

Avalanche accident documentation is of fundamental importance to understand the dynamics, taking place in snow, of risky activities in order to implement the best possible prevention strategies

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ABSTRACT: Avalanche accident documentation is of fundamental importance to understand the dynamics, taking place in snow, of risky activities in order to implement the best possible prevention strategies. Every year a hundred people die in the Alps buried by avalanches, of whom about 20% on the Italian side of the Alps. In Italy, although mortality statistical figures are available from 1967 to 2012, it is only since 1984 that data is collected systematically. AINEVA database stores about 1,200 known avalanche accidents, including even some significant events on the Apennines, with 2,400 people buried and more than 500 fatalities. The number of casualties varies every season depending on the snowcover type and quality. Backcountry skiing is still the recreational activity with the highest number of accidents, followed by off-piste skiing. Since 1984, snow conditions in the Alps have changed considerably, as well as the hikers' behaviour. In the last few years, accidents have been recorded in early winter, too, while in the 1980s they usually occurred mainly during spring time. The most dangerous slopes on the Italian Alps are the northern aspect with also the eastern quadrants, where avalanches with less thick snowcover may occur. During the 1990s, there has been an increase in the number of snowboarder accidents, while during the 2000s hikers with snowshoes replaced such trend. Lately, snowmobile and eliski categories have increased significantly, as well as accidents involving foreigners. For the most recent period, databases also store the duration of self-rescue operations and timing of organized rescue. Experiments carried out over the last 5 years on avalanche transceivers practice fields show a decrease in search times of avalanche victims with the latest devices.

KEYWORDS: avalanche accidents, historical series, Italy, professionals, search times of avalanche

1 INTRODUCTION

Every year in the Alps a hundred people die after being buried by avalanches. The number of casualties varies depending on snow conditions in each country (Italian, Austrian, etc.) and the snowcover type and quality. The 2009-2010 winter season recorded the highest number of casualties since 1984 to date, with 158 fatalities, while in the last season (2012-2013), 108 casualties were recorded (figures as at 30 May 2013).

In the Italian Alps, from 1984 to 2013, 1,286 avalanche accidents have been recorded with 587 casualties, 46 every 100 accidents (46%-mortality index). In the last 10 years (2004-2013) this index fell to 32%, though being always a really high rate if compared with the mortality index of road accidents, 1.85% (Istat, 2011 <http://www.istat.it/it/archivio/65205>).

The study of avalanche accidents is fundamental to understand the dynamics of accidents and find the best possible prevention strategies in a field that ranges from densely populated

areas subject to preventive control to individual recreational and sport activities.

The aim of this work is to illustrate some characteristics of the avalanche accidents occurred in the Italian Alps also in relation with the latest technological advances in searching equipment for buried people.

2 DATA

In Italy, data on avalanche accidents are collected by several organizations responsible for accident prevention and mountain rescue: the avalanche services belonging to AINEVA, the Italian Alpine and Speleological Rescue Authority (CNSAS), the Alpin Verein Sudirol (AVS), the Italian Avalanche Service (SVI/CAI) and the Financial Police Alpine Rescue Service (SAGF).

All related figures are gathered by the Associazione Interregionale Neve e Valanghe (AINEVA) - (Cagnati e Valt, 1989).

Only known avalanche accidents involving people and for which, in some cases, intervention of rescue teams was required, are filed.

For the historic reconstruction of some events, the works by Gansser (1986), Cagnati e Valt (1989), Valla (1990), Zuanon (1996), Valt e al. (2003), Valt (2009, 2011) have been consulted.

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In the present work, and mainly in graphics, when referring to events related to a certain year, this year is to be intended as hydrological year (from 1 October to 30 September of the following year).

3 AVALANCHE ACCIDENTS IN ITALY 1984-2013

In the 1984-2013 period, on average 20 people were killed every season (Figure 1). 2,717 people were caught by avalanches in 1,286 accidents and 587 of them died (22%), while 1,955 survived (78%). Similar percentages were also observed in Switzerland where, in the 1980–1999 period 2,301 people were buried, and 523 of them were killed (23%) - (Tschirky et al. 2000) and in France where, in the 1989-2001 period, 1,171 people were buried and 372 of them died (32%) - (Sivardi re, 2002).

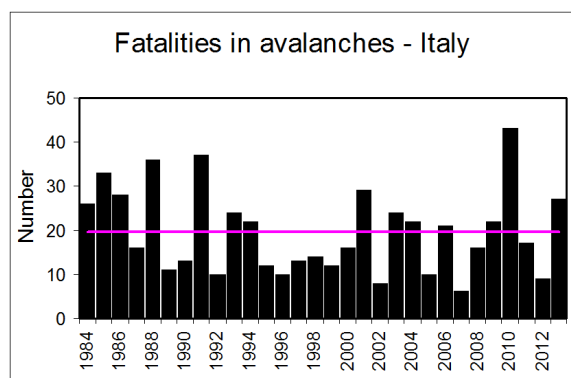


Figure 1. Avalanche casualties in Italy per winter season.

In 74% of fatal accidents there has been one casualty, while in 22% of accidents 2-3 people have died. In the remaining 4% of cases very serious accidents have occurred (with more than 4 victims), among which from 1985 to 2012:

- 17 February 1991, Vallone di Pra Moullin Pavillon. Courmayeur (AO), 12 skiers;
- 9 December 1990. Gola della Chiusetta – Marguareis (CN), 9 speleologists;
- 2 August 1993, Grandes Jorasses, Courmayeur (AO), 8 climbers;
- 17 September 1985, Lyskamm (AO) 6 climbers;
- 30 April 2008, Punta Basei. Valle Orco, 5 backcountry skiers;
- and 10 other accidents, each with 4 casualties.

4 CATEGORIES AFFECTED

According to CISA-IKAR classifications, avalanche accidents fall in two main categories:

- recreational activities that include backcountry skiing (hiking with sealskin and/or snow

shoes); off-piste skiing (skiers /snowboarders); skiing and climbing (also on icefall);

- non-recreational activities that include those accidents that occur on communication routes or that affect buildings and villages.

Figure 2 shows the percentages of avalanche casualties, in Italy, according to the different categories.

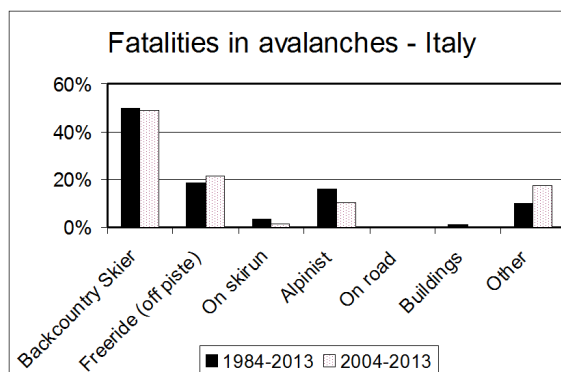


Figure 2. Avalanche casualties in Italy according to category .

Backcountry skiing is the recreational activity with the highest number of casualties, with an average of 9 casualties a year and a 50% rate in Switzerland (11 casualties), while the France rate is 45% (12 casualties) and 55% in Austria (14 casualties).

In the last 10 years, the percentage of casualties among backcountry skiers has slightly decreased (49%) as compared with the long-term average, just like the percentage among climbers, down from 16% to 10%, while the rate among off-piste skiers has slightly increased, from 19% to 22%. In France (1984-2013), the rate of casualties among off-piste skiers is 48% (36% in the last 10 years), 27% in Switzerland and Austria (24% and 28 % in the last 10 years, respectively).

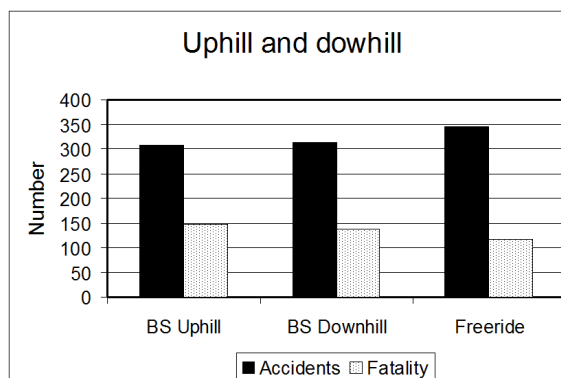


Figure 3. Casualties and accidents among backcountry skiers (BS) and freeriders.

Among backcountry skiers, the same number of casualties is recorded during uphill and downhill skiing. Considering off-piste skiers as well, most avalanche accidents generally occur during downhill (Figure 3).

In Morgex (Valle d'Aosta) in February 1999, the last fatal accident involving a village was recorded. In France and Switzerland, too, the last people to be killed by avalanches in their own homes date back to winter 1999, while in Austria the last casualty was recorded in 2002.

Hikers on snowshoes account for a strongly growing category in Italy, with 25 casualties in 27 known accidents in the last 10 years (Figure 4).

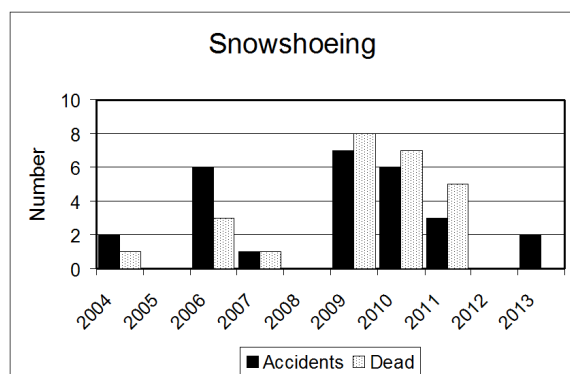


Figure 4. Casualties and accidents among snowshoe hikers.

As for snowmobile hiking, 9 accidents have been recorded, 8 of which with casualties.

The number of accidents taking place in areas not subject to control account for 92% of known cases, against 8% of accidents recorded in areas subject to preventive control. No changes have been recorded in the last 10 years. In general, in all the countries for which statistical figures over a significant period (10-30 years) are available, 95 - 97% of casualties are related to recreational activities. This confirms what has emerged from other studies, i.e. that 95% of avalanche accidents are triggered by people, whereas only 5 % are natural (Harvey and al, 2002).

5 SOME CHARACTERISTICS OF AVALANCHE ACCIDENTS IN THE ITALIAN ALPS

The study of the morphological characteristics of natural and/or artificial avalanche releases can offer some important indications about the regional characteristics of avalanches for the aim of prevention.

The average slope gradient value of the release area is 37.7° (38.5° for avalanches with casualties) that is close to the average value of 39° calculated by Scheweizer and Jameson

(2011) for 1,411 accidents observed in Canada and Switzerland. The average values calculated for the different categories do not show major variations and gradient values in avalanche release areas range between 37– 38° (Valt, 2009).

Avalanche accidents take place mainly on NW-N-NE slopes, and in the SE sector, where the snowcover height is lower than the 56 cm (average value) measured on the other slope aspects (Valt, 2011) (Figure 5).

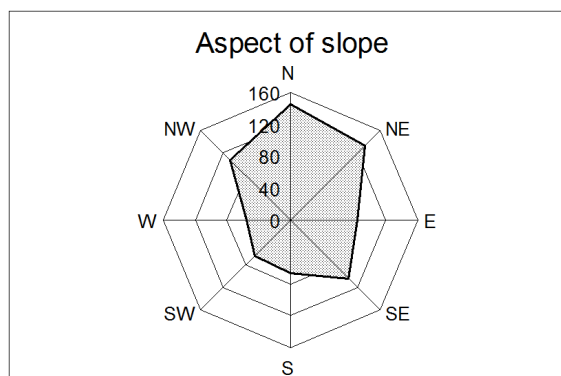


Figure 5. Aspect of slope for avalanche accidents.

As for altitude, no significant changes have been observed over the years. The average release height is between 2,300-2,450 m, much above the areas where a decrease of snowcover surface has been observed (an area between 1,500-2,100 m of height) (Valt e Cianfarra, 2010).

The weak layer of snowcover most frequently observed in avalanche release areas is made up of surface hoar (SH) covered by snowfalls, kinetic growth layers (FC and DH) and, for the eastern sector of Italian Alps, also melt snow layers (MF, MFsm) (Valt, 2011).

As it has been observed in Switzerland, most accidents take place during weekends (56%) and on Monday (12%). In Austria, in the Salzburg Land, the most critical days, other than weekends, are Wednesday and Friday. (Niedermoser, 2001).

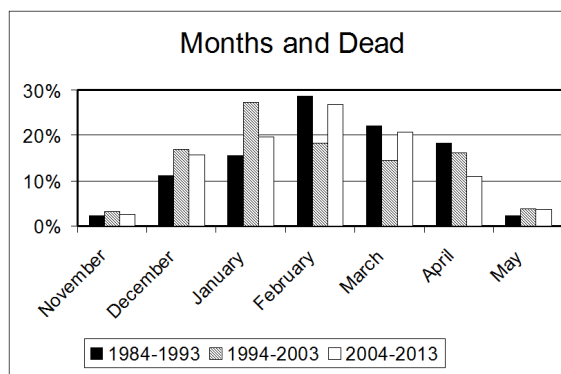


Figure 6. Casualties in the different winter months.

In the last ten years, a higher rate of avalanche accidents has also been observed in December and January, compared with February-March in the 1984-1993 ten year period (Figure 6).

6 RECOVERY OF AVALANCHE BURIED PEOPLE

Every time an avalanche accident occurs, there are “many” people who are not affected and who can therefore bring their help. Among all avalanche buried people, only 36% are completely buried, while the others are partially buried or remain on the surface (Fig. 7).

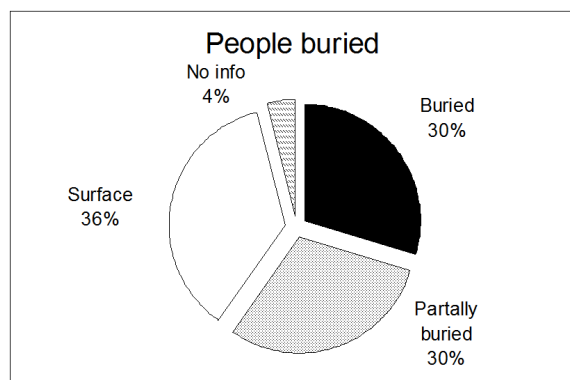


Figure 7. Avalanche buried people.

It is thus possible to say that, as a rule, save for the accidents where a single person is involved (19%), there are many people who are not involved and who can set off self-rescue procedures with Avalanche Transceiver (AT), shovel and probe.

However, recovery of avalanche buried people (buried, partially buried, on surface) using AT still amounts to a low rate corresponding to 8% of buried people, with only a slight increase in the last 10 years (12%).



Figure 8. Methods for finding avalanche buried people. Success rate.

In the last 10 years, 39% of fully buried people were found with the AT, over 51% through visual/audible search, 6% by means of probe

search and 4% by means of UCV. Compared with the other systems, the AT still turns out to be the most effective searching system (Figure 8).

Documentation provided by the AINEVA databank is probably incomplete with respect to the real case histories that can be found in specialized websites, but the figures shown in the present paper refer to accidents documented in AINEVA.

Using a database of accidents taking place from 2003 to 2012, it was possible to calculate rescue times of buried people.

The average time for finding buried people by their fellow travelers (self-rescue) is 16 minutes, with a time of 10 minutes for buried people found still alive. As for organized rescue, the average time was 62 minutes, with a time of 25 minutes for buried people found still alive (Valt, 2011).

These values highlight the importance of self-rescue as well as the importance of prompt organized rescue, thanks to which it was possible to rescue many buried people in a relatively short time (25 minutes) (Figure 9).

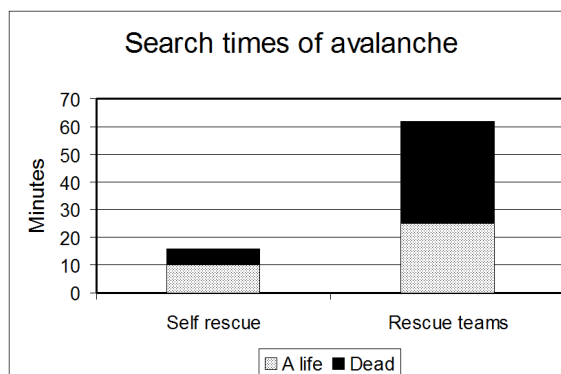


Figure 9. Rescue times for avalanche buried people.

It is therefore possible to say that search with AT, shovel and probe still represents the best rescue strategy for avalanche buried people.

In addition to having the suitable equipment, people need adequate training in order to be ready and effective in case of necessity.

Training is carried out at AT fields and it is of fundamental importance. A survey carried out on more than 400 new apprentice ski instructors, while learning search techniques with AT, underlined that the average search and probing time at the first attempt is 3'25", falling to 2'55" at the second attempt (AT with 2 and 3 antennas).

As for the first search attempt with double antennas beacons, the average time was 4'53" and 2'46" with a three antennas beacons, falling to 2'30" at the second attempt (Figure 10).

The AT field used for tests is at 2,350 m of altitude, it has uneven ground and measures 200x100 m; apprentices had previously attended a 2-hour theoretical lesson to learn to use AT, a 15-minute individual practical lesson on probing techniques and a collective search test.

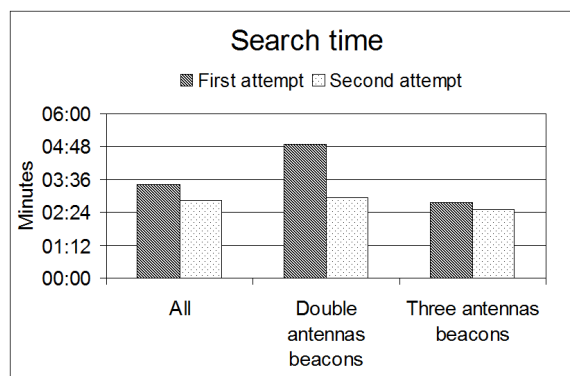


Figure 10. Search times with AT and probe at training fields

7 ACCIDENTS AND AVALANCHE HAZARD DEGREE

In the Italian Alps, most avalanche accidents occur with a considerable avalanche danger level. In the last 10 years (2004-2013), 2 accidents with very high danger level were recorded during 2008-2009, an exceptional winter. Accidents taking place with a low danger level only account for 2% of cases.

Analyzing the different categories of mountain hikers, it can be observed that, among backcountry skiers, a high number of avalanche accidents also occur with a moderate danger level and a much lower number with a high danger level. On the contrary, among off-piste skiers, the number of accidents with high danger level is almost the same as the number of accidents with moderate hazard level. As for communication routes, accidents too frequently occur with a high danger level, in addition to considerable danger level.

It's a common notion that in winter the hazard level most frequently used is "considerable", also in the light of the high number of accidents that usually occur in this period.

Yet, the figures provided by AINEVA and related to the avalanche hazard level shown in bulletins for the 47 homogenous climatic micro-areas of the Alps, for the 2007-2013 period, show that the most frequently used danger level is "moderate" (44% of days) followed by "considerable" (28%) and "weak" (25%). The "high" danger level was used only in 3% of cases, and the "very high" degree only for few days during the 2008-2009 season. Therefore in 72% of days the hazard level adopted is lower than

"considerable". It ensues that the number of critical days in a winter season is relatively low, but with a high probability of avalanche accidents.

8 AVALANCHE ACCIDENTS AMONG PROFESSIONALS

The term "mountain professionals" is used to indicate those people who regularly frequent mountains for their profession: mountain guides, aspirant guides, mountain rescuers, ski instructors, members of avalanche services, ski-patrollers and snowplough operators.

The AINEVA database shows that in 30 years there have been 174 accidents (15% of the total, 17% in the last 10 years) involving these categories. 47% of these 174 accidents involved a mountain guide or aspirant guides (either Italian or foreigner), in 14% of cases a ski instructor was involved, in 15% of cases people working in ski areas (snowmobile operators, people supervising road opening or closing, etc) and a lower percentage of Alpine Club instructors, avalanche service operators, operators responsible for route maintenance, and mountain rescuers (Figure 11).

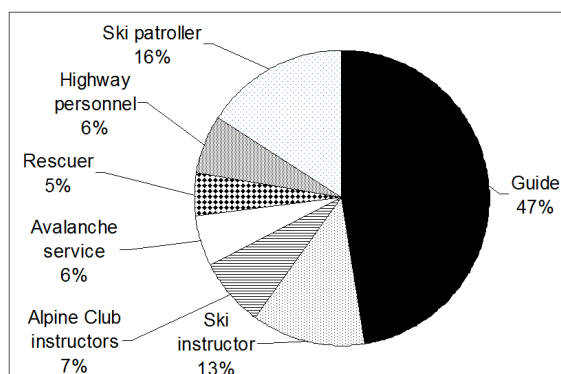


Figure 11. Avalanche accidents among professionals.

10 ACKNOWLEDGMENTS

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