information on travel conditions in the mountains (www.gipfebuch.ch, www.skirando.fr, www.camptocamp.org), on facebook (personal site of first author, posts on the sites of Snowboarder Magazine, Snowboarder MBM, Powder Magazine, Downdays, Freeskier Magazine, Snowshoe Magazine and youth of the German Alpine Club). The survey was also promoted via a number of email lists (avalanche accident reporters 2010-11, snowtrail map buyers, Academic Alpine Club Zürich). Despite the survey being posted in early summer, a total of 570 respondents completed the survey. Statistical significance was tested using the non-parametric Wilcoxon rank-sum test (Starnes et al., 2012).

4. RESULTS

4.1 Swiss avalanche accident dataset

An examination of the full dataset of people caught in avalanches shows that 81% (1985 of 2446) of Swiss avalanche victims were male and 19% (461 of 2446) were female with only very small variations over time (less than 3% over the last four decades). The age of avalanche victims ranged from 1 to 80. Thirty-one percent of the

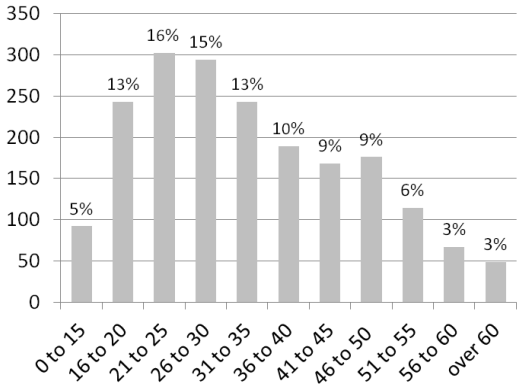

Figure 1: People caught in avalanches in Switzerland by age group, 1970-1971 to 2009-2010 (n=1937).

individuals (596 of 1937) was between 21 and 30 years old (Figure 1). Interestingly, the percentage of avalanche accidents involving people younger than 25 decreased significantly over the study period ($p<0.01$).

In 94% of the accidents (1713 of 1822) only one group was involved; in 6% two or more groups were involved in the same accident. Thirty-three percent of accidents occurred in groups of two (547 of 1663) and 19% in groups of three people (Figure 2). Single individuals were involved in 8%, groups of ten or more people accounted for 8% of accidents. The number of accidents reported increased with time as more and more accidents with no serious consequences are reported. The number of accidents with only one individual involved increased with time ($p<0.001$) while accidents with large groups (10+ people) decreased ($p=0.07$). Twenty-seven percent of the accidents involved guided groups (only accidents with one group, 329 of 1205) and 73% non-guided groups. The proportion of fatalities in guided groups was lowest in the 2000s (Figure 3). Sixty-

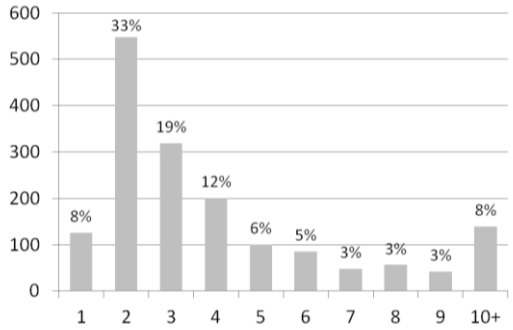

Figure 2: Accidents in Switzerland by group size, 1970-1971 to 2009-2010 (n=1663).

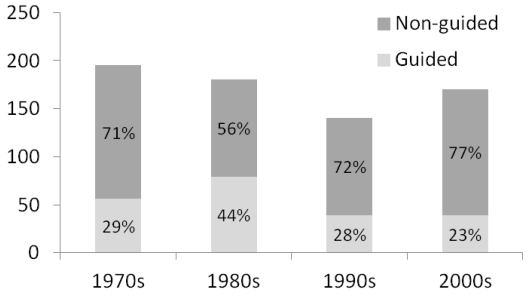

Figure 3: Proportion of fatalities in guided and non-guided groups in Switzerland from 1970-1971 to 2009-2010 by decades (n=685).

three percent (550 of 870) of avalanche fatalities were Swiss nationals and 37% were from other countries with the largest groups from neighboring countries Germany, France, Italy and Austria.

4.2 Online survey dataset

For the first part of the survey analyses were limited to respondents only. Data provided by respondents about other group members were not considered as data quality is uncertain. Eighty-seven percent of respondents were male (473 of 544) and 13% female. Main age groups of respondents was 25 to 35 years and median age was 39. People aged 25 and younger were under-represented in the survey compared to the age distribution found in the avalanche accident statistics. Sixty-five percent of the individuals participating in the survey reported to travel in groups of two to four people (373 of 570). Generally, these groups were not formally organized although most of them had an informal leader, who had more backcountry experience, was more avalanche trained and preferred to decide (rather than the other group-members).

In the survey people were asked to assess their willingness to take risk on a scale including “high”, “mean” and “low”. Respondents who were prepared to take a higher risk were more often caught in avalanches (41%) than people willing to take a lower risk (21% caught). Men had a higher willingness to take risk than women and were caught in 28% in avalanches, women only in 15%. Willingness to take a risk increased with increasing backcountry experience ($p<0.001$, Figure 4). A considerable proportion of the respondents had been caught at least once in an avalanche during their backcountry outings (26%). This percentage rises significantly ($p<0.01$) with increasing life-time backcountry exposure: from 10% for the 25% of the respondents with the least

backcountry days to 43% for the 25% with the most days.

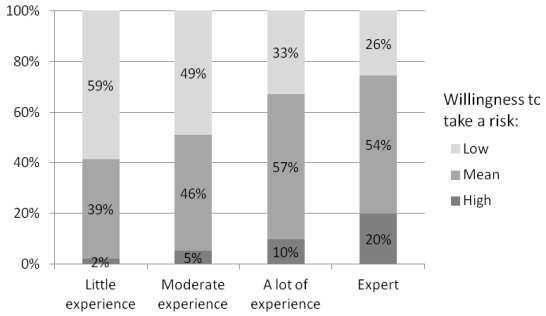

Figure 4: Relativ willingness to take a risk by experience (n=553).

Ninety-five percent of respondents (543 of 570) were aware of the risk of getting caught in an avalanche. Sixty-three percent (356 of 566) traveled with friends, 17% with a partner, 13% in organized groups, 4% alone and 3% with family members. Table 1 shows participants' motivation to go on a trip. Off-piste skiers were significantly ($p<0.001$) more motivated by adrenalin rush on the downhill than backcountry skiers, while backcountry skiers put more weight on summit experience than off-piste skiers ($p<0.001$).

Table 1: Travel motivation by activity

	Backcountry	Off-piste
Fitness/exercise	52%	26%
Outdoor recreation	80%	76%
Adrenalin rush on the downhill	21%	53%
Getting away from daily stress	49%	33%
Summit experience	66%	22%
Powder snow	60%	87%

Eighty-five percent of participants (462 of 541) stated that they plan a trip, 13% (with a higher percentage for off-piste skier) decided spontaneously (71 of 541), only 1% hired a guide (6 of 541) and 2 out of 541 went always on the same trip. The three most frequently named factors for trip-planning were related to the expected conditions: avalanche danger level as forecasted in the bulletin (85% of respondents "strongly agreed")[1], weather (82%) and snow conditions (76%). These were rated significantly ($p<0.001$) more important than characteristics of the planned tour (38-53%) and group-related factors (group-size, -experience, skiing abilities, 35-55%). For decision-making during the backcountry outing, again the condition related factors were most important (77-81%). Additionally, the terrain (71%) as well as the own snow stability assessment (79%) gained importance. The latter ranked similar to the official hazard forecast for both experienced and relatively un-experienced backcountry users. As was the case for the trip planning, these factors were rated more importantly than group-related factors ($p<0.001$). When people were asked what typically leads to poor decisions in their group in avalanche terrain, most often named was a poor assessment of the avalanche hazard ($p<0.001$). However, group dynamics and group pressure were also considered important factors (Figure 5).

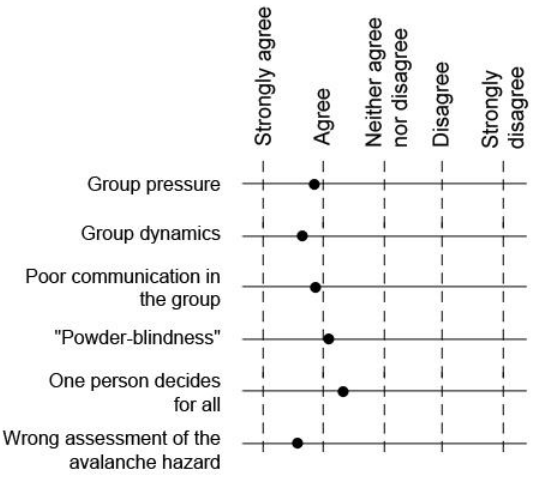

Figure 5: Factors for poor decision-making in avalanche terrain (488 respondents).

5. DISCUSSION

Results on gender and age were not surprising: males in their twenties are the largest age group among avalanche victims in Switzerland. This is in agreement with previous accident statistic studies from Switzerland (Harvey and Signorell, 2002) and also from other countries (Atkins and Williams, 2001; Irwin and Owens, 2005; Jamieson et al., 2010). Accidents with more than one group show up in 6% of cases. This situation may increase

[1] We used the 5-scale Likert scale: „strongly agree", "agree", "neither agree nor disagree", "disagree" and "strongly disagree".

with the increasing number of backcountry travelers. An example of such an accident occurred in the Safiental valley/Switzerland during the winter 2009-10 when three different backcountry groups on the same route were hit by an avalanche (Etter et al., 2012). Small groups (two to four people) show up most in avalanche accidents accordingly to Atkins (2010). The decreasing number of accidents with large groups may be a result of avalanche education as in the last decade education has focused on reducing the risk by, for example, forming small groups. Seventy-three percent of accidents happened in groups without a guide with the highest proportion (non-guided vs. guided) in the 2000s. This finding agrees with results of Harvey and Zweifel (2008), who found that the ratio of fatalities in guided and non-guided activities dropped significantly from 40:60 to under 20:80.

Data from the online survey should be interpreted more cautiously than data from the avalanche accident database as we do not know how representative our sample of respondants is. Most groups in the survey that were not under professional guidance seemed to have an informal leader. Males are willing to take a higher risk than females. Willingness to take risk correlated with avalanche involvement and increased with self-declared level of experience. This is in agreement with (McCammon, 2002) who has shown that experienced individuals are as frequently caught as un-experienced. We attribute this to be a risk-compensation effect (Sole, 2008; Wilde, 1982). Although 95% of survey particiants stated that they were aware of the avalanche risk, we can observe many avalanche accidents where people were not aware of the risk and got surprised. Probably people not aware of avalanche risk were not reached by the survey or did not respond. Travel motivation factors showed that off-piste skiers were more motivated by adrenalin rush on the downhill than backcountry skiers, while backcountry skiers put more weight on summit experience than off-piste skiers. That off-piste skier are more forced by fun and adrenalin factors than backcountry skiers was also found in previous research (Sole, 2008). Decision making factors (while planing and in the backcountry) showed that people rated factors related to the expected conditions (e.g., weather, forecast from the bulletin or snow conditions) more importantly than group-related factors (e.g., group-size, -experience, skiing abilities). But differences among groups were very small. Differences in “go or no go”-decisions in terrain that we observed, probably have different reasons. Factors favoring poor decision making were inconclusive.

6. CONCLUSIONS

We explored a 40-years data set of the Swiss avalanche accident database and data from an online survey focusing on groups exposed to avalanche terrain in terms of characterization of individuals by age and gender, groups by size, composition, organization, travel motivation factors, factors considered for decision making and potential factors for poor decisions. Accident data are the most valuable for describing who is involved in avalanche accidents and gives a sound base for further studies in this research field. But since the true number of people venturing off-piste or into the backcountry is not known (Zweifel et al., 2006) assessment of risk of different groups or individuals will be left difficult. And due to limitation in existing avalanche accident records, this approach can only provide limited details on aspects like group composition, group dynamic or decision making. Therefore we should investigate methods to further explore the risk of people exposed to avalanche terrain. To find more insights about group composition, group organization or decision making online surveys can give interesting results but we should always consider that representativeness of such survey populations is not clear. When we see that decision making in avalanche terrain is very complex, it is hard to gain detailed enough data from online surveys. Probably qualitative methods from social science can give better results in future.

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