

## AVALANCHE ACCIDENTS IN THE ITALIAN ALPS 1985-2009

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**ABSTRACT:** Avalanche accidents show a very high mortality rate that ranges from 60 % to 70%, i.e. much higher than that of traffic accidents (3% of casualties every 100 accidents). The study of avalanche accidents thus offers a basis to understand the dynamics of the event and search for necessary prevention strategies in a field that ranges from anthropised zones subject to preventive control to recreational and sports activities in leisure time. In Italy, the most exhaustive database is managed by AINEVA (the snow and avalanche interregional association), whose activities also include gathering of data and information on avalanche accidents, in order to determine, from the analysis of events, behavioral lines and useful actions aimed at reducing risk. This work follows the one carried out in 2003 by Valt et al. which analysed twenty years of data (1984- 2003) and, from one hand it is an update of the previous one, and from the other provides new viewpoints of the problem. Therefore the work illustrates the results of the analyses carried out on more than 950 avalanche accidents included in the information archives of AINEVA and compared with the results from similar works carried out abroad. The period considered goes from the winter season 1984-85 to 2008-09 (25 years). For the analyses of the morphological features of avalanches, the sample of data available is more limited (roughly 500 accidents), but is well-distributed within the period considered. For the analysis of the number of casualties the sample available is more comprehensive, going from 1967 to 2009 (41 years).

**KEYWORDS:** Avalanche accidents, Danger degree, Mountain professionals, Rescue

### 1. INTRODUCTION

In the last years, several papers on avalanche accidents and related issues were published on foreign scientific and sport reviews. In Italy, AINEVA (Interregional Association Snow and Avalanches) rearranged available data: as one of its institutional tasks is to collect and analyze avalanche accidents information and data to characterize behaviour trends and actions useful to reduce the risk (Cagnati and Valt, 1989).

This paper describes results of 950 avalanche accidents analysis (each accident is stored in AINEVA's data set), and compares them with similar works published in other countries. Record's time span covers the period between 1984-1985 and 2008-2009 winter seasons (25 years). The statistical analysis of morphologic avalanche characteristics uses a smaller dataset - for the same time span (nearly 500 accidents) - but evenly distributed. The dataset number of victims covers instead a larger time span from 1967 up to 2009 (41 years).

### 2. DATA SOURCE

In Italy several different organizations are in charge of avalanche rescue and accident prevention: AINEVA's Avalanche Services, National Alpine and Spelaeologic Rescue Service (CNSAS), Alpin Verein Suidtirol (AVS), Italian Avalanche Service (SVI-CAI), Guardia di Finanza Rescue Service (SAGF).

Listed accidents are only the ones with people caught, which often require rescue teams intervention or which are object of further investigations by Avalanche Services. Accidents with no data available or which produced only material damages are usually not considered. Seracs collapses are listed only if events gave rise to an avalanche, following CISA-IKAR recommendations.

In this paper and its figures, events are time-related using the concept of hydrological year (from 1<sup>st</sup> October of one solar year to the 30<sup>th</sup> September of next one). Some historical events where retrieved from Gansser (1986), Cagnati e Valt (1989), Valla (1990), Valt (2003) and Zuanon (1996) papers.

### 3. PEOPLE CAUGHT AND AVALANCHE VICTIMS

During the period 1967 – 2009, 827 people died in avalanche accidents in Italy. Mean value, over 41 years period, is of 19 victims per

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year, but in the last ten years a reduction trend takes shape (a mean value of 17 victims per season) – (Fig. 1). Switzerland shows, during the period 1985-2009, a medium value of 24 avalanche victims for each winter season, France has 30 and Austria 26 victims for each winter season (CISA-IKAR data). During the last 25 years, 2032 people were caught in 954 avalanches accidents, 466 were fatalities (23%), whereas 1566 survived (77%). Similar percentage values were observed in Switzerland, where during the 1980-1999 period (20 years), 2301 people were caught, with 523 fatalities (23%) - (Tschirky et al., 2000) and in France, where - during the 1989-2001 period (12 years) - 1171 people were caught with 372 fatalities (32%) – (Sivardière, 2002).

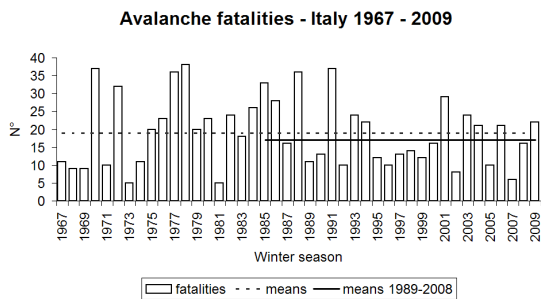


Figure 1. Avalanche victims in Italy.

4. AVALANCHE ACCIDENTS TIME DISTRIBUTION

Since 1984 avalanche accidents happened, in Italy, during all months with an, obvious, greater concentration between December and April (89%). November and May show a similar number of events.

Data on avalanche accidents provide a useful clue on how has changed mountain recreation activity during last two decades. During the 1985-1994 period 59% of avalanche accidents happened between February and April and only 30% between November and January. During the last decade the quarter between November and January accounted 45% of all events (Figure. 2).

Data from Canada emphasize March as more critical month (28% of accidents), in Switzerland is February followed by March (Harvey et al., 2002), whereas in Italy January and February are the more critical months with a predominance of the former in the last decade.

Avalanche accidents distribution during week days shows a peak during the week-end (56%), while the remaining value equally distributes between the other days with the exception of Monday (12%) which shows slightly higher values.

Avalanche accidents during 1985-1994 and 2000 - 2009

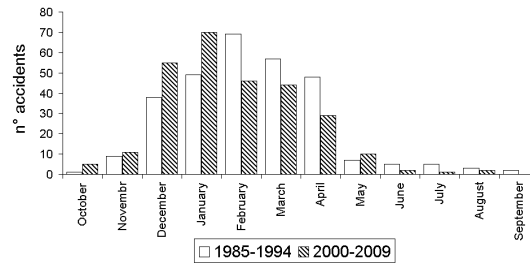


Figure 2. Avalanche accidents by month and distributed in two different decades.

Same distribution was found also in Switzerland, whereas in Salzburg Land (Austria) Wednesday and Friday prevail against the other three work-days with an increasing value toward Sunday.

5. SPATIAL DISTRIBUTION

Recreational avalanche accidents are located mainly on North West to North East slope aspects and on South Est ones. The mean altitude of the fracture line is comprised between 2200 and 2500 metres (mean value is 2419 m) – without any significant difference between Western and Eastern Alps. Mean fracture line altitude is at 2400 m in Switzerland and at 2000 m in Canada (Schweizer and Jamieson, 2001). Northern aspect slopes are classified as the most prone to avalanche accidents as shown also in foreign papers. On a dataset of 634 human triggered avalanches in Switzerland, between 1988 – 1997 period, prevailing fracture line were centred on North East slope aspect, in Canada on East ones.

Mean slope inclination value of fracture line is 37° (from 1411 avalanche accidents from Canada and Switzerland – Schweizer and Jamieson, 2001).

Depth of fracture values, more frequently observed, are comprised between 20 and 40 cm (Fig. 3). Combined data from Switzerland and Canada (Schweizer and Jamieson, 2001) show values between 20 and 60 cm for 68% of events (such range covers 50% of Italy's events).

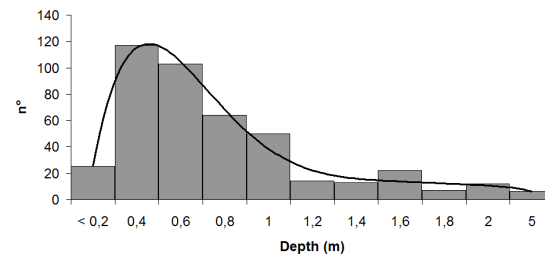


Figure 3. Depth of fracture of the avalanche.

## 6. ACTIVITY OF CAUGHT PEOPLE

Following CISA-IKAR classification, avalanche accidents include two main activity categories:

- Recreational activities which include back-country ski (also snowshoe); free ride (ski and snowboard); on-piste ski and mountaineering (ice-fall climbing included);
- Non-recreational activities (including accidents along roads, or inside buildings).

Figure 4 shows Italy's fatalities by activity categories, as listed before, during the 1985-2009

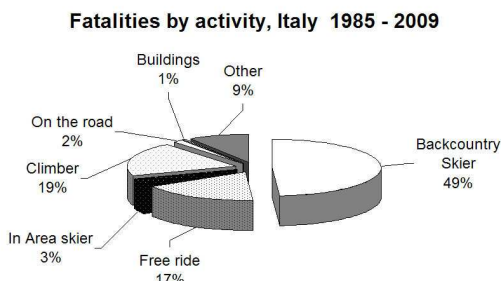


Figure 4. Avalanche victims distribution following CISA- IKAR's activity categories.

period. Backcountry touring is the recreational activity with the highest number of fatalities, with a medium value of 9 victims per year and 49%. Such category shows similar values along Alpine nations, 46% in France, 50% in Switzerland and 53% in Austria.

Mountaineering activities are, in Italy, at the second position with 19% of accidents, as in the last ten years several avalanche accidents during ice climbing and summer ascension raised its rank to the second place for fatalities.

Avalanche accidents during free ride activities places at third rank, in Italy, with 17% of fatalities (was 23% during 1984-2003 period) and a medium value of 4 per year.

For such activity category, France has 42%, Switzerland 25% and Austria 23% of fatalities.

As in Switzerland (Zweifel and Harvey, 2008), even in Italy the recorded number of accidents and caught people, during the last 10 years, has increased but the trend of fatalities is decreasing (Fig. 1).

Last fatalities along roads are dated back to 1986, even if avalanche accidents in non-recreational activities (with injured people) are registered each year, especially during last winter (2008-2009). The last avalanche accident with fatalities involving built-up areas is dated back to February 1999 (Morgex - Aosta Valley). New winter sports such as snowshoeing show a pronounced increase in avalanche accident fatalities (10 victims in the last four winters).

All nations with available statistics based upon significant records (10-30 years period) show that 95-97% of fatalities are due to recreational activities. Therefore, as already stated by several papers, such statistics support the idea that 95% of avalanche accidents are human-triggered whereas only 5% are naturally triggered (Harvey and al., 2002).

## 7. CONSEQUENCES FOR CAUGHT PEOPLE

In 840 avalanche events, 3359 people were present at accident location and 1766 of them have been caught. Further 113 accidents, with 2676 people caught, are lacking such data (12% of total accidents).

In 47% of accidents all people who were present have been caught, whereas in 53% (445 events), one or more people have not been caught by the avalanche (Fig. 5).

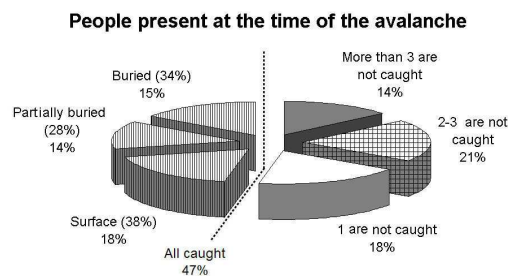


Figure 5. People who were present at the avalanche time.

The majority of people caught (1294 – 67% of total) was not buried or only partially buried with a good survival rate (only 73 fatalities in 25 years).

As a whole, for all known accidents with reliable data, 630 (33%) of caught people were completely buried (38% in Switzerland, 53% in France) – (Fig. 3).

Mortality of complete burials was 59% (369), whereas 47% people (262) survived, with an increase of rescue effectiveness in the last decade.

In Switzerland and in France fatalities of buried persons are, respectively, 53% and 54% (Tschirky et al., 2000; Sivardière, 2002), approximately 10% less than in Italy.

As Fig. 5 shows, in 53% of avalanche accidents, in Italy, people who were present at the time of the avalanche could rescue companions.

Data on mortality rate are, unfortunately, discouraging, due to low diffusion of companion rescue techniques. In Italy, only the 23% of completely buried people have been rescued with an avalanche transceiver whereas in Canada

this value is 42% (Jamieson and Geldsetzer, 1996).

8. LOCATION METHODS OF BURIED VICTIMS

Avalanche victims are located using different times and methods. Companion rescue equipment is still not widespread, in Italy, between backcountry skiers (AA.VV., 2001) and trend of mortality rates show it.

Usually, buried victims are located by avalanche dogs (canine units), by companions probe line, or more often by organized rescue teams, avalanche transceivers and, in few recent cases, using Recco devices.

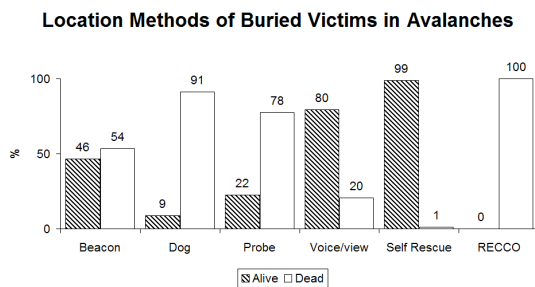


Figure 6. Trend of mortality and methods of location and rescue.

Location of buried people by rescuer outside the caught group shows high mortality rates due to yet too long time of recovery. Avalanche probing shows a mortality rate of 78 fatalities over 100 rescued, avalanche dogs of 91 over 100. In the last years, mortality rate using canine unit search method highly decreased due to higher search teams professionalism (often helicoptered) and lower times requested in emergency call (radio or mobile phones). For example, in Switzerland from 1995 to 1999, mean burial time for victims rescued using canine units decreased of 152 minutes, compared to the mean value, reaching a time of 60 minutes in 1999 (Tschirky et al., 2000), up to 20 - 30 minutes of the last years (Zweifel and Harvey, 2008)

Location of buried victims using avalanche transceivers method confirms its effectiveness (Fig. 6) as the mortality rate is of 54 fatalities over 100 rescued people (wearing it). In Switzerland and France survival rate is higher and equal to approximately to 51% (Valla, 2001; Tschirky et al., 2000) - (46% in Italy). Poor diffusion in Italy of companion rescue equipment (avalanche transceiver, probe, shovel) account for such difference as it has been used in 69 events over 641 cases (8%). In France it lines up to 15% value (Valla, 2001).

9. AVALANCHE ACCIDENTS AND DANGER DEGREES

European avalanche danger scale has 5 values and was adopted in Europe and also in Italy in 1994 (Cagnati, 1994). For the last decade is therefore possible to reconstruct, from regional avalanche bulletins, the danger level for each avalanche accident (Fig. 7).

Data testify, as for Switzerland (Harvey, 2002), that the majority of avalanche accidents happened when level is 3 – Considerable. In Italy are also present accidents (with fatalities) when danger scale values are extreme: 1 – Low (11 events) and 5 – Very High (3 events). The largest number of avalanche accidents in backcountry and free ride happened when danger level is 2 – Moderate (29%) with the latter activity prevailing. Accidents on ski runs happened more frequently when danger level is 4 - High.

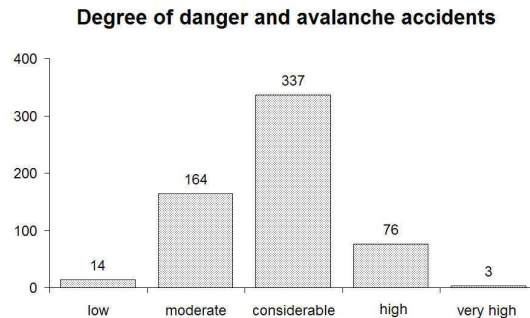


Figure 7. Avalanche Accidents and Danger Degree in Italy (1994- 2009).

10. MOUNTAIN PROFESSIONAL AND AVALANCHE ACCIDENTS

Term “mountain professional” defines people which usually work on snow slopes during their activities: mountain guide, aspiring guide, rescue technician, ski teacher, avalanche service technician, ropeway operators, road technician etc.

Analysis of AINEVA’s accident dataset shows that 120 avalanches accidents involved, in 25 years, mountain professionals. 48 accidents involved mountain guides or aspiring ones (Italians or foreign), 17 events caught snow and avalanche instructors of several agencies or organizations, 20 avalanches entangled ski teachers and 25 ones get ropeway or ski run operators.

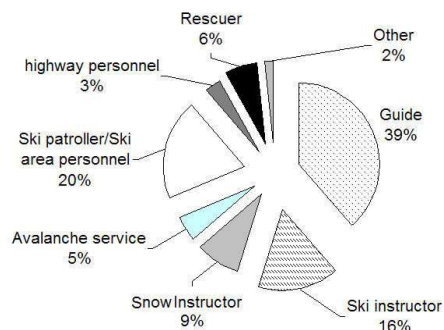


Figure 8. Mountain professional and avalanche accidents (Italy 1985- 2009).

## 11. CONCLUSION

Data analysis allows the conclusion that Italy's avalanche accidents are similar by number and dynamics to other mountainous regions, such as Switzerland, or areas with well developed winter recreational activities such as France or Canada.

Despite the always increasing development of snow related recreational activities, in Italy, there is not yet an individual full awareness of avalanche risk and the adoption of effective preventive actions - as shown by the high frequency of incorrect behaviours before and during avalanche accidents and the poor use of avalanche transceivers.

## 12. ACKNOWLEDGEMENTS

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