ISTITUTO SUPERIORE DI SANITA'

(NATIONAL HEALTH INSTITUTE)

National Mountain injury Surveillance System SIMON

Dpt. Environment and Primary Prevention

Index

1. INTRODUCTION

The epidemiological research carried out on skiing accidents has grown at a slow pace, both because the acquisition of health data within the sphere dealing with accidents has always been problematic, as for the difficulties in accurately quantifying the actual exposure to risk for the individuals involved. Moreover the lack of sufficiently detailed information represents a common element in the whole area involving traumas, accidents and violence (with the only exception, perhaps, of traffic accidents) for which the so called "external cause" is not reported or is not presented in a sufficiently detailed manner to provide useful indications, in particular in view of effective prevention policies. Especially as in Italy both the data related to mortality (usually more reliable) and the morbidity (disease) data do not report information on sporting accidents.

In the case of accidents related to recreational activities, as participation in a sport such as skiing is considered, not even informative flows are available recording the most elementary information on a national level, that is to say simply, the number of incidents which have taken place.

The influence of sports with regard to health matters, has been more evidenced for the benefits gained by participating in them, than for the consequent risks.

In an attempt to shed light on a phenomenon which potentially may involve several million individuals, who every year go on ski slopes and thus expose themselves to the risks in a physical activity, which while enjoyable represents for one's body a stress both from a traumatic as from an environmental stand point (the current estimate is that there are about 2 and a half million skiers, half a million snowboarders, and 400 thousand who do high mountain skiing), the ISS, within the context of the EPIV project, activated in 2003 a research path finalized on monitoring accidental events that occur on ski slopes.

It is for this reason that a new epidemiological surveying system called SIMON (Mountain Accident Surveillance) was set up within the Environment and Trauma department of the ISS. It has already provided - thanks to the dissemination of downloadable technical reports from the ISS site – an exhaustive picture of the phenomenon of the accidents on ski slopes. On the other hand, as can be inferred from its title, the interest of the research does not intend to limit itself only to the skiing environment, but refers in general terms, to the mountainous environment as a whole and for both the winter and summer seasons. In the future we intend to achieve a global surveillance system for the mountain environment able on one hand to follow the evolution of the phenomenon in time and on the other, to highlight probable risk factors and more efficient preventive strategies, evidence based, in order to counteract the accident phenomenon.

Since 2005 the SIMON system has been recognized in Europe as the chosen surveillance system, thanks to the approval of a research project on the prevention of skiing accidents for which SIMON constitutes the axis bearing instrument with regard to data (EU Project BE.PFRA.S.A.: Best Practices in Skiing Accidents). In our relationships with the European Union the collaboration between the ISS and ASL 20 of Verona has been considered fundamental, for its role of Project Leader of the BE.PRA.S.A. and the organizational secretariat of the Turin Chapter: producing the paper on rules

for the skier enacted in collaboration with the ISS and the TOROC (Organizing Committee for the XX th Winter Olympic Games) on the occasion of the Winter Olympics held in Turin in 2006.

The phenomenon already seems to be a mass problem of noticeable dimensions. In fact from practicable estimates on the partial data regarding sporting accidents, today available from various sources (CONI, State Police, Military Police, etc.), we can expect in Italy about 35.000 accidents per year caused by participation in winter sports; of these about 1.100 require hospitalization (3 per cent). Usually it is not the case of particularly serious traumas, for the most part lesions of the joints, muscle sprains, fractures and dislocations of the limbs. There is however a not insignificant percentage of brain concussions: between 10% and 15% of the injured in winter sports have suffered head lesions, one third of which are of a neurological nature.

The SIMON monitoring system emerges, as an integrated surveillance prototype system into which flow data of different types : in particular, the data from rescue teams on the slopes enter the system through the State Police Alpine Training Center located in Moena (Trento province) and the Military Police Alpine Training Center based in Selva Valgardena (Bolzano province). The data recording the number of times the slopes are crossed comes from ski lift managing societies – especially the Associazione Valdostana Impianti e Fune, a society which is part of the ANEF (National Association of Cableway Owners).

Of fundamental importance is, finally, the 24-hour Assistance Snow care contribution to the system's activities through their deep knowledge of the skiing environment, the safety conditions on the slopes, and for having provided the insurance data available to them.

However, the purpose of the inquiry is not only that of having the number of the incidents that occur (and thus an indication of the impact on the population), but most especially to typify these incidents so as to highlight eventual risk factors.

Having "valid" data, in fact, allows one to:

1. Better identify the cause of the lesions reported;
2. Provide a more accurate description of the clinical reality (some types of lesions, through media emphasis, often give a distorted view of the reality; on the other hand, a more careful analysis of the data can reveal unsuspected problems);
3. Evaluate the efficiency of preventive measures;
4. Quantify differing types of risks occurring ;
5. Provide a long term picture of the trends of lesions occurring by type of sport activity.

Carrying out research in the area of sport traumas should not seem as a habit of researchers always on the lookout for something to be discovered. Beyond the fact that knowledge of a phenomenon must be the base for decisions pertaining to the phenomenon itself, leisure activities in general and sports in particular are an important part of everyone's life. In Italy there are about 11 and a half million people who participate in one or more sports with continuity, while another 5 and a half million do it occasionally. Considering both those who do sports in a continuous manner and those who do so occasionally, the number represents 28% of the Italian population. This number compared to other European percentages may seem limited, however it represents a sizeable increase with regard to a survey done by ISTAT in

1959 on the occasion of the Olympics held in Rome. In that year only 2,6 % of the population had been participating in a sport for more than 6 years. Since then the Italian's vocation for sports has grown noticeably, increasing tenfold the number of individuals dedicated to one or more sports, furthermore differentiating them in time. As of today we can also observe a distinct typology by sex: for example soccer, tennis and bike riding tend to be activities carried out especially by men, while gymnastics, volley ball and swimming see more women participants. (table 1).

Table 1. Soggetti di 3 anni e più che praticano sport con continuità, by sex and sports

Sport	Male	Female	Total
Football	41,4	1,7	25,7
Athletics	6,8	5,1	6,1
Footing, jogging	3,1	2,2	2,8
Cycling	9,6	2,8	6,9
Gymnastic, Body building, dance	10,7	42,8	23,3
Basketball	6,0	2,2	4,5
Volley	3,8	11,1	6,7
Swimming, Water polo, diving	17,2	28,0	21,5
Tennis	9,8	4,5	7,7
Winter sports, alpinism	11,7	9,6	10,9

Source: National Institute of Statistics

Participation in different types of sports seems to vary also by age group: some sports activities are carried out mostly by young people, while others show a greater number of participants among the older generation. Soccer, gymnastics, basket ball and volley ball are especially prevalent amongst the young, while jogging and bike riding are very widespread among people above 35 years of age. Remarkable differences are also noticeable by geographic regions: in Northern Italy the region of Trentino Alto Adige is ahead of the rest for those who do winter sports, while basketball seems to be very popular in Emilia e Romagna. Naturally the different distribution by age, sex and geographic area cannot but influence the epidemiological picture regarding traumas caused by sports.

This scenario in constant evolution has brought us to apply the same methods for epidemiology and biostatistics to our focus on winter sports, and in particular skiing and snowboarding; these are most popular winter sports in our Country and, furthermore, they represent a considerable economic income.

The attention given this problem has, moreover, brought the European Union, within the area of Community programs aimed at prevention, on the occasion of the "Call for Proposals 2004" designed to approve a specific project on the prevention of accidents on the ski slopes (BE.PRA.S.A. – Best Practices on Skiing Accidents – European Grant Agreement number: 2004132) to which Italy is represented both by the ISS, and the ULSS20 of Verona.

The main point always to be kept in mind is that the phenomenon of

accidents on the ski slopes is a system phenomenon, highly complex and involving itself complex systems, such as Man (the skier), the environment (the ski slope) and type of equipment used (skis or snowboard); it requires thus beyond accurate research and evaluations, a general view of the state of affairs and its evolution.

This schematization is, above all, rather simplistic in as much as – carefully viewed - it refers to the point of view of a single skier only: himself, his skis (or snowboard) and the slope he is crossing over . In actual fact the problem is much more complex because one is the presence of a set of complex systems, which interact with each other: numerous skiers, each one with his /her type of equipment , each individual immersed – each one – in his/her own environment and interacting, when it occurs with each other.

For this reason, in the development of the current report we will refer to the DFPV (Data – risk Factors – Prevention – Evaluation) guiding model (used) to control complex systems, and designed by the ISS precisely to develop epidemiological research on accidents (figure 1).

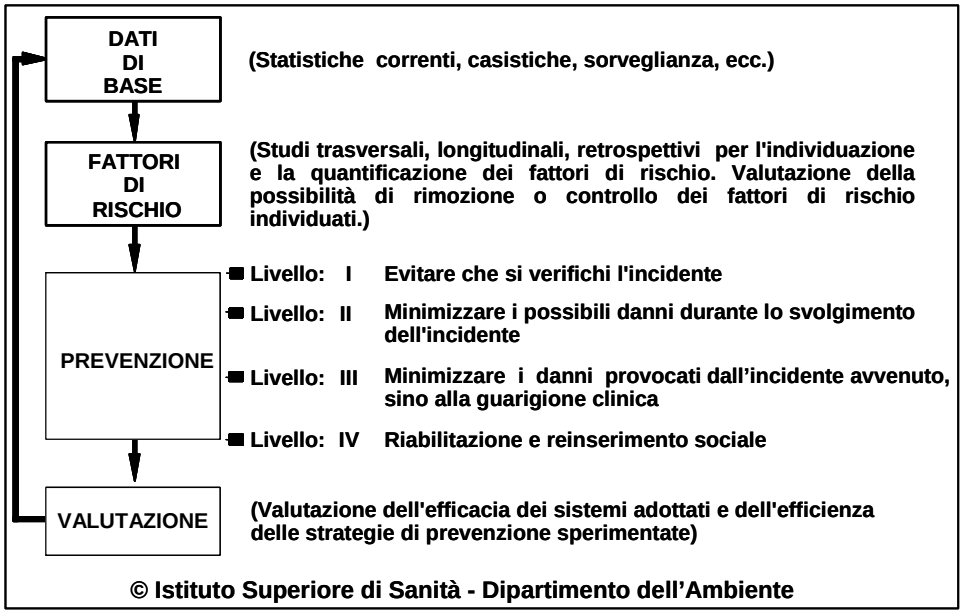


Figura 1. Modello DFPV

In this model of research-intervention, one starts out with the basic data (statistics and surveillance), one proceeds in the direction of the risk factors, through which the possible prevention actions are identified, and one reaches the evaluation process of the actions taken, process which links up with the surveillance (instrument which permits, beyond the verification of the efficiency of the preventive actions carried out, to observe the changes of the phenomenon and its possible new ways of manifesting itself, as for example, in the case of accidents on ski slopes, the possible accidents deriving from adopting new types of equipment. Please note that the model considered is not static, but that each phase interacts with the others, producing a cyclic process of successive approximations.

2. MATERIALS AND METHODS

In order to get know the dynamics of an accident, and thus, single out the risk factors of the same, we have produced an accident report form on the data collected at the rescue action on the slope, found in appendix 1, with instructions on how to fill it out. This form is used by the rescue team of the State Police Alpine training Center located in Moena (Trento province) and by the Military Police Alpine Training Center based in Selva Valrgardena (Bolzano province). The surveillance responsibility has been entrusted to these two structures for most of the ski slopes and also for rescue actions in mountainous areas without skiing slopes. Furthermore ski lift managing societies participate in filling out the form as Where this service is not available, the accident report form devised by the ISS may be used by the pisteur securiste, who work in some of the areas amongst which, for example, Valle d'Aosta, Sestrière and Livigno.

Information on the trauma – to define the injuries caused by typology of accident and the quantification of the frequency and seriousness of injuries, also considering the typology of the injured victim – data is collected in the out-patient assistance centers (by territory or district) and in Hospital Emergency center closest to the skiing areas.

The ski slope accident report form, in the appendix next to the instructions on how to fill out the form, has been distributed in paper form and at the same time electronically through forms to insert, export and data questions on an electronic terminal.

The software to apply for electronic registration the consultation of the ski slope rescue slope data (shown in the appendix of the manual) has been developed in accordance with a UFI interface (User Friendly Interface) through visual technology of the type WYSIWYG (What You See Is What You Get). To utilize this product knowledge of procedural instructions are not required. It's use is however of an intuitive type requiring only the graphic selection of the desired processing parameters. The product can be installed on MS-Windows 2000 and successive ones and works both on web as on stand-alone mode.

The processing procedures have been developed in Visual Basic language and they are based on an MS-Access data type repository; the entity-relationship database structure is described in figure 7 in enclosure number 2 of the appendix.

The product and its updates are distributed by internet to the skiing stations, to the State Police Alpine Training Center and to the Military Police Alpine Training Center. For each of these subjects a reserved area has been set up on the ISS site for the transmission of data with access protected through user name and password. The program includes a module on which to export the data allowing to save the same on a floppy disk or on a purposely set up archive file automatically visible by the user when the data is being saved desktop. The data exported on the files of the archive folder can be transmitted via internet to the ISS simply utilizing the drag and drop function of the S.O. Windows to copy the archive folder files to the reserved area.

The archive managing program for data on skiing accidents is made up by three modules: insert, research and data exporting.

The first module, subdivided into 5 files, allows inserting and cancelling data. As seen in the appendix the files deal respectively with information regarding:

A. the rescue mission (location, time of the rescue, etc.);
B. victim's personal data;
C. description of the dynamics of the accident;
D. description of the patient's trauma and his/her transportation;
E. special notes and information on the rescuers.

The second module allows the research and the consultation of data registered in the archives as well as their update. The research takes place by selecting parameters from the ski slope accident report forms chosen by the operator (for example the number of the form, the place and date of the accident etc.). The selected forms are viewed on an appropriate data prospect, in a two dimensional chart format, through which modification and also archive updating functions are available, with the possibility furthermore of printing on paper and exporting the information to HTML format readable through internet browser.

The export data module functions are described on their own transmission procedure instructions.

The same manner of transmitting data to the ISS is also to be utilized to acquire data on outpatient assistance and hospital Emergency assistance for the injured individual.

3. RESULTS

3.1. Sample typology

Ever since the SIMON system was instituted it has received on an yearly basis the ski slope rescue data for a total of 38.634 accidents registered by the Police on the slopes of 55 skiing stations in 16 provinces located in 11 regions in Italy (table 2).

Tabella 2. Monitored Resorts by Police Alpine Training Center

Resort	Resort	Resort
Limone Piemonte (CN)	Passo del Tonale (BS)	Cortina d'Ampezzo (BL)
Prato Nevoso (CN)	Alba di Canazei (TN)	Falcade (BL)
Bardonecchia (TO)	Andalo (TN)	Falzarego-Lagazuoi (BL)
Sestriere (TO)	Campitello di Fassa (TN)	Malga Ciapela (BL)
Alagna (VC)	Canazei (TN)	Sappada (BL)
Breuil-Cervinia (AO)	Cavalese (TN)	Gallio (VI)
Champoluc-Monte Rosa (AO)	Folgaria (TN)	Forni di sopra (UD)
Courmayeur (AO)	Madonna di Campiglio (TN)	Ravascletto (UD)
La Thuile (AO)	Moena-Passo S.Pellegrino (TN)	Tarvisio (UD)
Pila (AO)	Pampeago (TN)	Abetone (PT)
Valtournanche (AO)	Pinzolo (TN)	Campo Imperatore (AQ)
Aprica (SO)	Pozza di Fassa (TN)	Monte Pratello (AQ)
Bormio (SO)	Predazzo (TN)	Ovindoli (AQ)
Chiesa in Valmalenco (SO)	San Martino di Castrozza (TN)	Roccaraso (AQ)
Livigno (SO)	Vigo di Fassa (TN)	Terminillo (RI)
Medesimo (SO)	Colfosco-Alta Badia (BZ)	Campitello Matese (CB)
Passo dello Stelvio (SO)	Obereggen (BZ)	Etna nord (CT)
Santa Caterina Valfurva (SO)	Arabba (BL)	
Monte Campione (BS)	Civetta (BL)	

Source: Police Alpine Training Center

It regards, in this case, individual data which, as we will see further on, have turned out to be of fundamental importance in order to investigate, in particular, the relationship between rescue data and data on the traumas suffered .

Simply thanks to the data furnished by the Police Alpine Training Center, the SIMON system can base its estimates on a sample well distributed throughout the Italian territory. Moreover the most common dynamics at the base of accidents on skiing areas show a noticeable level of homogeneity on the territory for which the geographic coverage allowed by the analytic data of the State Police assures that the estimated produced are not afflicted by any selection bias.

The period to which the accident data entered into the system refers goes from 06 December 2003 to 01 May 2006. The sample also includes the data collected during the summer 2003 season, for the period 14 March 2003 to 26 October 2003 in the area of the Passo dello Stelvio.

For this third report, besides the data collected by the Police, also the data

summarizing the last 3 years of activity of the Military Police (Carabinieri)Alpine Training Center of Selva Valgardena (Bolzano) have been acquired. It concerns about 14.000 cases per year.

Adding together the data from the State Police and the Military Police brings the SIMON system to have collected for the last three skiing seasons about 25.000 cases per year, equal to about 75% of the total number of accidents estimated annually.

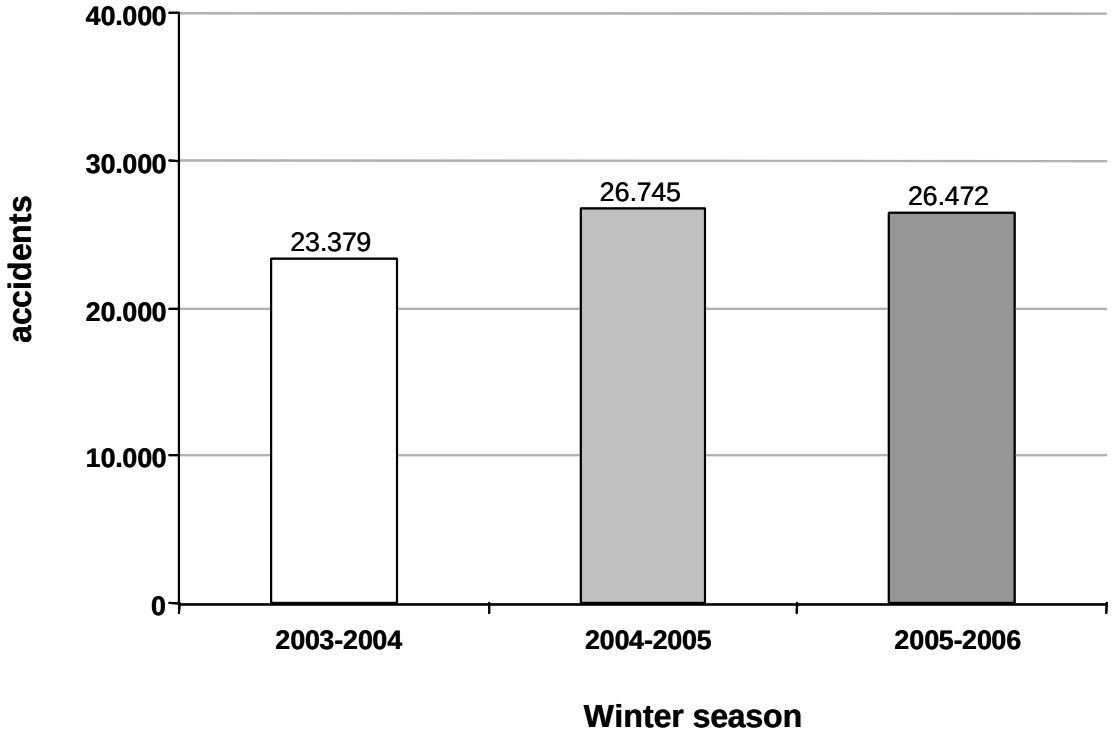
Besides the State Police and the Military Police, where necessary, steps have been taken to acquire the data directly from the societies that manage the ski lift systems to which the ISS has provided the appropriate software for data collection. In particular the SIMON system has acquired for the three years being considered the individual data regarding the ski slopes of Champoluc and Gressoney, that is to say the area of the Monterosa ski complex.

The acquisition of this new database allows the SIMON system to extend its coverage for a sample also including the areas where the Police is not present.

The data collected by the SIMON system, regarding the past ski season (2005-2006) indicate an absolutely stable situation compared to what has been observed in the two previous years; this in light of the over 26.000 accident cases which occurred in the 2005/2006 season and were reported by the State Police, the Military Police and "Pisteur Securiste".

Because of the substantial invariance of the phenomenon in the three year span considered (ski seasons 2003/2004, 2004/2005 and 2005/2006), the analyses which will be successively presented will be often done grouping up data from a three year period; thus the estimates can be based on a comprehensive sample of as many as 76.596 rescue actions.

Comparing the trend of the last 3 seasons one notices a substantial stability in the number of rescue actions, particularly in the last two Seasons (figure 2).



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and Military Police

(Carabinieri) Alpine Training Center data

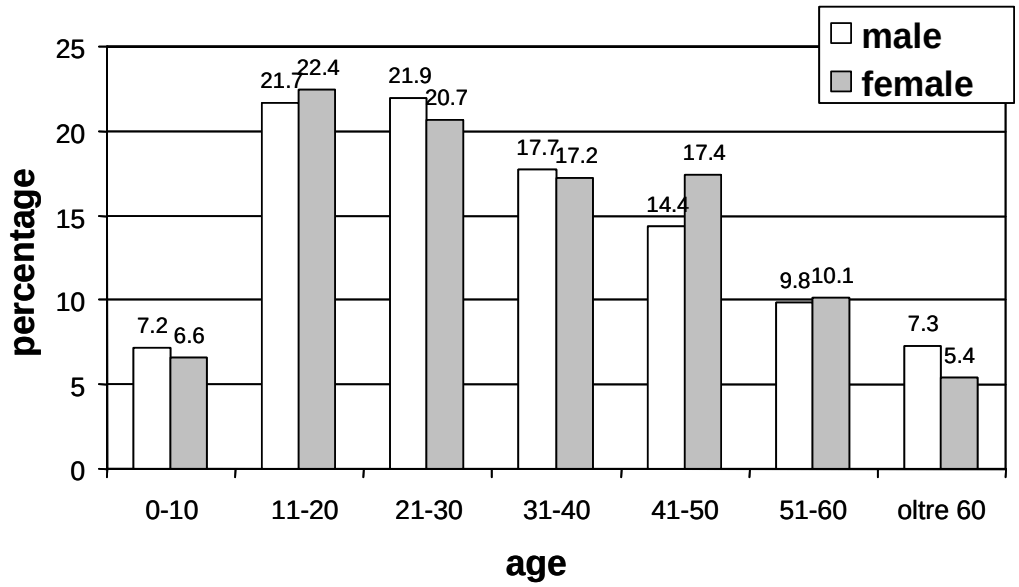
Figure 2. Rescues by winter season

Skiing is a sport that can certainly be enjoyed at all ages; however the peculiarity of this sport is that it tends to involve one's body for the physical stress it must endure, as for the weather conditions present where skiing is possible, as well as for the altitudes one must reach in order to ski. For these reasons the ski slopes are most prevalently used by younger people. This fact clearly influences the age structure of the sample available, consisting mostly of young individuals as the average age is 32,4 years (33,0 M – 31,7 F), even if the general range spans from 1 to 90 years of age. Furthermore, the evolution within the 3 year span shows an absolute stability which leads one to think of a substantial maintenance of the skiers' typology (the average age was 32,2 in 2003/04, 32,3 in 2004/05 and, as previously mentioned, 32,4 for 2005/06).

Of the 76.596 cases analyzed in the current report, 42.504 are males and 34.092 females (respectively 55,5 % and 44,5 % of the total).

While in absolute terms for all ages there are a greater number of injuries amongst males than females, in relative terms the distribution of accidents by age in the two sexes appears very similar, so much so that for both sexes up to 18 years of age about 25% of the accidents reported occur, up to 30 years of age 50%, while up to 45 years of age about 80% of the accidents occur. This uniformity in distribution is recognizable in all three seasons for which the SIMON system has the data and it could be superimposed both for what pertains to the sexes as in time.

Because of the uniformity observed, the 3 year data has been compounded , in order to provide an accident distribution percentage by age group (figure 3).



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and Military Police (Carabinieri) Alpine Training Center data

Figure 3. Distribution of the rescues by sex and age

It might be of interest to note that in more advanced age (beyond 60 years of age) men tend to be more involved in accidents than women, both in absolute terms as (3.112 vs 1.856), as in relative terms (7,3% vs 5,4%) and this regardless of a natural increase in bone fragility for women in this age bracket often exposing them to a greater risk of traumas.

Perhaps both the fact of being exposed in the over 60 age group which differs between men and women, as greater caution common to women, especially adult women, have produced the observed differences in the number of rescue actions which have been carried out for older individuals. We remind you, in fact, that what has been observed in the rescue action data, refers to a situation (the accident) which came about because of risk taking situations and risk factors which oftentimes cannot be accurately quantified. Percentages or absolute values similar or at times even identical could imply very different incidence ratios. Taking as a point of reference the over 60, the fact that in 3 years time 3.112 rescue actions took place for men and almost half (1.856) for women, does not say much about the inclination towards risk between one sex and the other. If hypothetically on the ski slopes the over 60 male skiers made up a group 10 times larger than that of women, the number of accidents actually observed would make one hypothesize a high risk scenario for women.

Considering the situation in more details, we observe that in absolute terms the accidents increase with age up to 15 years of age, and then have an inverse tendency between the ages of 16 and 20; they start increasing again between 21 and 26 years of age, they finally decrease up to 34 years of age, when the number goes up again, reaching a third peak around age 40; after which the phenomenon slowly diminishes (figure 4).

SOURCE: National Institute of Heath elaboration on Police Alpine Training Center data

Figura 4. Distribution of the rescues by age

A different method of reading the skiing accident phenomenon with regard to age of those injured consists in seeing as "saturated" the percentage distribution of case by age. It is as if we had a container full of water and we wished to backtrack and figure out how the container filled up in the first place. If the water pressure of the faucet from which the water was coming out had always been constant or if there were times when more or less water would come out.

In the case being considered we are interested in understanding how the accident volume saturated itself (we refer here to the 38.634 analytical cases of the Police Alpine Training Center of Moena which went from 0% to 100%. Obviously, differently from what would happen in the situation described as an example, instead of the time employed to fill up the container with water we have the age of the injured.

SOURCE: National Institute of Heath elaboration on Police Alpine Training Center data

Figure 5. Rescues cumulative distribution by age

Figure number 5 shows how ski slope accidents are a phenomenon that involves the younger population especially : 50% of the accidents occur within the age of 30, while within the age of 40 more than 2/3 of the injuries. Attention should be paid to what has now been stated for, as will be seen later on, differentiating the phenomenon with regard to the type of equipment (skis and snowboard) things change considerably.

On the other hand, that there are some sporting disciplines that are particularly concentrated in specific age brackets is a well known fact for

anyone involved in the epidemiology of sport traumas. Rather recent estimates, regarding the year 2001, carried out by the Swiss Office for the Prevention of Injuries (UPI), indicate that the percentage of young people below 25 years of age who have suffered lesions following participation in a sporting activity is about 55%. While keeping in mind that in absolute terms Switzerland does not represent a reality that can be over imposed on the Italian one, as in its case the winter sports are over represented, the distribution of accidents by age group in relation with different sports should vary a great deal from that observed in our country. In other words, whatever is the number of injured individuals per sport, the internal relation between the number of the injured per age category should be sufficiently similar between the two countries.

Considering only the principal sports, we can observe as, although the younger age group is the most represented as to number of accidents, there are some sports that represent a high number of accidents even in the older age group (table 3).

Table 3. distribution of sport injuries according age and sports

Sport	age			
	<25	**26-45**	**46-64**	**65 e oltre**
Basket	63,4	29,2	7,2	0,2
Football	52,0	43,9	4,0	0,1
Handball	60,8	35,7	3,3	0,2
Tennis	9,5	42,6	47,6	0,2
Volley	44,2	45,4	10,2	0,2
Trekking	17,8	25,3	30,4	26,6
Martial arts	47,3	47,8	4,5	0,5
Body building	92,4	5,4	1,8	0,4
Fitness	43,4	35,8	14,3	6,5
Jogging	15,1	56,8	27,8	0,4
Athletics	89,3	8,5	1,8	0,4
Swimming	53,7	31,4	14,1	0,8
Sci	38,1	36,5	23,6	1,8
Snowboard	79,0	19,2	1,6	0,2
Cycling	43,8	49,7	6,3	0,3
Mountain Bike	91,0	6,5	2,3	0,2

SOURCE: National Institute of Heath elaboration on Council for Accident Prevention (Switzerland) data

In particular tennis, trekking and jogging seem sport activities which cause injuries especially in the older age range, probably in relation to the inclination of being practiced more by those who are older.

It is an interesting fact that the introduction of new sporting activities outlines a substantially different accident picture than that of traditional sports from which the new sports have sprung. Comparing, in fact, snowboarding with skiing, and biking on road with mountain bike riding, we notice that while the accidents in traditional sports seem more “spread out” through the different age groups, in the case of new sports activities the accident picture regards especially the younger generation.

What has been observed with regard to the Swiss Office for Prevention of Accidents is verifiable also in Italy for what concerns the accidents on skis and

snowboards, whereas we observe that while the average age of the accident victims is 32 years of age, the average age for skiers is 34,2, while that for snowboarders is 23,8. Clearly the fact of finding amongst snowboarders many young people who have accidents comes from the fact that the use of the snowboard, as it is a relatively recent trend, tends to spread more amongst the youngest population, in particular amongst males , usually more inclined to explore new trends and new approaches to sports activities.

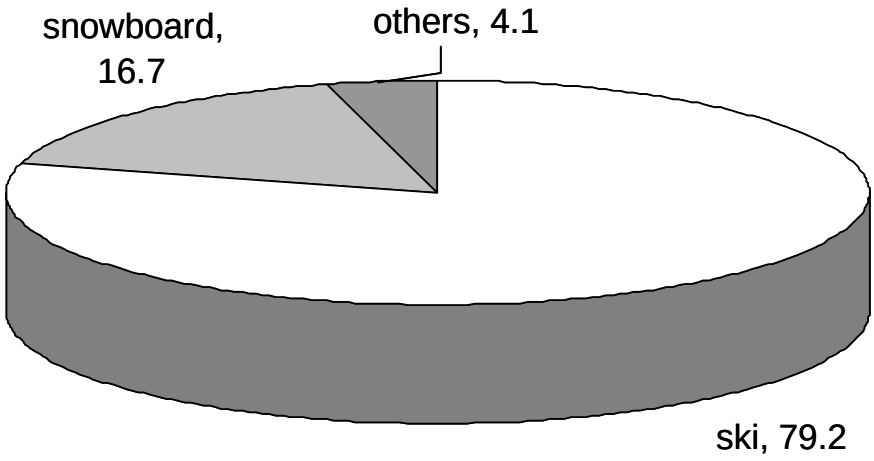
It would be very interesting to try to find out the provenience of these individuals. Beyond the obvious consideration, as the survey is held on the Italian territory, that for the most part it concerns Italian skiers, it would be useful, however, to understand how the nature of tourist flows may have consequences on the country of origin of the injured individuals. In ¾ of the cases the injured individuals are of Italian nationality (72,9 average over the 3 years period). The remaining portion is to be divided between the countries of the Alpine area (France, Switzerland, Germany, Austria and Slovenia count for 6,5% of the accidents) the other nations (20,6%). With regard to this last group, amongst the countries we could consider "emerging" the United Kingdom stands out with 5,9% of the accidents; while the new frontier of tourism, constituted by the Eastern European countries, begins to make itself noticeable also in these surveys (Poland 3,0%, Czech Republic 2,1%, Hungary 1,0%).

With regard to this, one should note that the quota regarding the countries from Eastern Europe as a whole has increased, even if not much, in the 3 year period, growing from 5,8% to 7,2% of the total number of accidents, with a significant increase, in absolute and relative terms, of injured individuals being of Russian nationality (from 36 to 79 cases, which means going from 0,30% to 0,57 % of the cases), Polish (from 227 to 416 cases, which means an increase from 2,32% to 3,01% of the cases), and of the Baltic republics (from 12 to 45 cases, which means an increase from 0,10% to 0,33% of the cases).

The rest is made up by a fine dusting of cases, oftentimes isolated, coming from different countries, at times distant both geographically as for their sports culture (Australians, New Zealanders, but also Saudis, Indonesians and citizens of Singapore), this is proof of how popular and appreciated winter sports have become in every part of the world and how much the touristic areas of our country are sought after.

3.2. The sports equipment used

In 79,2% of the cases the equipment used by those injured were skis, while in 16,7% of the cases they were snowboards (other equipment used for mountain skiing, telemark, etc. cover a residual 4,1%) (figure 6). In this case the proportions are different between the two sexes: amongst women the accidents because of snowboard use is much lower (12,2% versus the 20,4% amongst males).

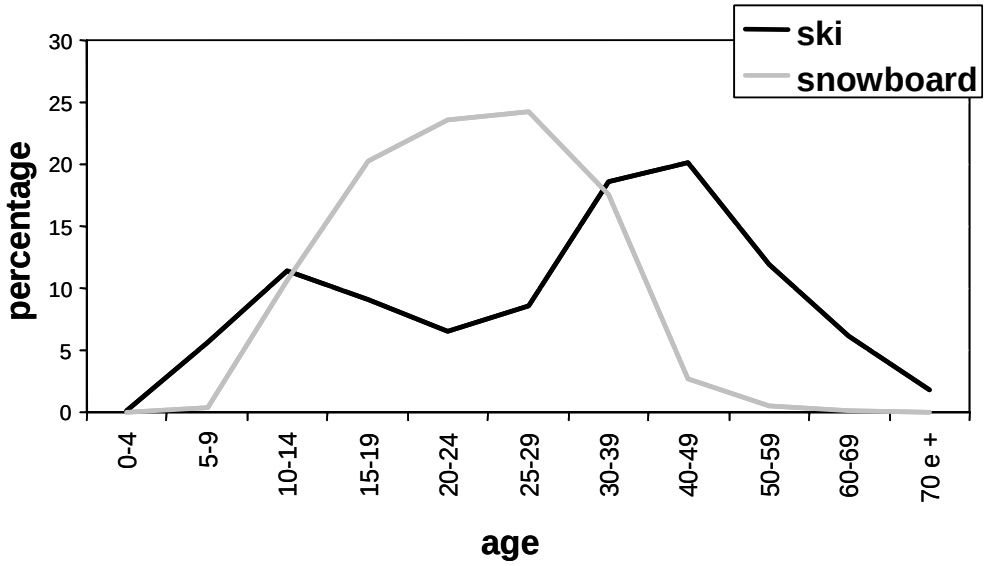


SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and Military Police (Carabinieri) Alpine Training Center data

Figure 6. Rescues distribution by equipment

This difference observed may reflect a different use of the equipment (probably the male is more prone to taking risks and inclined toward innovative and explorative approaches to new realities, as is that of snowboarding).

In rough terms yet sufficiently indicative for the purpose of this discussion we can state that the use of the snowboard began to be popular on the Italian ski slopes about 20 years ago, eating up always greater quotas from the traditional skiing market and spreading especially amongst the young as an alternative way of enjoying the mountains' environment. This prominent preference in a youthful vein for of this piece of equipment, obviously has created repercussions on the structure of the sample of injured individuals' which is being analyzed.



SOURCE: National Institute of Heath elaboration on Police Alpine Training

Figure 7. Injured distribution by age and equipment

Figure number 7, in fact, emphasizes how while the accidents on skis are, so as to say, spread out on the whole range of age groups, the accidents with the snowboard are concentrated amongst the young.

In particular it is worth the trouble to take notice that within the 20 to 29 age group about half (47,8%) of the snowboard accidents are reported, compared to 15% for those on skis. It is always on snowboards that 7 accidents out of 10 occur in the 15 to 29 age group, while on skis for the same age group about ¼ take place.

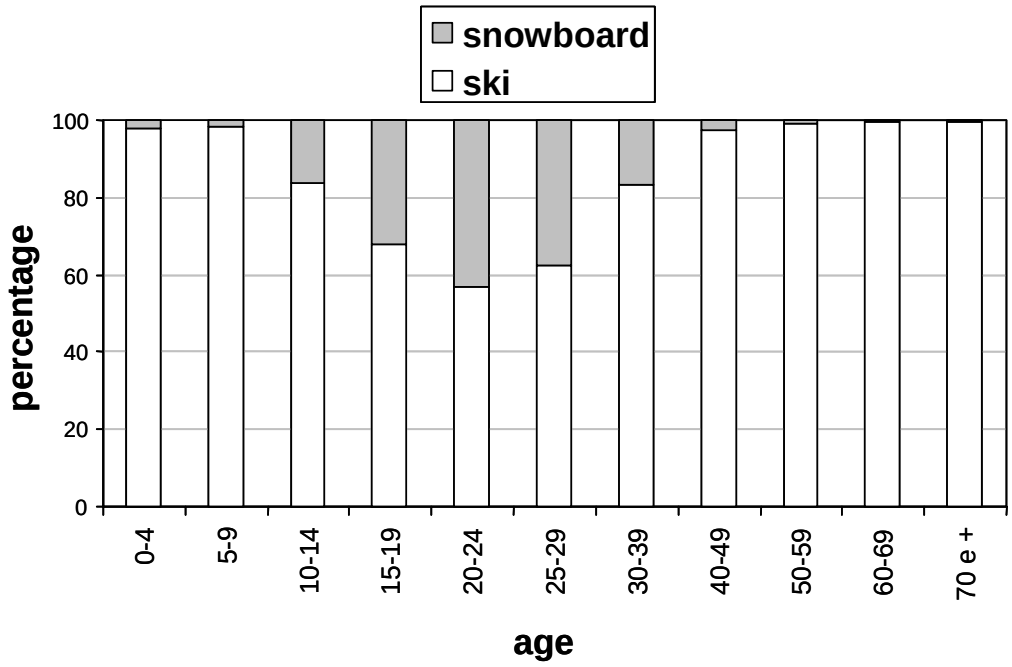
The fact that for those above 40 years of age snowboard accidents are practically inexistent, while instead those on skis (3,3% vs 40,0%) are very much present, proves on one hand how the use of the snowboard is not yet spread amongst the less young generation, but on the other it points to the fact that probably the cohort wave of those who in the last 10 years have begun to ski directly with the snowboard, that is to say who have migrated from the ski to the snowboard, will also, in the future, capture the less young group.

As we will better see later on, under rather general conditions both for the quantity of accidents registered as for the type of equipment used by those injured, we have kept track of the number of skiers present on the slopes for which the fact that of 10 injured individuals, 8 were using skis and 2 the surfboard, reflects the fact that that taking a series of samples of 10 subjects observed on a ski slope, we will have an average that 8 use skis and 2 the board.

The 8 to 2 ratio of the injured individuals has a middle range value, also because, for as we have already mentioned, while the use of skis represents a relatively stabilized phenomenon in time inclusive of all ages, the snowboard, being a recently acquired piece of equipment, is part of a phenomenon, also

cultural, which perhaps still needs to find its own stable dimension, and is strongly age-specific.

Leaving momentarily aside all those accidents which do not concern either skiers or snowboards, we see in figure 8 a correlation between each age group and the number of skiing or snowboarding accidents. From the comparison it clearly emerges how amongst the young even in absolute terms the snowboard accidents represent a substantial quota, even exceeding 40% between the ages of 20 and 24.



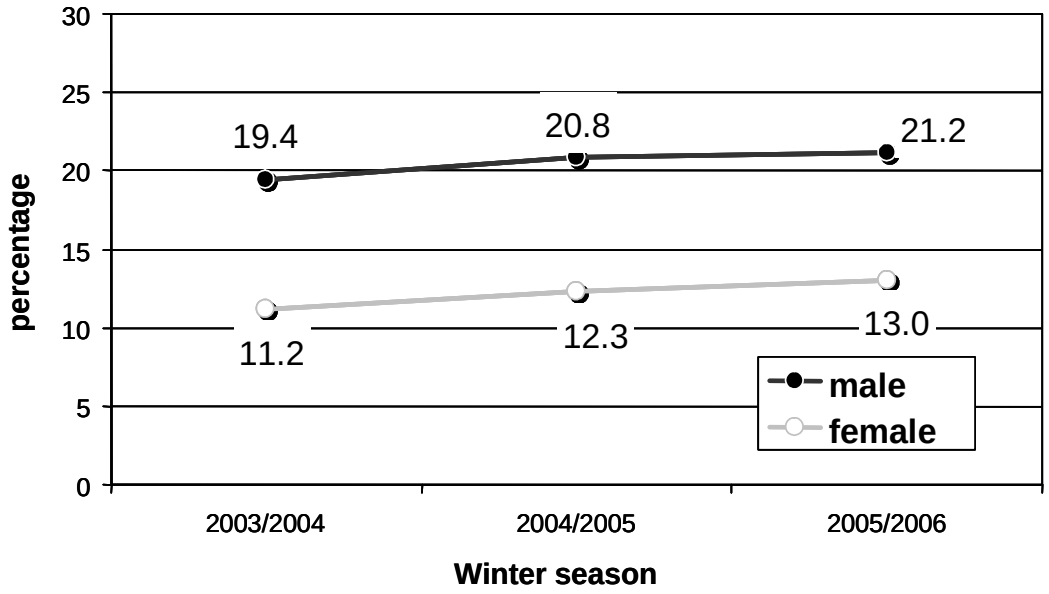
SOURCE: National Institute of Heath elaboration on Police Alpine Training

Figure 8. equipment distribution by age

In a stationary system hypothesis, in which the level of use does not vary in time, neither in the ratio ski/snow nor in the trans-variance between one type of equipment and another, a future scenario is conjecturable in which the snowboard accident distribution is less concentrated on the young and involves also the older age groups. In less rigorous terms perhaps but certainly more communicative, one can say that today's young will be tomorrow's adults and will carry on with their acquired habits. This will imply that beyond the predictable increase of snowboard accidents also the target of future prevention strategies will need to change: in absolute terms the snowboard accidents may not have remarkable variations within the 30 year age group for whom the diffusion in use of the new piece of equipment has already manifested all of its effects, but increase for the cohort effect to those above 30 years of age.

There are also differences between the two sexes: amongst women the quota

of snowboard accidents is much lower. Accumulating the data on a three year basis, it represents 12,2% compared to 20,5% for men. The trend of accidents per equipment type shows a substantial stability in the three year data, even if a slight increase in snowboard accidents may lead one to think, not as much of an increase in the acquisition of greater risk for this type of equipment, as the slow and progressive growth amongst the population of the use of a type of equipment more recently introduced on the market (figure 9).



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and Military Police (Carabinieri) Alpine Training Center data

Figure 9. *snowboard* rescues by sex and winter season

3.3. The role of the environment

A question that many ask themselves is if the environmental conditions may

have an influence on the probability and type of accident. This is a very stimulating theme because there is a great debate that has been carried out for a long time on the approach to follow that is appropriate both to one's techno-physical form as to the environmental conditions.

The majority of accidents occur in good meteorological conditions: 69,2% in the 3 year average, with percentages depending, obviously, on the type of conditions prevailing throughout the year (one goes from a 65,4% of the accidents in clear sky conditions in the 2003/2004 season, to a 74,9% in the following season).

The same type of questions apply to the snow conditions on the ski slopes at the time of the accident. Most of the rescue actions occurred on compact but not frozen snow conditions (56,9% in the three year average with values that go from 51,8% to 60,4%, depending on the season). As an average, in the 44,9% of the cases, the accidents took place on natural snow; but in this case the percentages vary considerably from period to period: in the 2003/2004 ski season, with abundant snow falls, in 60,8 % of the cases the accidents

occurred on a natural snow surface; while in the following season, with fewer snowfalls, this percentage decreased to 35,0%. There is, in any case a residual percentage of accidents that occur on a ski slope exclusively covered by artificial snow, this percentage varies as well between 1,6 % and 7,8%. Obviously the visibility conditions at the time of an accident also reflect the current meteorological conditions. Thus, as we have seen the majority of the events occur in substantially good meteorological conditions, even the visibility at the time of the accident turns out to be good on an average. In fact, contrarily to what at first could be supposed, in less than 1 case in 20 the accident takes place in conditions of poor or insufficient visibility (4,5%). For what concerns the difficulty level of the ski slope, it has been observed that the majority of the accidents occur on medium difficulty slopes, while only a small percentage (7,9%) occur on difficult slopes. Furthermore such percentages turn out to be quite stationary through time.

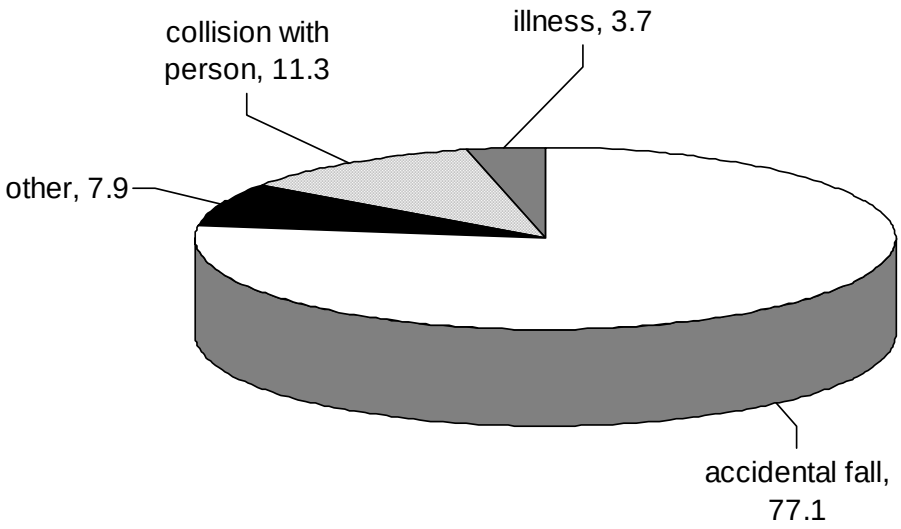
This data leads one not to exclude the hypothesis that the increased level of familiarity with one's technical movement performed on a terrain that is not too challenging encourages one increase one's speed which, in addition to the greater crowding on average difficulty slopes , may bring about situations of a higher average of risk.

While keeping in mind that discussions regarding specific risk factors should consider data relevant to the exposure in order to be able to formulate conclusive considerations on the risk level of the different conditions of visibility, one should stress that the analysis of the data received, on the whole brings us to keep in mind that extreme conditions (difficult ski slopes, adverse meteorological conditions, poor visibility) may on one hand represent potential risk situations, on the other induce more careful behavior (even in terms of the probable reduction of exposing oneself to risk) which seem to largely compensate the greater danger inherent in a difficult environment.

3.4. The accident and its dynamics

Oftentimes the press reports with great emphasis the problem of growing crowds on the ski slopes, resembling always more highways with heavy flowing traffic, oftentimes blocked by traffic jams. Actually with the increase of the hourly capacity of the ski lifts one can now avoid the bothersome lines at the ski lifts, but at the same time an always larger crowd of people swarms the ski slopes. Clearly as common sense and the data indicate, the larger the crowds on the ski slopes, the more accidents occur, but it is worthwhile to ask oneself if, as often chronicled on the papers, the crowding on the ski slopes is actually and truly the cause (or one of the causes) of the accidents which every year are witnessed on the ski slopes.

A simple description of the prevalent dynamics makes us doubt the truth of this position. The greatest part of the accidents observed, in fact, occurred after an accidental casual fall (an average of 71,1% cases), while only 11,3% come about from bumping into another skier (figure 10).



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and Military Police (Carabinieri) Alpine Training Center data

Figure 10. Rescues distribution by dynamic

In other terms, only one accident out of 10 (of those requiring rescue action) can be blamed on a crash with another person on the ski slope. It is hard to say if this fraction is high or within the threshold defined as "physiological", however it is worthwhile to keep in mind that in other life situations where there is the possibility of being involved in accidents because of a third party - a typical case is that of auto accidents – the quota of accidents caused by a collision is much higher (about half).

Thus it would seem that the crowding up of the ski slopes – often blamed for many of the accidents – is not actually the principal reason for many of them, at least not in a direct manner as one would presume considering accidents caused by a collision between skiers.

One should, however, take into account that the quota of accidents caused by a collision between individuals is higher amongst skiers than snowboarders (12,5% vs 7,7%).

On table 4 a comparison has been drawn up considering the percentage distribution by number of accidents per type of user (ski versus snowboard) on the slopes above mentioned. In other terms we have considered how men and women using skis were injured (what was the dynamic causing the accident). The same thing was done for those using snowboards. These distributions were then compared.

Table 4. Accidents distribution by dynamic, equipment and sex

Dynamic	SKI		*SNOWBOARD*	
	Male	**Female**	**Male**	**Female**
Accidental fall	76.5	78.2	85.5	87.6
Collision with persons	13.3	11.6	8.5	6.1
Collision with fixed obstacle	1.1	0.6	0.5	0.1
Collision with moving obstacle	0.2	0.2	0.1	0.2
Lift	1.2	1.4	0.5	1.1
Illness	3.6	4.4	1.5	2.0
Other	4.1	3.6	3.4	2.9
Total	100.0	100.0	100.0	100.0

SOURCE: National Institute of Heath elaboration on Police Alpine Training

As one can easily observe marked differences between the sexes using the same sports equipment are not noticeable. Men and women using skis are involved in accidents with the same dynamics: the great majority of the accidents with practically identical percentages for both sexes are caused by accidental falls or collisions with other skiers. A matching type of reasoning can be made for the snowboard users with a greater occurrence of accidental falls and thus a slightly lower tendency of collisions with other individuals. The slightly different percentages between the two users, do not, in our opinion, justify considering that the two types of ski slope users risk accidents in different manners.

This thought and the consideration that in global terms the percentage of accidents by type of equipment (79,2% skis vs 16,7% snowboard, see point 3.2) seems to reflect enough the typology of ski slope users, leads us to feel that the fears regarding the inherent danger of one type of equipment versus the other, are unfounded and consequently we do not see strong motivations, for example to set up ski slopes for the exclusively for snowboard users, as later on will be hypothesized.

Another matter is to be taken into account regarding the dynamics of collisions between individuals. Considering only ski and snowboard users, the accident essentially occurs because of the responsibility of a third party, that is to say that 9 times out of 10 the impact with another person which causes an accident of such seriousness as to require a request of rescue assistance takes place not for victim's fault, but because of another person that collides into the individual who then has the accident (that is to say/i.e.:"I hurt myself because someone ran into me!").

Considering the above described situation (accident caused by a collision with someone caused by a third party) the probabilities seem different than being hit by a skier or snowboarder depending on type of equipment being used.

Consider the following probabilities:

- P_{ski}/SKI = 80,9%
- P_{ski}/*SNOW* = 18,0%
- P_{snow}/SKI = 68,9%
- P_{snow}/*SNOW* = 30,1%

P_{sci}/SKI indicates the probability of being hit by a skier if one is using a pair

of skis. $P_{ski}/SNOW$ indicates, instead, the probability of being hit by a snowboarder if one is using a pair of skis. And so on.

This probability spectrum on one hand reinforces what above mentioned regarding the supposed dedicated slope. Seeing the situation from the skiers point of view, one has many more probabilities of being hit by another skier than by a snowboarder (81% vs 18%, and this is obvious, as there are many more skiers), but this probability seems absolutely appropriate considering the different use of the equipment (an accurate indication in regard is not available, but one can suppose that the percentage of the number snowboard users falls between 10% and 20%).

If anything one notes a certain tendency for snowboarders colliding with other snowboarders: in 1/3 of the cases if one is on a snowboard and is hit by another person, it is another snowboarder. In other terms, if hypothetically, 15% of the individuals on the ski slopes use the snowboard and the type of equipment were not in the least influential on the dynamics of the accident one would expect to be hit by skiers or snowboarders in similar proportions to those of the actual users per type of equipment. This does not always happen as if one uses a snowboard the probability of being hit by another snowboarder doubles.

3.5 The risk of trauma

Wishing to introduce the concept of risk to what has been explained so far it is necessary to integrate the information regarding the number and typology of accidents to a significant denominator. In other words on the base of the information reported up to now, it would be to say the least rash, to conclude that it is more dangerous to use the snowboard rather than the skis, or that, for example, the young are the most at risk group. To do this it is necessary to compare the number of incidents to a denominator that quantifies, so as to say, that segment of the population from which are drawn the accidents being considered. In Italy, unfortunately there are no systematic surveys on who the users of the skiable areas are, nevertheless, referring to the data published by a research carried out for the ASSOSPORT (national association of the producers of sports equipment) one may infer what follows:

Table 5a. incidence of injuries by age - SKI

	Accidents	Skiers	Rate per 100.000 skiers	Adjusted rate	Relative risk	IC 95% RR I	
4-14 years	1.746	413.219	422,5	1.148	-	-	-
15-24 years	1.596	218.654	730,1	1.984	1,73	1,61	1,85
25-34 years	1.787	444.720	401,8	1.092	0,95	0,89	1,01
35-44 years	2.104	411.366	511,4	1.390	1,21	1,14	1,29
45-54 years	1.614	218.654	738,3	2.007	1,75	1,63	1,87
Over 54 years	1.345	146.387	919,0	2.498	2,18	2,02	2,34
TOTAL	10.192	1.853.000	550,0	1.495			

SOURCE: National Institute of Heath elaboration on Police Alpine Training and ACNielsen SITA research

Table 5b. incidence of injuries by age - *SNOWBOARD*

	Accidents	Snow-boarders	Rate per 100.000 boarders	Adjusted rate	Relative risk	IC 95% RR I	
4-14 anni	239	74221	321.6	874	-	-	-
15-24 anni	944	130463	723.3	1966	2.25	1.95	2.60
25-34 anni	804	170570	471.2	1281	1.47	1.27	1.70
35-44 anni	134	68228	196.4	534	0.61	0.49	0.77
Over 44 anni	33	17518	188.4	512	0.59	0.39	0.84
TOTAL	2153	461000	467.0	1269			

SOURCE: National Institute of Heath elaboration on Police Alpine Training and ACNielsen SITA research

As one deducts from the data found in the ASSOSPORT research and related on tables 5a and 5b, about 1 out of 5 winter sports participants currently uses the snowboard (461.000 versus 1.853.000). In the hypothesis that there is no difference as to risk between the 2 types of equipment, we would expect similar proportions in the number of accidents actually reported. In effect analyzing the accident data and considering only skis and snowboards – for which the number of accidents has been calculated on the average of the accidents per age group reported in the three referenced skiing seasons, we find occurrence ratios which we can consider substantially similar: 1.495 accidents every 100.000 skiers versus 1.269 accidents out of 100.000 snowboarders. It should be noted that this ratio occurrence estimate regarding the two types of equipment has been obtained applying new parameters to the ratios obtained considering only the accidents reported by the Police, which certainly represent a significant sample of the accident typology (and thus usable without qualms to describe the characteristics of the accidents) but which are nevertheless part of the 35.000 accidents which the SIMON system estimates occur every year.

Besides, utilizing as numerator the estimate of all of the accidents which occur every year in Italy (35.000 accidents) and as denominator the

comprehensive volume of the participants as estimated by the ASSOSPORT research (2.314.000 participants) we reach a rough ratio of 1.513 occurrences per 100.000 participants per year. As each participant skis an average of 10 days per year, we can also consider a denominator that refers to the comprehensive mass of days actually skied throughout a season. We should thus multiply by 10 the denominator referring to the number of participants. The new accident occurrence ratio is , thus, equal to about 151 cases per each 100.000 presences per year.

In the considerations so far put forth and in those which will follow we have utilized and will utilize indistinctly the terms accident and trauma, sacrificing somewhat the scientific rigor for a greater comprehension of the concepts. In fact, technically in this "paper" one is not evaluating the absolute probability of an accident, but a conditioned probability of suffering a trauma such as to entail the request for medical assistance, the necessary condition bring that an accident has occurred.

Tables 5a and 5b also relate, between the two distinct groups (accidents with skis and with snowboard) and cumulatively, the relative accident risk per age group and type of equipment used, that is to say the rapport between an accident ratio typical of a specific age group which we consider the base ratio of reference and another ratio of a different age group. In this case the base level accident ratio is the 4 – 14 year old age group for both types of equipment and from here we have proceeded to calculate how many times the accident ratio of the other group was higher (or lower) to that of the referenced age group. For example in snowboarding a RR=2,25 in the 15 – 24 year old age group indicates that this group carries a risk 2,25 times higher of suffering a trauma following an accident with respect to the age group selected as the base (4-14 year olds).

The analysis of the data reported on the table shows that the age group plays two different roles depending on whether one is considering accidents on skis or snowboard. In the accidents in which skiers are involved, one singles out two particularly at risk groups : the young between the ages of 15 and 24 and the older adults from 45 year olds up, with a concentration of the risk between the older ages (RR=2,18 for the over fifty four year olds). This is a situation that seems typical of a consolidated picture. Even in traffic accident dynamics, for example, we have a two way pattern in the accident ratios, with high values both amongst the young between 15 and 29 years of age, as amongst the elderly over sixty five years of age.

In the case of accidents amongst snowboarders the pattern of the accident ratio (and consequently of the related risks) is completely different. With regard to the reference age group (4 – 14 year olds), the 15 – 24 year old group presents a relative risk RR= 2,25, similar to what is seen amongst the skiers of the above 54 year old group. But this risk excess in comparison with the 4 – 14 year old group is only present amongst the 15 to 24 year old group. Successively the risk diminishes considerably so much so that the 25 to 34 year old age group repositions itself to values close to those of the 4 – 14 year old age group. But it is for the over 35 year olds that the accidents decrease considerably and, perhaps, in an unexpected manner. In fact it does not seem to happen what can be witnessed amongst skiers where the incidence of skiing traumas increases with age.

Comparing the estimated number of rescue actions to the population of snowboarders over 35 year olds, one sees on one hand that the number of accidents are few in absolute values, on the other hand comparing these to the

population below this age, there are fewer than what would be expected if these individuals faced at accident with the same inclination of the younger individuals.

Referring to a MEE (Man-Environment-Equipment) matrix correlation often mentioned on other themes, it is as if the environment and the type of equipment interacting with the individual were able to send danger inputs which the individual perceives in a more or less attenuated manner depending on the presence or not of some variables.

The fact is in certain ways surprising as generally it is a widespread opinion that the snowboard is an intrinsically less manageable piece of equipment, and thus potentially more dangerous than are skis. How can it then be that using exactly the higher risk type of equipment, and always according to common opinion, considered more suited to the natural impetuousness and quicker reflexes of the younger individuals, the more mature snowboarders seem to have always fewer accidents than both skiers as the younger snowboarders?

The most logical and credible answer is, according to us, to be found in the different evolution of the subjective perception of risk.

When one speaks of lower manageability for the snowboard one doesn't mean to say that it is of itself a more difficult type of equipment to handle than the traditional skis. One should , however, note that when for several reasons one skis in conditions that are not the best as, for example the ski slope is damaged or visibility is poor, it is exactly in this phase that one's subjective perception of risk is most instrumental. The young individual, with the tendency of being more self assured of his own means, is given to somewhat underestimating the variables (i.e.: the risk factor) with regard to the course he has ideally planned, with the consequence that an eventual unexpected impact with an obstacle or troublesome situation concerning the snowboard-ski slope combination, can often turn into a sudden loss of control and thus not recoverable. The more mature snowboarder, be it for having more experience, or awareness of a natural decline in his quickness of reflexes, and thus basically more conscious of his own limits, may be lead to a more cautious and prudent behavior, from which follows a reduction in the risks, or better, the reduction of instances in which he would lose control when facing unexpected risk situations and, thus, the reduction of accidents.

But why is this explanation not applicable to accidents on skis? Evidently the ski is perceived as being more manageable and readier to "forgive", than is the case with the snowboard, eventual mistakes or critical situations. The consequence is that the feeling of greater safety and the sense of mastery of the skis – presumption that, as has been seen, is missing or is however lower in the use of the snowboard – should induce a "routine" type attitude, more nonchalant, with less attention, and thus potentially rendering the skier unprepared in facing an unexpected risk and therefore more liable to cause an incident-accident. At this point all that remains would be entirely the effect of age which pilots the seriousness of the trauma towards higher levels with the same impact energy.

Excluding the 15 to 24 year old age group, when one often feels "immortal", it is as if the different perceptions of the potential risk situations – in turn filtered through the perception of the environment and the feeling of familiarity with his own type of equipment – can more easily induce the snowboarder to a "pull the handbrake" move, compared to what the traditional skier would be apt to do.

On the other hand it should also be taken into account that beyond what has been said on what we may call "psychological feedback", the skier, especially the more adult skier, with regard to the snowboarder of the same age, is more exposed to the risk of accidents, not because he practices his favorite sport for more days throughout the year, but because throughout the day the actual time spent skiing on the slopes is more. The reason is that snowboarding is a sport which entails a great energy expenditure because of the amount of time spent dragging the snowboard on the plain, lacing and unlacing one's boot when going up the lifts, etc.

Going back to what is shown on tables 5a and 5b, we wish to point out that the ratios reported are rough, in so far as the number of accidents has been divided by the number representing the population exposed to the risk of producing the accidents themselves. The rough ratios are certainly valid ratios as risk indicators, but their use in heterogeneous populations may create a problem some problems. When one compares the rough accident ratios regarding skiers and snowboarders it can be preliminarily necessary to eliminate the influence of some bothersome variable which one knows, or one fundamentally assumes, as capable of producing e on its own some differences in the ratios. Comparing the rough ratios of the two groups of ski slope user, we find that the skiers present a slightly higher comprehensive accident rate (1.495 vs 1.269).

But what does this slight difference actually tell us about the dangerousness of one type of equipment versus the other, knowing that the demographic structure at the base of the two typologies of snow sports users is rather different? Stratifying the data by age group and applying to the various age groups the related accident ratios (age specific ratios), we see how the effect of age is removed (table 6).

Table 6. Incidence rate of injuries by age and equipment

Age	Ski rate	Snow rate	RR sci/snow
4-14 years	980	784	1,25
15-24 years	1746	1770	0,99
25-34 years	905	1048	0,86
35-44 years	1190	454	2,62
over 44 years	1530	478	3,20

SOURCE: National Institute of Heath elaboration on Police Alpine Training and ACNielsen SITA research

Another technique in order to remove disturbing variables is that of ratio standardization, when it becomes necessary to allow valid comparisons between different population ratios. In the case of skiers and snowboarders accident ratios, the comparison between different age specific ratios may become difficult; however it is possible to obtain a comprehensive accident ratio free of age influence through the technique of direct standardization.

Direct standardization consists in determining the ratios one would have in a reference population, chosen as standard, if the ratios in the single classes composing it were equal to those of the corresponding classes of the groups one wishes to compare. With this method we obtain the total number of the expected accidents which we would expect in the standard population if the

specific ratios of the populations to compare were applied to it. The total number of the expected accidents for each one of the populations compared is then divided by the standard population to provide the standardized accident ratio which can be compared to other standardized accident ratios on the same population of reference.

Neutralizing the confusing effect of the ages we obtain the following table:

Table 7. Standardized incidence rate of injuries by equipment

Ski rate	Snow rate	RR sci/snow
1484	1016	1,46

SOURCE: National Institute of Heath elaboration on Police Alpine Training and ACNielsen SITA research

As one sees on table 7, that the differential between the two ratio increases. This is understandable because of the young component between 15 and 24 years of age (i.e.: that at greater risk of accidents) is proportionally much more present amongst snowboarders; once "fixed" this disturbing factor with regard to the ratios, these in the snowboard tend to be comprehensively lower.

Wishing to synthesize what has been presented up to now with regard to the whole class of snow users, it is possible to refer to what has been reported on table 8 in the RR TOT column.

Table 8. Relative Risk of accident by age and equipment

Age	RR TOT	IC 95% RR TOT	
SKI 4-14 anni	-	-	-
SKI 15-24 anni	1,73	1,61	1,85
SKI 25-34 anni	0,95	0,89	1,01
SKI 35-44 anni	1,21	1,14	1,29
SKI 45-54 anni	1,75	1,63	1,87
SKI oltre 54 anni	2,18	2,02	2,34
SNOWBOARD 4-14 anni	0,76	0,66	0,87
SNOWBOARD 15-24 anni	1,71	1,58	1,85
SNOWBOARD 25-34 anni	1,12	1,02	1,21
SNOWBOARD 35-44 anni	0,46	0,39	0,55
SNOWBOARD oltre 44 anni	0,45	0,31	0,63

SOURCE: National Institute of Heath elaboration on Police Alpine Training and ACNielsen SITA research

In this column we have recorded the risks related to all age categories and type of equipment used ; using as reference class young skiers between the ages of 4 and 14. From this synoptic table, two seem to be the groups most at risk towards whom especially to address synergic prevention measures:

1. Indiscriminately the young in the 15 to 24 age group
2. Adult skiers over 45 years of age

In conclusion to this paragraph a small annotation should be of interest

regarding a phenomenon fortunately very rare compared to the volume of people that every year participate in winter sports, but often brought to the forefront by the press. We are referring to those cases of accidents with lethal consequences. Mortal accidents are, fortunately, very rare. Based on the data regarding the last three seasons, one observes, an average of one death every 880 emergency rescue actions, which compared to the 35.000 estimated accidents per year, indicates a total of about 40 deaths per year – more than half of which due to sudden illness (62,8%).

Getting into further details, one observes that the greatest majority of cases for which analytical information is available, concerns males (33 of 36). This could imply a more daring attitude amongst males who much more often than females tend to go over the limit with an excessive risk taking attitude. If this explanation, that brings us back to the perception of risk and to the propensity towards recklessness, enters directly into play with deaths for traumatic etiology, in which case considering that 18 out of 19 individuals who died of sudden illness (distributed quite uniformly throughout the whole span of the day) are males (between 24 and 74 years of age), the greater inclination of males towards risk does not seem to be directly connected to the death. Of course the inclination towards risk doesn't necessarily need to manifest itself through skiing recklessly fast down a mountain slope. Such a view of reality obviously will have repercussions also on the ability of analyzing all the potential risk situations. It would not be surprising, in fact, if this greater bent in males toward daring behavior were displayed even when facing particularly difficult environmental conditions, which may entail protracted exposure to, as an example, intense cold. This in itself undoubtedly represents an at risk situation for cardiovascular pathologies. If one also associates to this scenario a consumption of alcoholic beverages, averagely higher amongst men, one could explain the unbalance observed in cases of death caused by sudden illness.

3.6 Accidents and Time

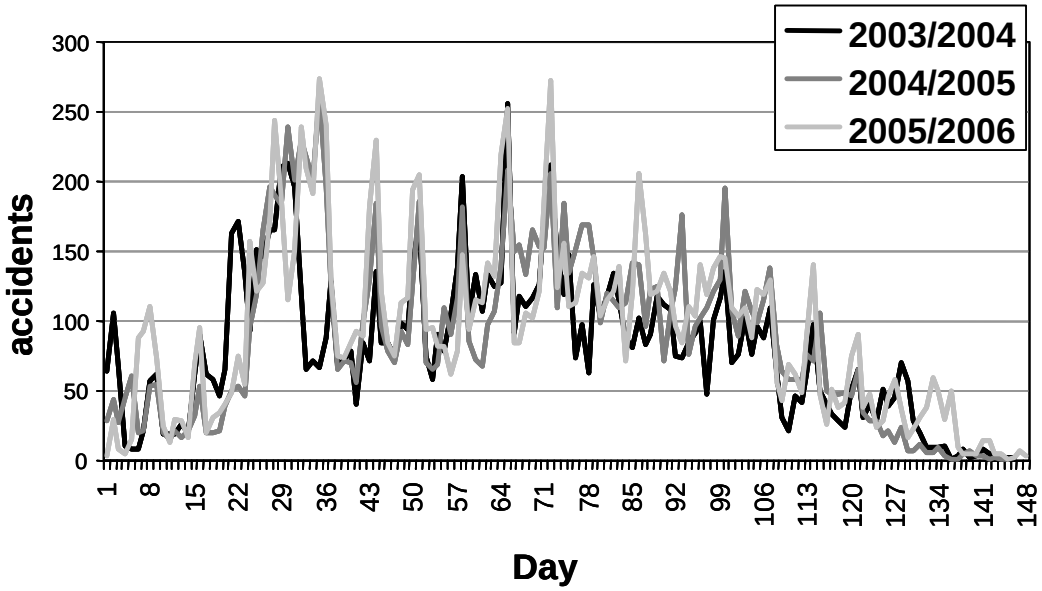
Having considered the subjects, i.e., the ski slope users, who unfortunately encounter accidents, we will go on to analyze when, in which period of the year, in what day of the week, or in what hour of the day more rescue actions take are carried out.

The data provided by the State Police Alpine Training Center of Moena and by the Military Police (Carabinieri) Alpine Training Center of Selva are perfectly in agreement that Sunday is the day in which the greatest number of rescue actions is carried out.

In relation to the chronology of accidents, one should consider that the skiing season - naturally depending on weather conditions – starts at the beginning of December and ends between March and April with some flexibility dependent on the continuation of favorable weather conditions and the Easter season holiday dates, which often tend to correspond with the end of the skiing season, and which vary from year to year.

Figure 11 shows the distribution of rescue actions for the last 3 years by day of the week. In order to facilitate reading the graph and especially comparing longitudinally two seasons the data has been matched by day of the week and not by calendar date. In other words drawing a vertical line, one finds the two patterns by the same day of the week (for example by Sundays), even if the two calendar dates differ (for example the third Sunday of the

skiing season considered in 2003-2004 was December 21, 2003, while in the 2004-2005 season it was December 19, 2004).



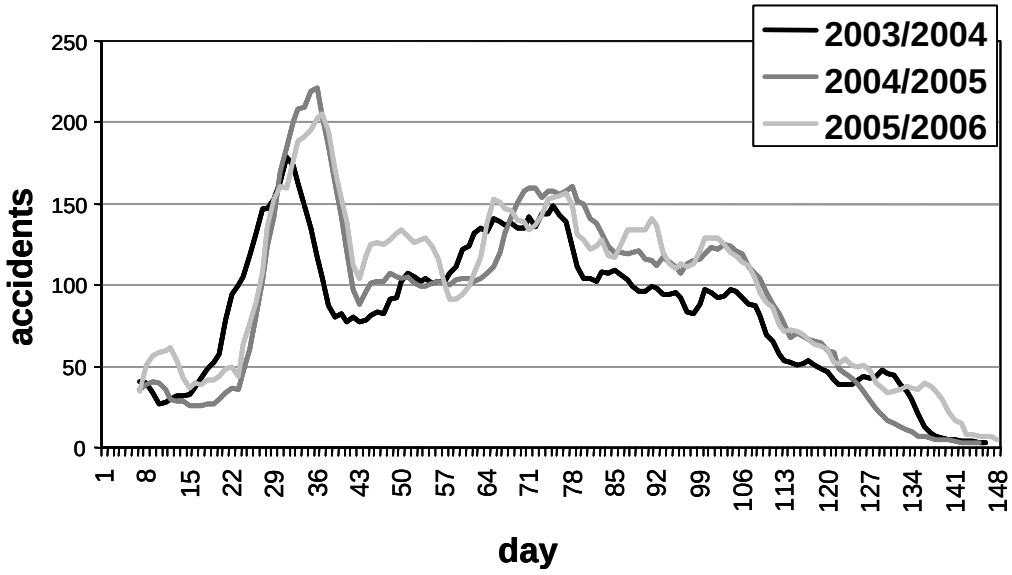
SOURCE: National Institute of Heath elaboration on Police Alpine Training

Figure 11. Trend of accidents (winter seasons 03/04, 04/05, 05/06)

This way of comparing skiing seasons is extremely useful in the case in which it is not so much the variability within a long time range to influence the accident occurrence, but that within the cycle of the week itself.. The peaks of accident occurrences regarding Sundays are in this manner immediately comparable with each other.

The strong fluctuation is most evident in the number of rescue actions carried out between weekends (especially for Sundays and other holidays).

This accident occurrence fluctuation turns out to be certainly more legible in figure 12 which relates the same information of figure 11 but, so as to say, compacted with the criteria of a mobile average calculated on a 7 day period. This form of representation makes it easier to capture in a better way the overall flow of the phenomenon, “smoothing over”, so as to say, the positive and negative peaks of the micro-cyclic movement so as to allow an easier identification of the variation tendencies. A 7 day period has been chosen for the mobile average as it corresponds to the weekly micro-cycle period and period, in order to be certain that the average is always made up by the number of accidents occurring in the seven days of the week.



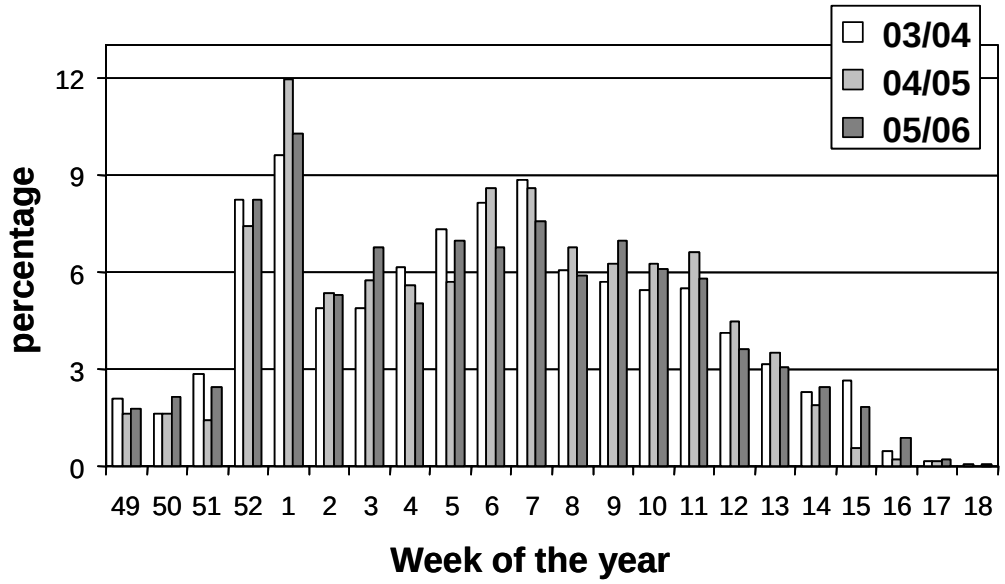
SOURCE: National Institute of Heath elaboration on Police Alpine Training

Figure 12. Trend of accidents – mobile average - (winter seasons 03/04, 04/05, 05/06)

As can be noted, the flows are very similar in form, with a large peak of occurrences corresponding to the Christmas and New Year holiday period, and a second peak, less pronounced but broader, between February and March, that is to say the usual period for "winter school week holiday".

Another way to describe the accident flow is that of distributing them by yearly week. Obviously, as the skiing season begins at the end of one year and follows on with the beginning of the next year, in abscissa the numbering begins from the 49th week (early December) until the 52nd week (last week of the year), to then continue from the 1st week to the 18th.

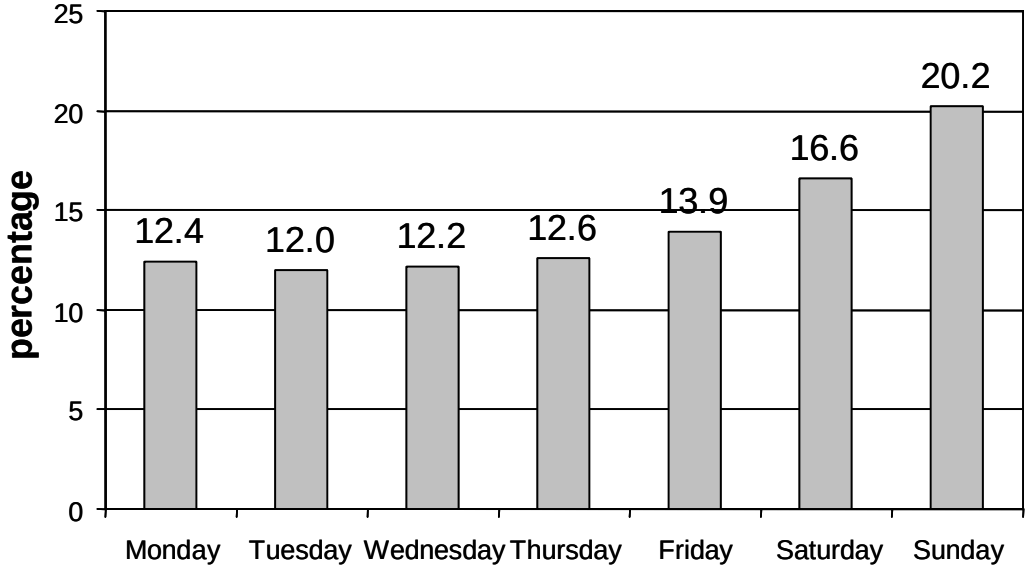
Distributing the data percentage wise by week we notice that the maximum number of rescue actions take place during the first week of the year, during which the number of rescue actions go from 9,6% to 11,9 % (figure 13). Besides the period coinciding with the Christmas holidays which attracts a considerable number of skiers on the slopes, the other critical period is that typical for the "winter school week holiday"; especially in mid-February when 16% of the all of the rescue actions occur (the total depending on the season, ranges between 14,3% to 17,2%).



SOURCE: National Institute of Heath elaboration on Police Alpine Training

Figure 13. Rescues distribution by week of the years (winter season 03/04, 04/05, 05/06)

After having reviewed longitudinally what takes place during the entire skiing season, both analytically (figure 11), as in a more synthetic manner (figure 12 and 13), we can observe the same phenomenon transversely, compacting the precise information of figure 11 in a more synthetic picture in which the data is grouped by day of the week (figure 14).



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and Military Police (Carabinieri) Alpine Training Center data

Figure 14. Rescues distribution by day of the week

Take note that as from Mondays to Fridays there is an absolute stability in the number of rescue actions carried out with this number beginning to grow, even if only slightly, on Fridays. It is, however, during the week-end, when the ski slopes are most crowded, that a considerable number of accidents occur; especially on Sundays when more than 1/5 of all of the accidents are reported.

It might be of interest, at this point, to ask oneself if and in which way there is a correlation between the number of accidents and the number of individuals present on the ski slopes. In order to do this we have to consider the analytical data of the number of transits at the ski lift stations of 3 extended territories : the Via Lattea in the Piemonte region, which includes the ski lifts of Sestriere, Sauze d'Oulx, Sansicario-Cesena and Claviere (that is to say the territory where the XXth Winter Olympics of Turin 2006 were held), Madonna di Campiglio in the Trentino region and the territory of 3 Valli which includes an area that goes from Moena (Trentino) to Passo S. Pellegrino a Falcade (BL). It consists of an area of over 25.000.000 recorded transits in 3 of the most important skiing areas, which, while not able to provide an exhaustive picture of the Italian skiing panorama, can represent a sample of it whose structure does not differ much from that which is the actual use of the ski slopes. In other words, if we were able to have the analytical count of the transits for all the Italian ski stations and wished, however, to make some sample based estimates, we would necessarily need to select a series of areas whose location reflects as much as possible the reality; one should then include more centers from the Dolomite area where the ski slopes are used by a greater number of skiers and fewer from the Western Alps.

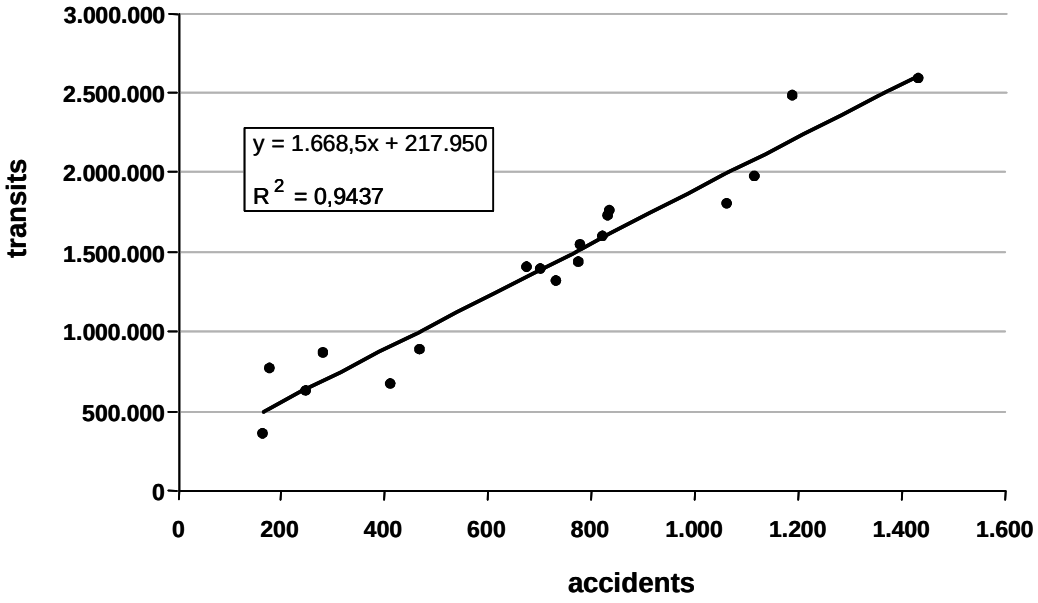
In this case, the "natural" sample almost overlaps the representative-theoretical one. It is for this reason that with a margin of uncertainty in the estimates that we consider most reasonable, we will set forth a series of arguments on the crowding of the ski slopes considering the data which reflects the transits at the ski stations in these 3 territories as representative of the entire Italian situation.

Parallel to this, the analytical data of the accidents reported by the State Police Alpine Training Center, which as we have seen is spread out throughout the territory, can rightly be considered a true statistically representative sample of the Italian accident scenario.

At this point we have two parameters, accidents and transits, independent of each other, both of which, however, relay something about what happens on the ski slopes in Italy and which can opportunely be put in relation to each other, albeit with some "noise".

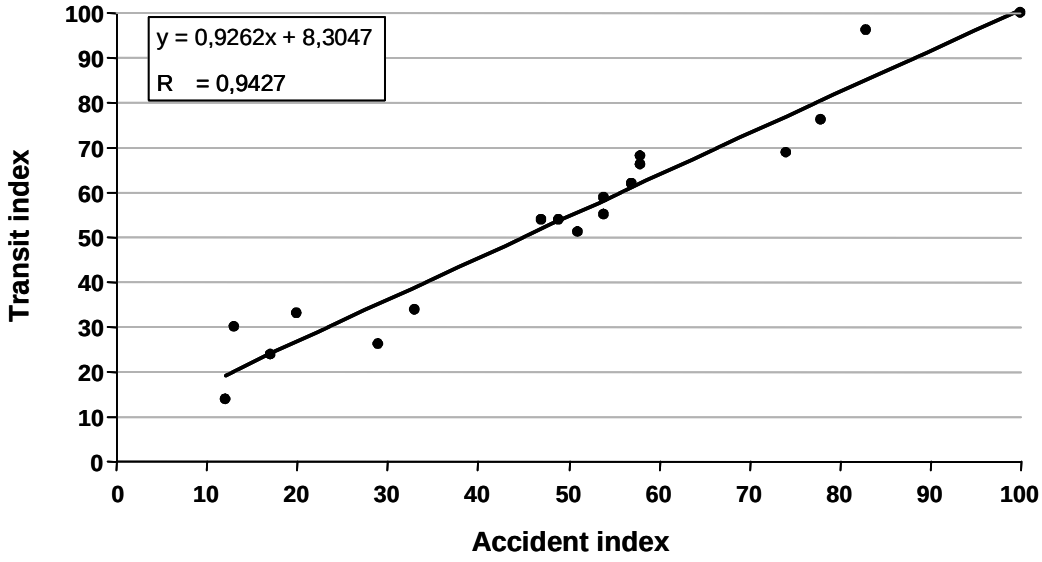
A question to ask ourselves is: how do accidents vary based on the number of transits and thus on the crowding of the ski slopes?

To answer this question we have taken as time unit – the week – and for each one of the weeks of the skiing season, we have calculated both the number of transits as that of rescue actions carried out. The results are pointed out in figures 15a and 15b.



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and resorts Via Lattea, Madonna di Campigio, 3 Valli data

Figure 15a. Correlation between number of transits and number of accidents per week



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and resorts Via Lattea, Madonna di Campigio, 3 Valli data

Figure 15b. Correlation between Transit index and Accident index per week

Both figures describe the same thing, that is to say they make a relation between the weekly data of transits recorded at the ski lifts in the three sample areas and that the number of accidents which occurred in the same

weeks. Figure 15a is built up using the absolute values, figure 15b, instead, uses index numbers. In the second case the number of transits of a typical week (the one right after New Year's Eve has been chosen, from January 3 to January 9) has been set as equal to 100 and new parameters have been applied on the base of 100 to the number of transits of the other weeks. The very same thing has been done using as base 100 the number of rescue actions carried out in the chosen week. Obviously the strong degree of correlation is identical (r2=0,94), however in figure 15b, as the two quantities are expressed in percentile terms, it is more evident how the linear law that correlates the two quantities is such that doubling one of them also doubles the other (a straight line at 45° would have an angular coefficient equal to 1 and in this specific case the angular coefficient observed is equal to 0,92).

The absolute linearity of the $Y = aX + b$ type relation clearly evidences that one is not in the presence of a situation similar to that described by Smeed with regard to the number of deaths caused by traffic circulation. In the case of traffic circulation, in fact R.J.Smeed, since the 1940's, demonstrated that the mortality observed by auto accident was strictly correlated to the number of registered vehicles and to the population.

Studying the mortality data observed throughout the years in several countries, he came up with an invariant relation on different groups of data (in the sense that even if the data being analyzed varied, one single structure could explain the fluctuations).

If one carefully considers Smeed's formula, one sees that it has the structure of a power function, which is to say of a relation of the type $Y = aX^{-b}$, highly non-linear structure. The reason is that once one has gone beyond a critical traffic threshold, circulation slows down, reaching the limit point of traffic congestion, for which no more deaths can occur.

The crowding of the ski slopes, calculated on a weekly basis, instead, while being a problem of which to keep track, does not reach levels such as to create a true congestion, nor does it seem that a greater density of skiers should bring them to a markedly more prudent behavior to the point of reducing in a considerable manner the probability of accidents.

There are different considerations if we instead consider the day by day level. Does the variability between days of the week have different repercussions on the accident flow with regard to the variability between weeks?

One should consider the data reported on table 11, regarding the transits per day of the week recorded in the territories of Madonna di Campiglio and 3 Valli and the corresponding number of rescue actions carried out by the Police Alpine Training Center.

Table 9. transits and rescues by day of the week

Day of the week	transits	rescues
Monday	2.065.922	152
Tuesday	2.009.641	159
Wednesday	2.141.988	177
Thursday	2.159.473	164
Friday	2.330.855	166
Saturday	2.264.406	168
Sunday	2.521.662	261

SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and resorts Via

Lattea, Madonna di Campigio, 3 Valli data

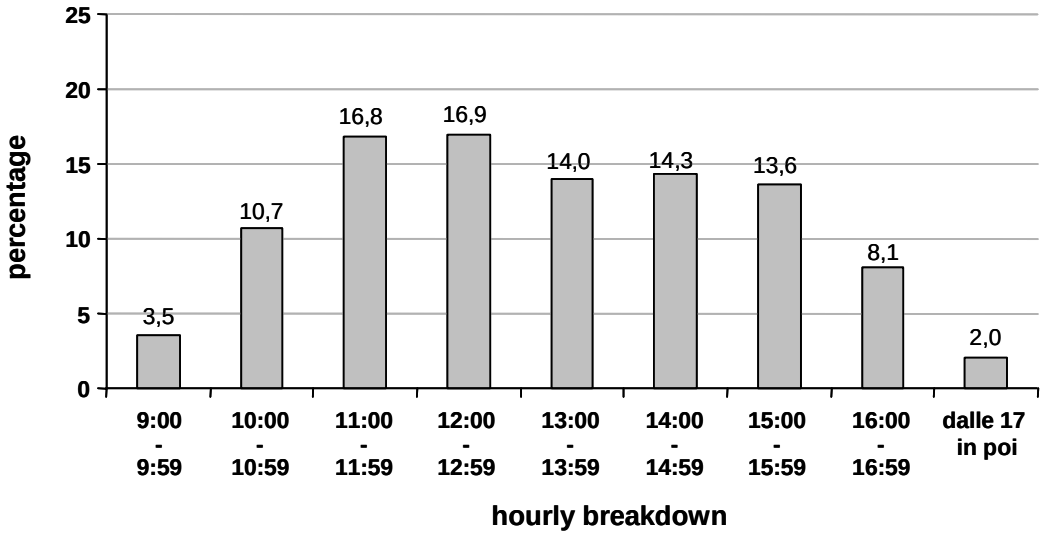
In this case the comparison is direct: both the transits as the rescue actions refer to the same days and to the same skiing areas. As one can observe, and in agreement with what has been outlined on the comprehensive data in figure 14, we find a substantial uniformity in the number of transits from Mondays to Thursdays, with transits that increase on Fridays and Saturdays and reach a peak on Sundays. The number of rescue actions carried out shows an analogous pattern. Looking more closely, however, between Mondays and Saturdays the figures regarding the number of transits fluctuate by approximately 16% between the highest value and the lowest while in the same days the number of rescue actions fluctuates by 16,4%. The flexibility of the two variables, transits and rescues, in these six days of the week seems to be similar. On Sundays, instead the situation seems completely different. With regard to the average number of transits that is seen between Mondays and Saturdays, on Sundays one notices an increase in transit to 16,6%, but in comparison to this, the increase in the number of rescue actions is 58,8%. The fact that on a weekly basis the number of rescue actions, as seen in figure 15a and 15b, is in linear correlation with the number of transits, leads one to think that the non linearity observed within the weekly cycle, is not due to having gone beyond a critical threshold for transits (and thus of crowding) as much as /than rather to the different typology of skiers present on Sundays on the ski slopes. It should be enough to think that the make- up of the injured individuals, compared to a 17,4% average of snowboarders on Sundays, thanks especially to the local skiers contribution, this percentage increases up to 28,5%, with an absolute increase of over 11 points, but which in relative terms indicates an increase of 63,9%! (table 10)

Table 10. Percentage of accidents with *snowboard* by day of the week

Day of the week	**% *snowboard***
Monday	13,5
Tuesday	15,5
Wednesday	20,8
Thursday	15,3
Friday	16,1
Saturday	23,1
Sunday	28,5

SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and resorts Via Lattea, Madonna di Campigio, 3 Valli data

We have been able to observe how the frequency of accidents is to be related with the number of presences on the slopes. It has been seen longitudinally throughout a long period (figures 11, 12 and 13) and transversely within the week (figure 14). This law is not even confuted within the day itself. In figure 16, in fact, the frequency of accidents is shown by hourly breakdown.



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and Military Police (Carabinieri) Alpine Training Center data

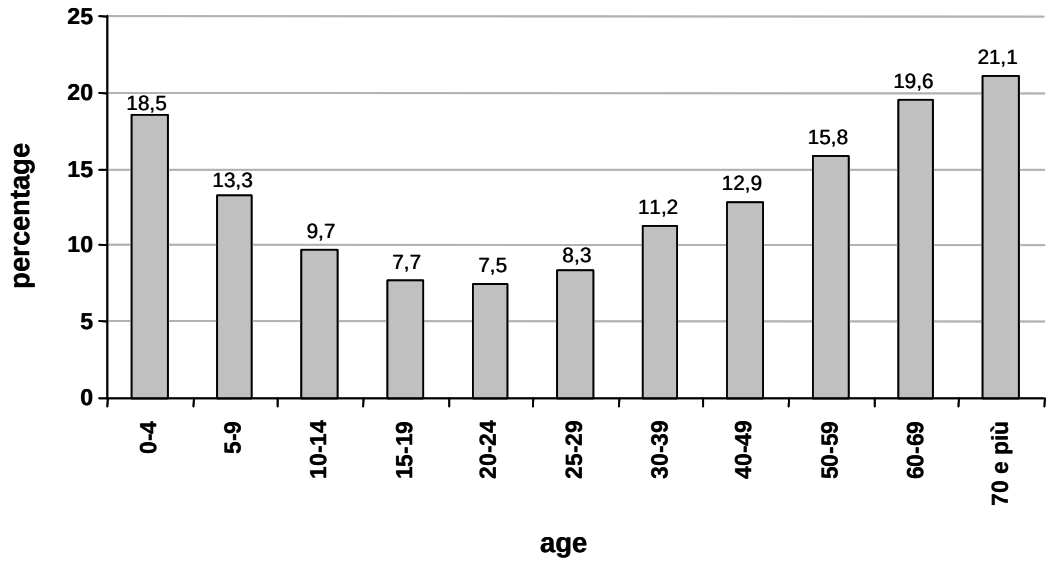
Figure 16. Accidents distribution by hourly breakdown

As can be deduced from figure 16, the rescue actions carried out in the span of time between 11:00 and 13:00, that is to say the time of greatest crowding of the slopes, were 1/3 of the total number. It should be noted that in the 6 hours between 10:00 and 16:00 there is a concentration of about 86,4% of the accidents.

3.7 Accidents and responsibility

We have already seen how the majority of the accidents observed occurred following an accidental fall (an average of 77,1%), while only 11,3% of the accidents took place because of a collision with another skier (figure 10)

There is an aspect often neglected in the analysis of these complex phenomena: that of the responsibility for an accident. Percentile distributions by age of accidents whose responsibility was that of a third party are reported in figure 17.



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center

Figure 17. distributions by age of accidents whose responsibility was that of a third party are reported

To be noted is the "U" shaped curve these percentage make, with values starting from 18,5% in the 0-4 age group to 7,5% in the 20-24 age group to progressively increasing again by age up to over 20% for the oldest individuals (figure 17).

Since the responsibility of a third party is clearly recognized almost exclusively in the case of an accident caused by a collision between individuals, two different situations seem to emerge: one low risk situation in which one is hit by another skier, more common amongst the young and the young adult groups (between the ages of 5 and 39 an average of 1 accident out of 10 happens because of another skier running into the one who suffers the injury); the other situation, more common amongst the older skiers, in which about 1 accident every 5 happens because of the following motivations.

"I hurt myself because an incompetent ran into me..." Wanting to make a bet on who, between a young person and an elderly one would have pronounced these words, we should bet on the older person who has a probability almost 3 times higher of getting into a situation of this type. This, after all, is not very strange as we are not discussing the probability of an accident taking place, but the probability of suffering an injury as the consequence of an accident, and it is known, that the elderly (and in part also pre-adolescence aged individuals) with the same force of impact, suffer more serious consequences because of the greater frailty of their bones and thus have a greater probability of finding themselves in situations requiring rescue action. One should note furthermore that compared to the younger generation, the older generation is more careful and tends more often to seek, for precautionary purposes, medical assistance.

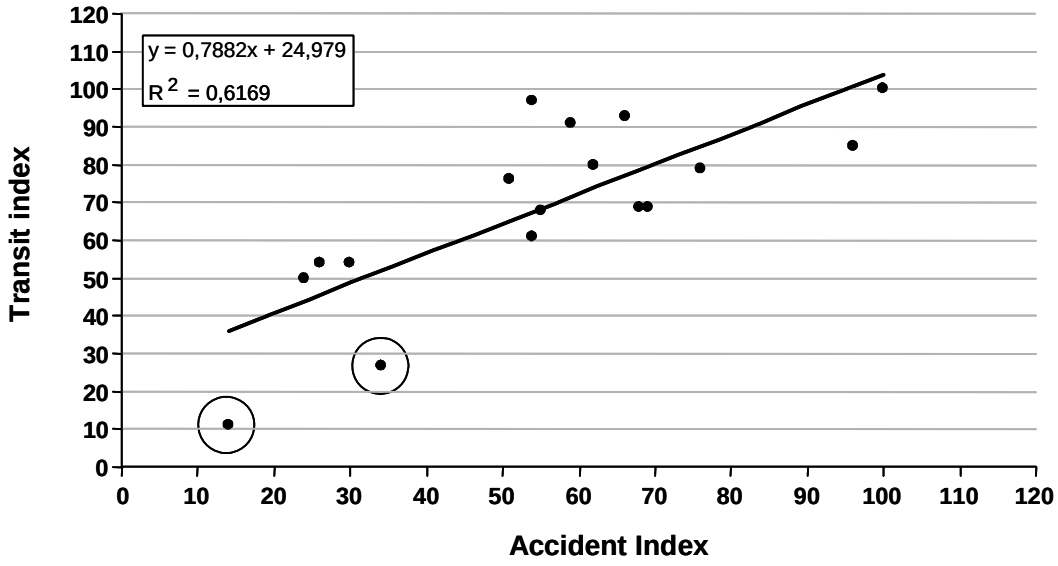
The data also demonstrate that if the rescue action on the slope is motivated by an accident because of a collision between people, in the almost totality of cases the responsibility of the accident is to be blamed not on the person suffering the accident but on the person unintentionally hitting the

victim.

A good question to ask oneself is if, by chance, this propensity towards generating particularly dangerous situations of colliding with other skiers (or skier and snowboarder or between snowboarders) is a direct consequence of the over- crowding of ski slopes. In other terms, does one bump into others more often when there are more people on the slopes or not? The question is not trivial because if it is true that one expects that greater crowding is the cause of a greater probability of contact, it is true as well that those psychological feedback mechanisms called upon when considering the risk factor of skis vs snowboard can also be summoned on this occasion. Seeing a very crowded ski slope one may be induced to a more careful behavior, compensating thus with a more cautious attitude a theoretical greater probability of being hit.

Still referring to the analytical data of the ski lift transits in the 3 extended territories used as a base to estimate the accident probability (Via Lattea, Madonna di Campiglio and the area of the 3 Valli), is it possible with the same methodology, to go a bit further, considering in fact, that portion of traumatic events which come about as a consequence of collisions between people?

Thus the values both for the number of transits (crowding index), as for the proportion of rescue actions for accidents caused by a collision between people (index of the propensity to collision) have been indexed by week. The correlation between these two measures is shown in the underlying figure 18.



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center and resorts Via Lattea, Madonna di Campigio, 3 Valli data

Figura 18. Correlazione tra indice di affollamento e indice di propensione allo scontro

In this case the linear correlation is evident also if it is not very strong as those related in figures 15a and 15b when the number of transits at the ski lift stations were compared with the total number of accidents. Certainly the right coefficient for the correlation (r2=0.62) indicates that for a good portion of the weeks the two indexes follow the same flow. The points which are much higher or much lower than the regression line regard those weeks in which the linear

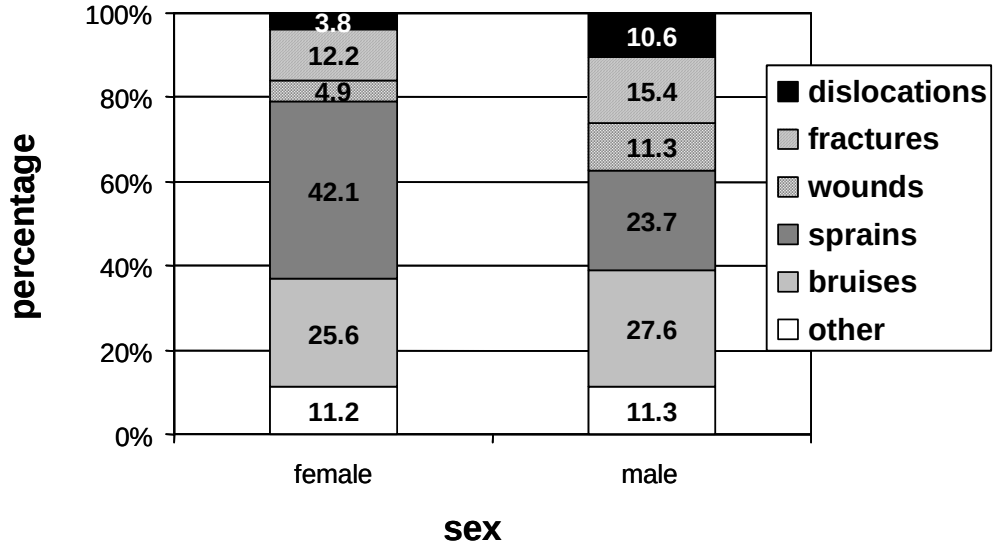
function approximating $Y = 0{,}79X + 25$ identified by the linear regression does not does not succeed in describing the phenomenon and, notices a quantity (for example the crowding of the slopes), in order to predict the other. Actually, carefully observing the correlation of figure 18 it would seem that, keeping in mind both the distance from the regression line, as the isolation of the points, two are the weeks which are "strange", appropriately evidenced in figure 18 by a small circle.

When we try to see which the weeks involved are, we notice that it is 2 of the last 3 weeks of the season, in the period between March and April, when the crowing of the slopes decreases below the minimum threshold beyond which the incident-accident evidently becomes truly sporadic. One should note that of the last 3 weeks of the skiing season, the one which seems to escape this rule is precisely the one in which the Easter holidays happen to be, when for the crowding up of the slopes and perhaps because of the skiers typology, dynamics similar to the rest of the season seem to come up again.

3.8 Accidents and Lesions

In 32,8% of the cases the rescue action on the slopes is carried out because sprains (94,2% involving the lower limbs). Next are bruises (27,4%), fractures (15,7%), dislocations (8,7%) and wounds (8%).

For women, dislocations occur twice as many times as for men (42,1% vs 23,7%), while for men the different typologies of lesions seem to split up more evenly : wounds occur for 11,3% of the males and 4,9% of the females, dislocations 11,6% of the males and 3,8% of the females (figure 19).



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center

Figura 19. Accidents distribution by sex and diagnosis

In males, instead the different typologies of lesions seem to split up more evenly and these differences can be ascribed only in part to the fact that males

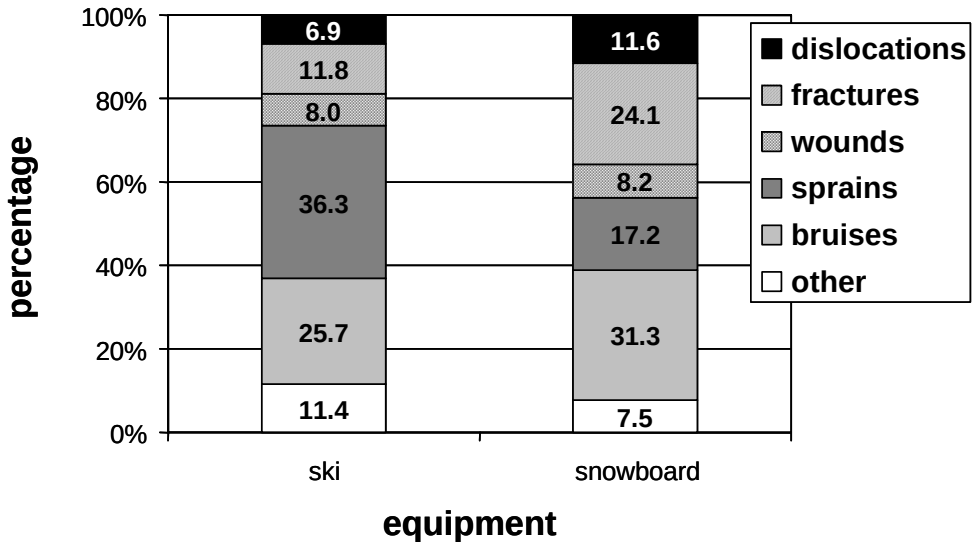
use snowboards much more than females do.

As a matter of fact the typology of lesions differs according to the type of equipment used (even in this case we will limit the analysis to accidents with skis and snowboards). Excluding simple bruises which can be considered as an expected outcome, for an accident of some seriousness, one can recognize a typology of specific lesions per type of equipment used: sprains from skis and fractures from snowboards.

As shown in figure 20 sprains are diagnosed from skiing twice as frequently than is the case from snowboarding (36,3% vs 17,2%). On the other hand exactly the opposite happens in the case of injuries with the snowboard where the diagnosis of fractures is reported in 24,1% of the cases while in ski accidents fractures are diagnosed only in 11,8% of the cases.

In case of an accident the ski can much more easily than the snowboard act as a lever that uses the foot as a pivot imparting tangential forces which, if not efficiently dispersed/relieved by the ski boot security attachment, discharge their energy especially on the closest free articulation, that is to say, the knee, causing it to sprain.

For diametrically opposite reasons the snowboard preserves relatively better the lower limbs, even if it exposes one to accident dynamics which , as we will see more clearly later on, especially involve the higher limbs, which being less sturdy, risk fractures.



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center

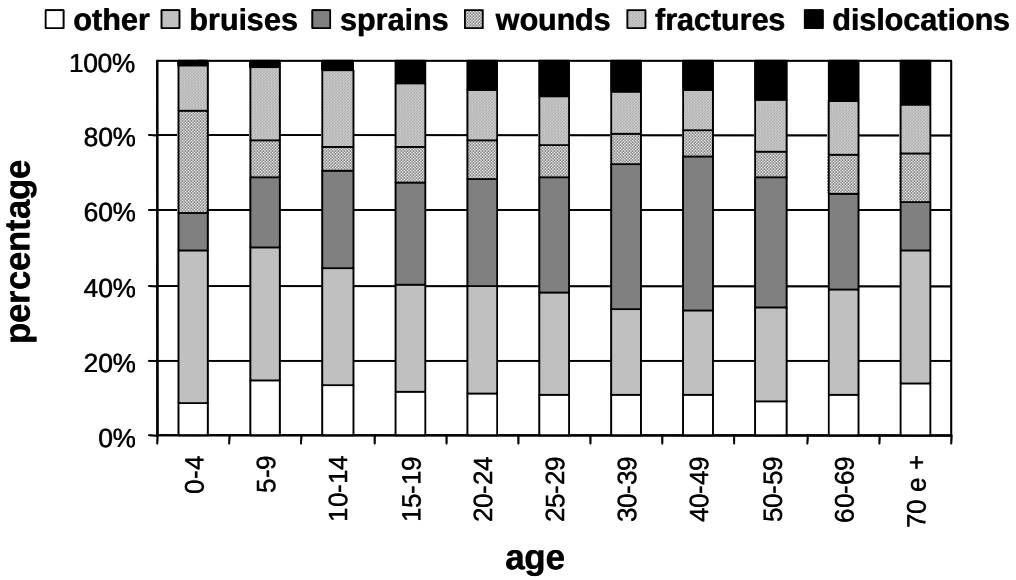
Figure 20. Accidents distribution by diagnosis and equipment

Still with regard to lesions it must be said that they involve each age group in a different way. Figure 21 shows how the different age groups are involved in various types of lesions. One can picture each age group as a cylinder containing sand of different colors depending on the type of lesion and in the proportion in which these lesions occur in each group. Such a reading of the data expressed in proportions, while it obviously, does not refer to the number

of cases actually occurring in each age group (for example, while between 0 and 4 years of age there are only 81 cases in the three year span registered by the State Police Alpine Training Center, in the 10 to 14 age group there are as many as 7.109 cases registered), yet it allows one to capture in a glance how much the traumatic situation changes according to age.

In other terms, reading the data in this manner one answers questions of the type: "What probability is there that the lesion is a fracture knowing that the injured person is between 20 and 24 years old?" (in this particular instance, around 12%).

One should note that amongst children, especially the very young , wounds and fractures, besides, bruises, of course, are the most common lesions. Amongst adults, instead the clearly predominant role is held by bruises, while amongst the elderly a traumatic picture similar to that of the children, once more becomes evident.

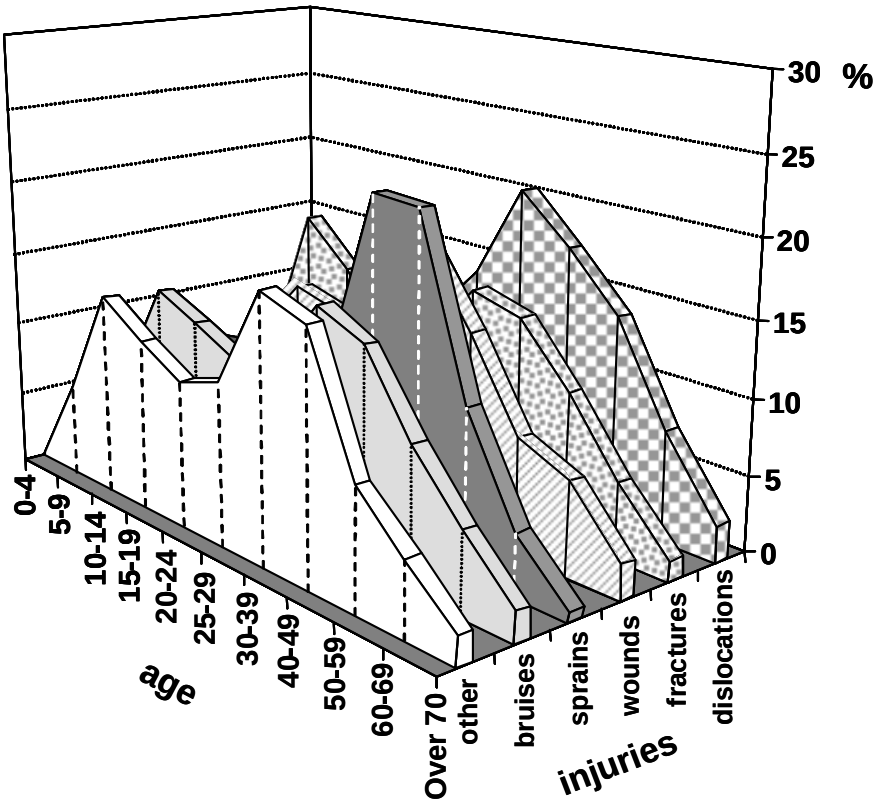


SOURCE: National Institute of Heath elaboration on Police Alpine Training Center

Figure 21 Accidents distribution by age and diagnosis

In figure 22, instead, the distribution by age is reported for each single type of lesion. It represents a view of the situation which is complementary to the previous one, as in this case the information is not about how lesions involve each age group, but how each age group differs in type of lesion. In this case one loses the information of how numerous the cases are for fractures, sprains, etc.…but on the other hand it is possible to have an overall picture of how many cases of each lesion (percentage wise) are present in each age group.

In other terms, the questions to which one can answer will be in this case of the type: "what probabilities are there that the injured individual is between 20 and 24 years old knowing that he/she suffered a fracture?" (in this case 9%).



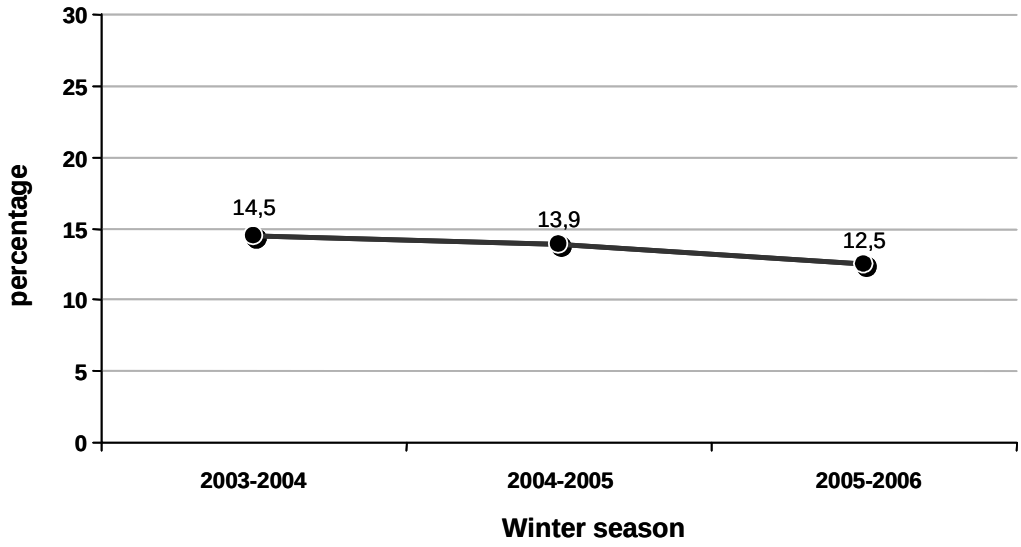
SOURCE: National Institute of Heath elaboration on Police Alpine Training Center

Figure 22. Injuries distributions by age

Referring to the location of the lesion, in about half of the cases (46,4%) lesions occur in the lower limbs, in 21,1% the lesion regards the upper limbs while in 13,4% it concerns a head or face trauma.

With regard to the cranial-facial traumas one should note that law 363/2003 ("Norms dealing with safety issues for downhill and cross country winter sports participants") approved definitively by the Senate, December 17, 2003, decrees the obligation for all youngsters up to 14 years of age to wear a helmet, beginning from the skiing season 2004/2005. Even if later the application of this law may have encountered some problems, it certainly represented a very important step in the prevention of injuries connected to skiing. Furthermore it should be indicated as good practice (perhaps recommended and not necessarily imposed by law) to use the helmet at any age, since in all accidents which involve head and/or the face injuries only 17% concern the age group between 0 and 14 years of age (for which age however, about 16,2% of the accidents take place).

On the other hand a possible sign of the impact of the law can be seen in the descending trend of cases of lesions to the face. If it is true, as mentioned above, that 13,4% of the lesions regarded the head and/or the face, it is also true that this value is the average based on the whole 3 year period considered. If we take a look at the flow we will notice a downhill trend even if it is only slight (figure 23).

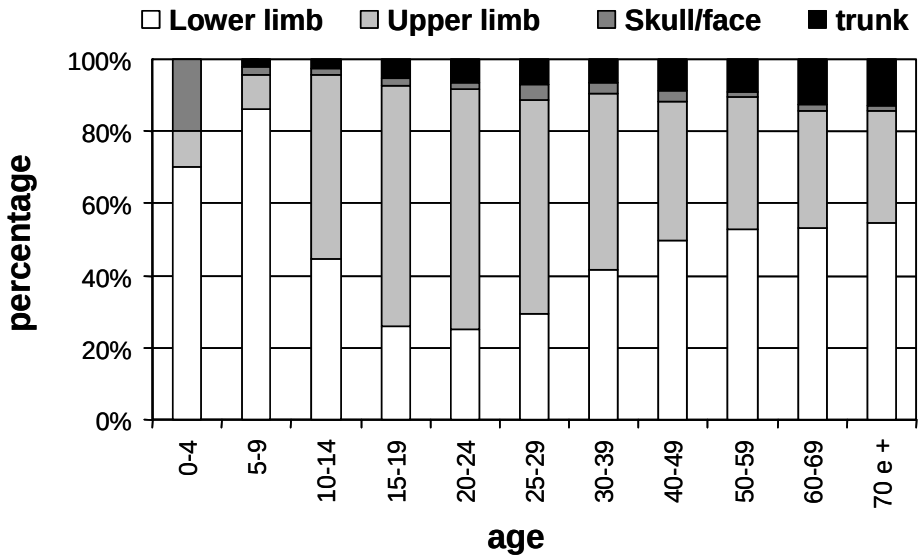


SOURCE: National Institute of Heath elaboration on Police Alpine Training Center

Figure 23. trend of skull/face injuries in winter seasons 03/04, 04/05 and 05/06

As has already been said there is a rather precise relation between the type of lesion and its localization. Sprains occur essentially in the lower limbs, dislocations mostly involve the upper limbs while wounds are specifically concentrated in the cranial-facial area. And this regardless of age. Age, moreover, does not seem to hold a significant role not even in the case of bruises, which, however, involve in similar proportions all areas of the body. The case of fractures is of greater interest.

Figure 24 shows how fractures are distributed by location and age group. If we exclude the very young children (0-4 years of age) for whom in the cases analyzed by the Police one finds only 10 cases of fractures in 3 years, the traumatic picture shows us different cases depending both on the localization of the lesion as on the age of the individual injured.



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center

Figure 24. location of the fractures by age

Fractures of the head or face represent a "pool" fortunately of no great entity, never exceeding 4,3 %. Fractures of the trunk fluctuate around an average of 6,4 %, indicating a slight tendency of increasing with age, going from a 2,5% average for children up to 14 years of age to a 13% average beyond age 70.

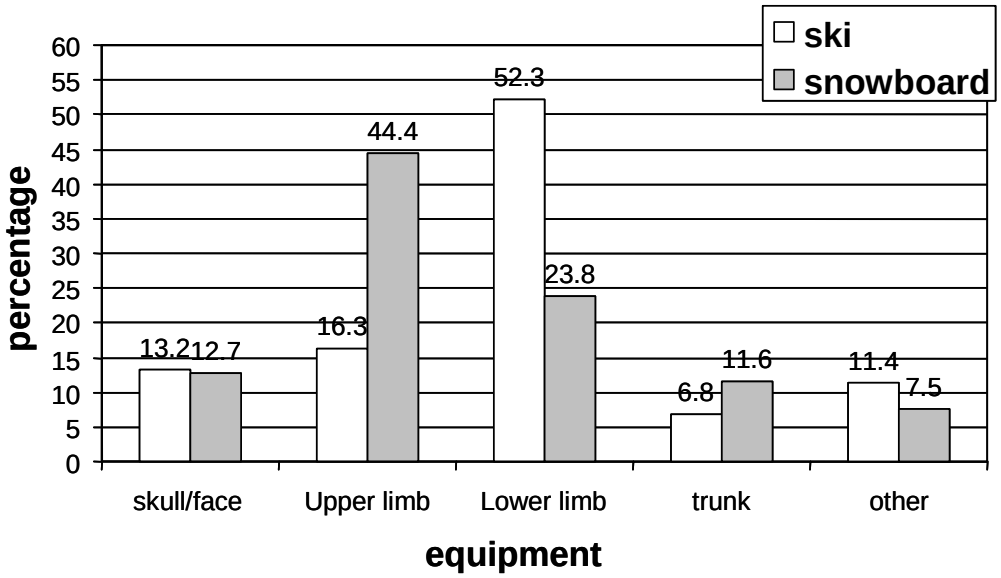
The case of fractures to ones limbs is different. The flow in this case, is clearly symmetrical. In small children (5 – 9 years of age) the lower limb fractures prevail, but soon after, beginning with 10 year olds the situation reverses : beyond the age of 10 and up to 39 years of age it is the upper limbs to be principally involved in the occurrence of fractures. Later on, amongst adults and the elderly it is again the lower limbs most at risk of suffering fractures.

Certainly the high percentage of upper limb fractures found amongst the young is also to be related to the high use of the snowboard common in this age group and which endangers especially this part of the body.

In fact, as mentioned before, there are different types of lesions depending on the type of equipment used (figure 25): excluding simple bruises, to be expected in any accident, sprains are typical of skiing (36,3 % for skiers versus 17,2% snowboarders). In the case of snowboard accidents the diagnosis of fractures occurs in 24,1% of the cases (more than ¾ of which involve the upper limbs) compared to 11,8% in skiing accidents.

The parts of the body primarily involved in these accidents are first of all the knees. Skiing is, in fact, a sport, that especially stresses the articulations and, amongst these, especially those of the lower limbs. Contrariwise, snowboarding preserves one's knees relatively more, exposing to greater risk the upper limbs. With regard to skiing , in more than half of the cases, in fact, the injury regards the lower limbs (52,3%) and only in a relatively marginal

percentage, it interests the upper limbs (16,3%), while the area of the head or of the face is involved in 13,2% of the cases. Those who use the snowboard turn out to be instead at much greater risk of suffering a lesion to their upper limbs (44,4%), while the lower limbs are involved in a reduced manner (23,8% of the cases).



SOURCE: National Institute of Heath elaboration on Police Alpine Training Center

Figure 25. location of injuries by equipment

Fortunately the particularly serious cases in which a helicopter was required for the rescue action are very few, a 3,09% average of the total number of accidents in the three years considered. One should note as well that the quota of rescue actions carried out by helicopter shows a slightly decreasing trend (3,51% in the '03/'04 season, 3,20% in 04/05 and 2,55% in '05/'06), a sign perhaps of a lower level of seriousness in the accidents. Nevertheless one should keep in mind that the use of a helicopter as a ski slope evacuation means is conditioned by many factors, amongst which the weather conditions and the availability of an area on which to land. When these conditions are not present, even in the occurrence of serious accidents, one is obliged to turn to alternative means as the toboggan, for which it is legitimate to suppose that in the rescue actions carried out with this means of emergency transport (39,4% of the total) harbor, however rare they may be, a series of particularly serious accidents.

Using exactly the rescue assistance of a helicopter as a measure of the seriousness of the lesion, we can verify that compared to a comprehensive average of 3,1% cases of cranial or trunk lesion cases the helicopter is called upon much more often (7,4% in the case of cranial or facial lesions and 9,6% in the case of trunk lesions). However the victims with cranial or facial lesions transported by helicopter have diminished with time. While, in fact, in the 2003/2004 season of all individuals with head injuries 8,7% was transported by helicopter, in the 2005/2006 season this quota diminished to 5,8%. It thus

seems conjecturable a scenario in which one observes less serious cranial and/or facial lesions besides fewer cases of this type of injuries (the reduction of lesions to the head and face equals 11,3%), which can be put in relation also with the obligation of making the use of helmets compulsory up to 14 years of age, as ratified by the law 363/2003. On the other hand, this conclusion seems to be supported by the fact that the reduction in traumas to the face is particularly noticeable in the age group "protected by law", in which we find a reduction more than double compared to what happens for individuals above 14 years of age (-20,1% vs 9,3%).

For what concerns the destination of the injured victims, we gather from an analysis of the ski accident rescue report forms that only in 24,7% of the cases, the injured individual is rescued on the ski slope, medicated if the case requires and sent back home. In most of the cases a rescue action request was followed up by at least one visit to a public or private out-patient clinic l (23,7%), or admittance to a First Aid Station (46,0%). Such percentages remain stable throughout the three seasons being considered for this report.

One should stress that with regard to destinations, so as to say, they are in part presumed since in actuality it is not always possible to follow up on the injured individual throughout his/her therapeutic journey which goes from the site of the accident to the out-patient clinic, to the First Aid Station and eventually to the hospital ward. We will, however come back later on, with regard to this subject

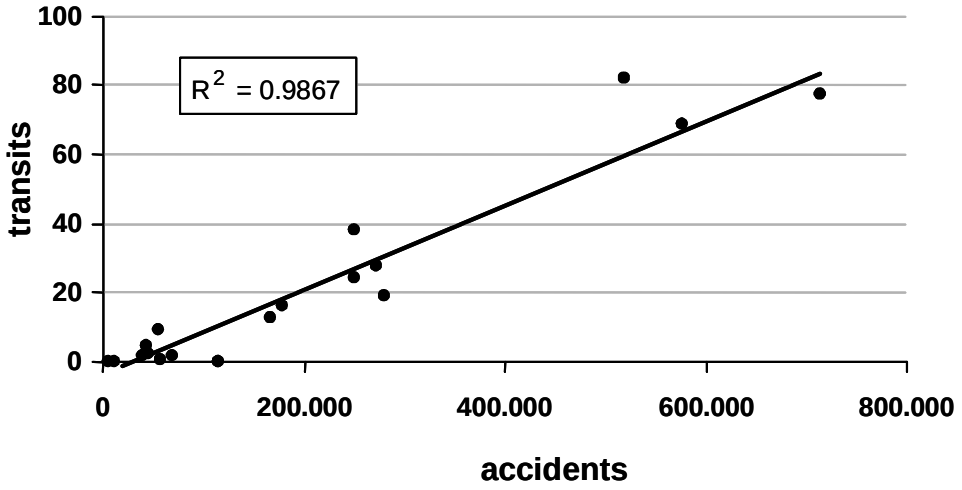
3.9 Reflections on the estimate of accident occurrences

We have observed how the SIMON system quantifies a quota of 1.495 accidents every 100.000 skiers compared to 1.269 accidents every 100.000 snowboarders (see paragraph 3.5). It might not be banal to relate the number of accidents, not to the number of winter sports participants, but rather to a measure representing risk exposure while also keeping track of the number of kilometers covered. The type of reasoning one wishes to develop later on refers to data collected in Valle d'Aosta and dating back to the 2003/2004 ski season. Due to the substantial stability of the accident phenomenon being considered, the estimates furnished may be considered consistent with the current reality. Furthermore what seems interesting, besides the estimate provided is a strategy with which to calculate the accident incidence that if shared can constitute a methodology which can be applied generally.

In order to calculate the incidence the data considered is both that relative to the entire Valle d'Aosta (for a total of 25 skiing districts), as the data regarding the a sub-area including 7 skiing stations still pertaining to the Valle d'Aosta area. It contains the ski stations of Cervinia, Valtournenche, Courmayeur, Monterosa Ski, La Thuile, Pila and Champorcher which on their own count for 89,9 % of the transits reported by the ski lift facilities of the entire region, 91,3% of the accidents, 65,9% of the ski lift stations whose hourly load, expressed in number of individuals per hour is equal to 75,5% of the whole volume of registered transits in the region, as well as the 81% of the total length in kilometers of the ski slope development. Thus it regards an absolutely representative sample of the entire region of the Valle d'Aosta, the results of which, beyond being applicable in a general way to the entire region, can also, on the base of some observations on the way in which the ski slopes are used, be projected on the entire national reality.

A first explorative analysis of the phenomenon shows how there is a very

close correlation between the number of accidents and the number of transits registered by the ski lift stations (figure 26) as, furthermore already shown in figures 15a and 15b.



SOURCE: National Institute of Heath elaboration on AVIF (Associazione Valdostana Impianti a Fune) data

Figure 26. Correlation between accidents and transits – Valle d'Aosta, winter season 2003-2004

Thus the functional relation evidenced clearly indicates that the increase in the number of transits increases in a linear manner the number of accidents.

Another way to estimate the incidence of the phenomenon is to correlate the number of accidents to the number of kilometers covered or to the number of days in which one has actually skied.

One should consider the data in table 11 in which a series of indicators are recorded for a subset of 7 stations.

Table 11. Indicators for incidence estimation

Resort	Transit	Acci-dents	Estim. Atten-dances.	km slopes	N° slopes	avg lenght slopes	Km per day	Estim. Km covered	km by 1 accid.	ski days per 1 accid.
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(L)
1	6.600.237	710	660.024	212	43	4,9	39	26.032.563	36.666	744
2	6.002.637	660	600.264	115	49	2,3	19	11.270.257	17.076	728
3	4.626.560	672	462.656	70	26	2,7	22	9.964.898	14.829	551
4	4.286.718	499	428.672	100	26	3,8	31	13.189.902	26.433	687
5	3.829.883	435	382.988	150	74	2,0	16	6.210.621	14.277	704
6	1.687.180	195	168.718	35	13	2,7	22	3.633.926	18.636	692
7	650.189	75	65.019	21	15	1,4	11	728.212	9.709	694

SOURCE: National Institute of Heath elaboration Center on AVIF (Associazione Valdostana Impianti a Fune) data

The key point is to try to estimate how many kilometers are on average

covered every day by a skier, measure which, intuitively may also change depending on the station.

As previously mentioned, on an average in the Valle d'Aosta there is a ratio of 1:10 between presences and transits at the ski lift facilities. Considering this carefully it also means that on an average an individual takes the lift 10 times to ski down the slopes. We could even hypothesize that for each ski lift run taken there corresponds a descent, however experience and common sense suggest that it would be more realistic to modify this equal ratio towards a more likely 0,8, that is to say that for 10 transits correspond 8 ski slope descents considering that often one happens to take several ski lifts in order to ski down a slope (one should consider, furthermore that for one of the most well known ski areas, that of the Sella Ronda, the ratio between the kilometric development length of the ski lift facilities and the length of the ski slopes is around 0,75).

Thus referring to the columns in table 11, from the simple calculation of the expression:

$$KM_{die} = \frac{D}{E} \times 10 \times 0{,}8$$

we obtain an estimate of the average number of ski slope kilometers covered every day by an individual who skies at a particular ski station. These values are recorded in column G of the same table.

As an example one should consider that the average of the values regarding the daily distances skied is 23 Km, length that coincides with the overall development of ski slope length of the one covers in order to complete the just mentioned tour of the 4 passes (or Sella Ronda), a tour which also thanks to the efficiency of the modernly conceived ski lift facilities can be carried out in the span of a day without any problem by most skiers.

At this point, if an individual covers on an average "G" kilometers a day, multiplying this value by the number of individuals who have used throughout a ski season a particular ski stations, we will obtain the comprehensive value of the kilometers covered sample in that place.

Thus we have:

$$KM_{tot} = G \times C$$

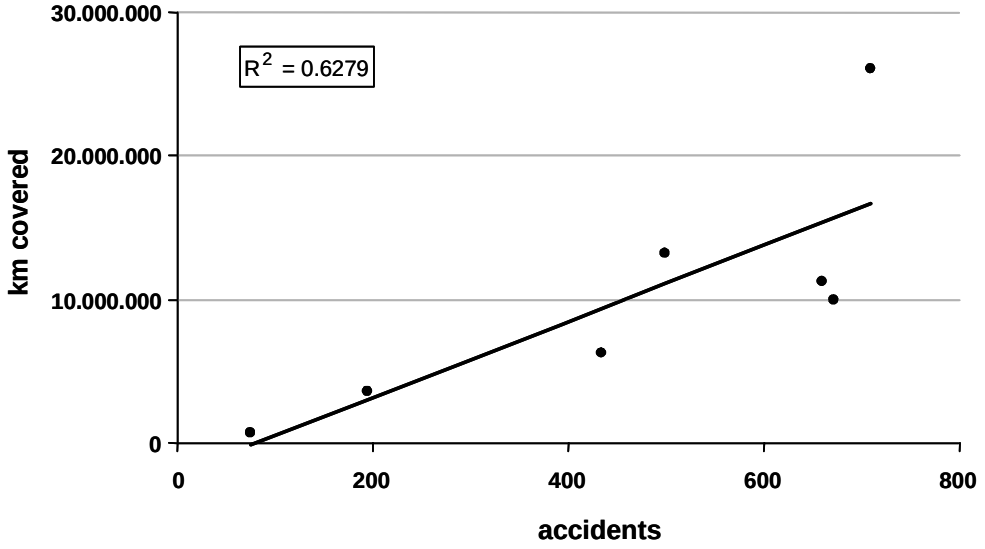
These values are recorded in column H of table 11. Dividing the number of accidents by the comprehensive volume of kilometers covered we obtain the measure of the incidence of accidents (Ti) which we had proposed to correlate to the length covered.

Thus:

$$T_i = \frac{B}{H} \times 100.000$$

These values, recorded in column I of table 11, vary considerably from station to station, as does also the comprehensive volume of kilometers covered. The length covered appears, in fact much less correlated to the number of accidents than does the number of individuals present on the ski slope. One should thus compare with regard to this, the linear correlation values (R^2) of figure 26 and of figure 27 below it, which records, in fact, the correlation between the number of accidents for which a rescue action has been carried out and the comprehensive volume of kilometers covered in the 7

stations chosen in our sub-sample.



SOURCE: National Institute of Heath elaboration on AVIF (Associazione Valdostana Impianti a Fune) data

Figure 27. Correlation between accidents and kilometers coverei during 1 season – Valle d'Aosta, subset 7 resorts - season 2003-2004

Where one had taken into consideration the presences, these seemed very closely correlated to the number of accidents (R^2=0,98) while in the last case the correlation seems weaker (R^2=0,63).

Nevertheless, considering carefully the data in table 11, the over 36thousand kilometers which on average an individual who uses station 1 must cover to run into an accident requiring rescue action, compared to the 17thousand of station 2, depend on the fact that on average in station 1 per day an individual skies many more kilometers compared to the number he/she would be able to in station 2. Were one to quantify the accident risk normalizing the length to cover by the number of days on an average necessary to carry out such a distance, the differences between place and place tend to decrease considerably so much so that column L of table 11 shows values included between 551 and 744 days of skiing.

Using an average value considered, we can therefore conclude that in our sample one has an average of 1 accident (of some "seriousness) every 680 ski days. This, therefore, seems to be a risk index which disregards from the different characteristics of the territory and nevertheless can be generalized. It concerns, essentially a rather remote risk considering that, skiing an average of 10 days per year, 68 years need to go by before running into an accident requiring a rescue action, and which would places Italy in the lead with regard to other countries for which data included in their literature mention risk indexes close to 1 accident every 300 days of skiing.

4. THE PROVINCE OF TRENTO IN-DEPTH RESEARCH CENTER

One of the major problems in trauma epidemiology is that it is difficult to connect information regarding an accident with the health outcomes it brings about. Often there are data bases that concern either one or the other aspect of the traumatic incident, but any connection between the various information sources seems often totally absent. At times one reaches the point that for an erroneous evaluation the data bases are hastily opposed one to the other, as if one were the guardian of the truth and the other a pale and much less reliable imitation. This is, for example, the problem which afflicts the area dealing with traffic accidents where the overabundance of figures, apparently conflicting with each other, can be explained by having referred to different data bases.

The SIMON system has made it possible, for the first time, to establish a dialogue between two different data bases: the first one consisting of the Alpine Training Center's Police ski slope rescue actions and the second of the Autonomous Province of Trento's health-care system. Both these case records are useful for a better understanding of skiing accidents as they are by their nature complementary to each other. In fact the unit on which the statistics are based for the autonomous Province of Trento's health-care system is the injured individual; thus one has good information on the traumas. One of the limits, however, of this type of data is that no description is provided of the accident itself.

The unit on which the rescue action statistics are based is, instead, the accident itself: this way one obtains a very detailed picture concerning the manner in which the skiing accident occurred, combined with general information on the individual/s involved.

Experimentally with the area of Trento's province as a reference sample and with the collaboration of the Epidemiological Observatory of the Province of Trento, one has successfully carried out a data-linkage.

One should be aware that all First Aid stations of the province are computerized even though referring to different management systems; nowhere, however, does the First Aid recording of data allow for a specific report on "skiing accidents" as such, nor of the physical location where the accident occurred, nor what specific activity one was carrying out at the time of the accident, nor the dynamics of the accident itself. Nevertheless, utilizing the appropriate keys to make connections, it has been possible, first of all to verify the feasibility of creating a linkage and secondly, upon accomplishing it, the ability of defining in a more precise manner the medical consequences of the accidents.

The in depth analysis consists of a sample of 8.273 rescue actions carried out in the territory of the province of Trento by the Alpine Training Center's Police throughout the skiing seasons of 2003/2004 and 2004/2005. Table 12 shows the referenced skiing stations in which the accidents included have taken place.

Table 12. In-depth analysis of the following Resorts of the Province of Trento

Resorts
Alba di Canazei
Andalo
Campitello di Fassa
Canazei
Cavalese
Folgaria
Madonna di Campiglio
Moena Passo S.Pellegrino Bellamente
Pampeago
Pinzolo
Pozza di Fassa
Predazzo
San Martino di Castrozza
Vigo di Fassa

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

In the analysis one assumes that, if the majority of those who are injured skiing on the ski slopes of the Trentino are directed to a medical facility for further check-ups, it is likely that this facility is part of the province's own territory. Obviously there might be cases in which the individual is moved from one province to another, however this should represent a marginal quota, especially concerning admittance to a First Aid facility which we consider the first step of one's medical itinerary towards health verification. It may even be that a number of the injured individuals in bordering areas of the Trento province, may go to First Aid facilities of neighboring provinces (i.e.: Bolzano, Belluno, Verona or Brescia); however, we feel that such migration may be offset by a probable move in the opposite direction. For these reasons we believe that, what has been observed in the Autonomous Province of Trento's in-depth research Center, may be particularly significant for a more thorough evaluation of the numbers of First Aid center admittances and of following admittances caused by injuries on the ski slopes, as well as for a clinical identification of the injuries suffered.

Of a total of 8.273 rescue actions considered 1.687 cases (20,4%) have been intercepted as being treated in 10 medical facilities of the province of Trento (table 13).

Table 13. In-depth analysis of the following First Aid facilities of the Province of Trento

First Aid facilities
Arco
Borgo
Cavalese
Cles
Mezzolombardo
Rovereto
Tione
Trento (adulti)
Trento (pediatrico)
Villa Igea

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

The first fact that emerges is that, actually, for one rescue action out of 5 a First Aid facility check up is prescribed. Of these 209 are then admitted to the facilities where they were taken to or to which they went autonomously, 131 refuse to be admitted and 33 are transferred to another facility outside of the province of Trento. If we consider hospital admittance as an indicator of the seriousness of the trauma, should we wish to quantify the quota of the most serious injuries , it might be conceptually mistaken to consider together with the individuals actually admitted, also those who should have been admitted, or those who were transferred elsewhere. Having quantified in this manner the quota of the most "serious" cases out of the total number entering a First Aid facility, one reaches 22,1%. In other terms, when one enters a First Aid facility, even in this case 1 time out of 5 one has suffered a lesion serious enough for hospital admittance (whether it actually takes place or is refused by the injured individual).

We can thus start out with these first admittance estimates to build up a pyramid for ski traumas. The base of the pyramid is formed by the estimate of the accidents that occur in Italy every year: we saw earlier that the SIMON system estimates around 35.000 of them. The peak of the pyramid is formed by the number of deaths which have been quantified as around 40 per year. The problem is now to quantify the two intermediate levels, that is to say the number of cases receiving medical assistance from First Aid facilities and the number of those admitted to hospitals.

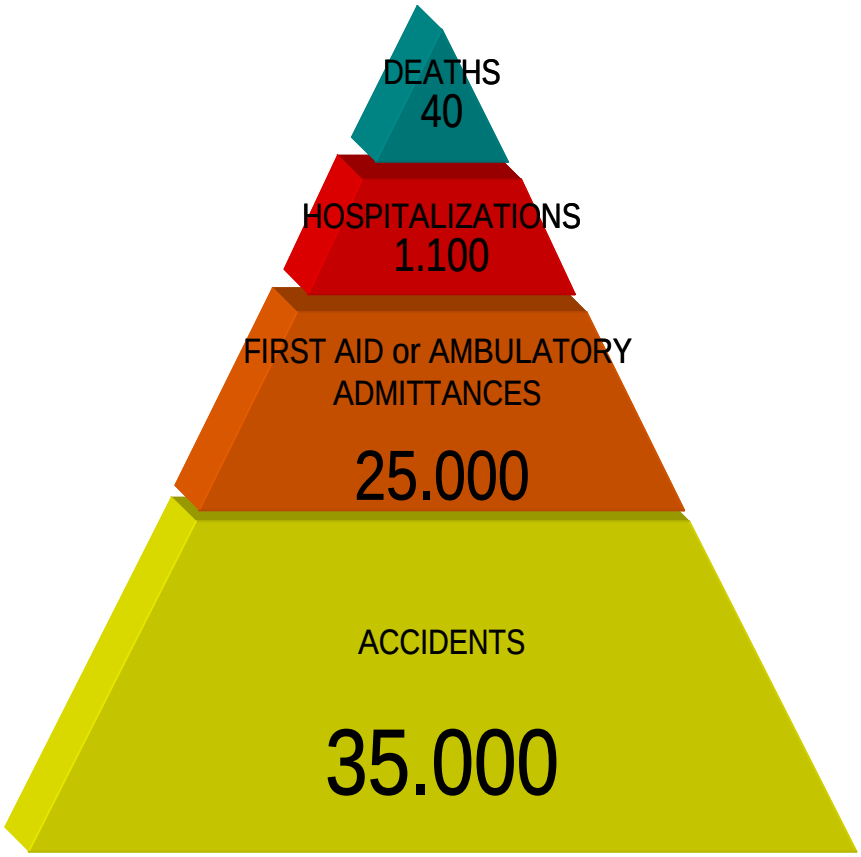
For what concerns the first aspect (First Aid medical care) one should note that, in many cases, one does not turn to the emergency facility simply because, in a mountain area, it is harder to find a true and proper hospital facility in the neighborhood. Precisely to avoid this problem one often goes to the public or private outpatient clinics in the area, which act as a first step substituting the actual Emergency facility. In the case of skiing injuries it seems, thus, more appropriate to seek outpatient or first aid medical assistance. After all, bringing together outpatient and emergency medical assistance, besides being correct from a clinical standpoint, allows us to project the data from the Trentino area on a national level, considering the fact that there may be other territorial realities in which the proportion between

medical assistance in outpatient clinics versus Emergency facilities may differ from that of the Trentino, but does not change the final total significantly.

In the hypothesis that what has been observed in the Trentino area is typical of what occurs on the national territory, we can estimate that the number of outpatient and first aid medical visits is around 25.000 every year in Italy. The sample of the in-depth Trentino research center indicates that on 1.687 cases, 209, equal to 12,4%, have been later, hospitalized. One could apply this proportion to estimate the total number of admittances in Italy (it would be 884 individuals), however, we feel that there could be a quota of individuals which is "not observable" because redirected to other facilities outside of the province (Bolzano or Verona). What contributes to support this hypothesis is the fact that of a total of 8.273 cases of injuries on the ski slopes in Trentino, based on the Alpine Training Center Police records, 145 emergency actions have been carried out with helicopters. Because of the costs of carrying out helicopter rescue actions this number should credibly represent the most serious cases. Of these 145 helicopter rescue actions, only 65 turn out to be in the in-depth sample. There are thus 80 missing which have been redirected towards facilities beyond the Trento province. Adding these 80 cases to the 209 admittances, regularly recorded, we have a total of 289 cases which brings the quota of admittances to 17,1% of the total number of First Aid admittances. This correction implies an estimate for Italy of about 1.220 admittances per year.

One should however consider that transporting someone by helicopter is not always followed by a hospital or first aid admittance: for example, of the 65 cases of helicopter rescue action in the sample being considered, for only half of them does admittance follow. We could, thus, decide to add to the 209 admittances actually recorded, only half of the 80 cases of helicopter rescue action not seen, reaching a total of 249 admittances. This new more conservative estimate indicates that about 1.050 cases are expected to be admitted every year in Italy. A good compromise, sufficiently conservative between the two estimates, could be that of at least 1.100 admittances per year.

Based on the projections carried out above, one thus comes up with 1 first aid or outpatient medical assistance for every 1,4 rescue actions, 1 hospital admittance every 32 rescue actions, and since, because of what above reported, one death occurs out of 880 rescue actions, on the base of the 35.000 rescue actions estimated per year one obtains the picture shown in figure 28.



SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

Figure 28. Trauma Pyramid of the skiing accidents

This is obviously a first estimate which will need further verifications on the basis of a broader sample; however, already in this phase one can draw useful indications. First of all, the phenomenon seems to be of contained dimensions, especially if compared to other traumatic phenomena which burden the population.

The quota of hospital admittances does not differ between skiers and snowboarders, for which, at least in a first approximation, using as reference the proportion of hospital admittances to the total number of First Aid visits as an indicator of the average seriousness of the lesions, this appears similar between the two groups: considering those who are hospitalized, together with those that refuse to be admitted, and those who are transferred to other facilities, the resulting percentage of "seriously" injured skiers is 21,5% versus 20,3% for snowboarders.

If, at this first level, the seriousness does not seem to differ between skiers and snowboarders, there seems to be a slight differentiation regarding the dynamics of the accident. There seem to be slightly more serious, even if less frequent accidents caused by collisions between individuals versus those due to accidental falls. In the first case, 24,2% of the Emergency facility entries, present a "serious" clinical picture, while in the second case this percentage decreases to 20,7%.

Getting more specific with regard to lesions checked in the Emergency

room, overall the most common are knee sprains (19,2%), followed by (brain) concussions (13,3%), by shoulder dislocations (6,6%), by tibia and/or fibula fractures (5,0%) and wrist fractures (4,2%). These 5 diagnoses, by themselves, add up to about 50% of all lesions reported in the Emergency room. One should note, however, that there is a noticeable difference between the clinical picture pertaining to skiers compared to that regarding snowboarders. This has already been highlighted analyzing data regarding rescue actions on the slopes (see above); however from the Trento in-depth research center, this difference appears much more defined.

On table 14 one can see, ordered from the most common to the least common, the first 20 diagnoses regarding skiers who checked in the Emergency room (one should note that the first 20 diagnoses cover 80% of the Emergency room entries).

Table 14. First Aid admittance distribution by diagnosis – Ski (first 20 diagnosis)

Diagnosis	**%**
Knee sprain	22,72
Head trauma	13,32
Shoulder dislocation	6,25
Leg linear fracture (tibia and/or fibula)	5,72
Knee linear fracture	2,93
Face bruise	2,71
Shoulder linear fracture (scapula, clavicle, acromion)	2,71
Pelvis bruise (sacrum, coccyx, hip)	2,63
Femur linear fracture	2,63
Trunk bruise	2,48
Leg fragmented fracture (tibia and/or fibula)	2,48
Wrist linear fracture	2,03
Arm linear fracture (humerus)	1,73
Knee bruise	1,73
Injury of the muscles, tendons and ligaments of the knee	1,66
Non traumatic causes	1,50
Shoulder bruise (scapula, clavicle, acromion)	1,43
Cervical rachis sprain	1,35
Pelvis linear fracture (sacrum, coccyx, hip)	1,35
Trunk linear fracture	1,20

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

As can be easily noticed in the case of skiers the prevailing lesions regard knees, head and shoulder. These are the 3 body zones chiefly damaged by ski traumas. In the case of snowboarding the situation seems different. Knee lesions disappear, while head and shoulders are still involved; it is however the wrist and forearm that are damaged (table 15).

Table 15. First Aid admittance distribution by diagnosis – *Snowboard* (first 20 diagnosis)

Diagnosi	%
Wrist linear fracture	13,80
Head trauma	13,13
Shoulder dislocation	8,08
Forearm linear fracture (ulna and/or radius)	6,06
Shoulder linear fracture (scapula, clavicle, acromion)	4,04
Trunk bruise	3,70
Arm linear fracture (humerus)	3,37
Knee sprain	3,37
Pelvis bruise (sacrum, coccyx, hip)	3,03
Lumbar bruise	2,69
Wrist sprain (carpus and metacarpus)	2,69
Wrist fragmented fracture (carpus and metacarpus)	2,69
Forearm fragmented fracture (ulna and/or radius)	2,02
Leg linear fracture (tibia and/or fibula)	2,02
Face bruise	1,68
Cervical rachis sprain	1,68
Wrist bruise (carpus and metacarpus)	1,68
Knee lacerate and bruised wound	1,68
Shoulder bruise (scapula, clavicle, acromion)	1,35
Face lacerated and bruised wound	1,01

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

It is thus clear that many lesions in skiing have to do with the torsion movement, accentuated by the lever effect which can be caused by the ski. Even in the case of the snowboard the first 20 diagnoses cover 80% of the Emergency room entries. In this case, however, the typical dynamic of the accident and type of equipment used do not contribute to favor the torsion movement, but rather the impact mechanism. The high proportion of wrist and also forearm fractures makes one think of the typical fall flat on one's face with hands instinctively stretched out to protect one's face. It should be pointed out that between skiers and snowboarders the percentage of brain concussions does not differ (about 13% of the total in both groups).

Traumas suffered, vary greatly instead, based on the dynamics of the accident. In the case of an accidental fall (which we remind you is by far the most common dynamic), the most prevalent lesions cared for at the outpatient or emergency facilities are knee sprains and brain concussions (table 16), the first occurring twice as many times than the second. There are also shoulder dislocations and leg (tibia and/or fibula) and wrist fractures. These first 5 diagnoses grouped together cover over half of the injuries caused by an accidental fall.

Table 16. First Aid admittance distribution by diagnosis and dynamic (first 5 diagnosis)

Dynamic (fall)	%	Dynamic (collision)	%
Knee sprain	22,3	Head trauma	26,0
Head trauma	10,2	Knee sprain	9,3
Shoulder dislocation	7,8	Trunk bruise	6,1
Leg fracture	5,8	Face bruise	5,1
Wrist fracture	5,0	Pelvis bruise	4,2

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

The case of accidents due to collisions between people seem to be different. Even in this situation the first 5 types of lesions observed in the Emergency facility cover 50% of the occurrences. One should keep in mind that this type of accident, much as one may blame the crowding of the ski slopes, is much less common than that of accidental falls (1 collision for every 7 falls). It can, nevertheless bring about potentially very serious lesions, as brain concussions, which occur in more than 1 case out of 4. If we also add face bruises following a collision between skiers, it is in about 1/3 of the cases that the head is involved. This represents a much higher frequency compared to the result of accidental falls. This is an important result because for the first time one has highlighted the fact that, as shown in table 17, in the case of a collision between people on the ski slopes the injured individual runs more than twice the risk of developing a brain concussion than through a fall (OR 2,55, $p<0,0005$). Moreover the brain concussion is not a rare event because not only does it occur in more than 10% of the cases of accidents observed in the Emergency facility, but in case of a collision between individuals the quota increased to 26%. This on one hand pushes us to suggest a generalized use of the helmet at all ages, on the other it points to the necessity of improving the technical characteristics of the protection helmets used for holiday sports. In terms of probability one can conclude that the probability of suffering a lesion that involves the head (brain concussion or simple face bruises) is 3 times higher in the case of a collision than of a fall.

Table 17. First Aid admittance distribution by diagnosis and dynamic

Dynamic	Head trauma	NO Head trauma	Total
Collision	83	235	318
Fall	131	1.156	1.287
Total	214	1.391	1.605

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

A last observation with regard to the cases treated at the Emergency facility concern lesions suffered by men or women. For the men there is a more "spread out" distribution of injuries, including brain concussions, knee sprains and shoulder dislocations (table 18). There is not, therefore, a type of lesion which is clearly more prevalent than the others as is the case instead for women, for whom the knee sprain is distinctly the most prevalent. One should note on this point that for women: the knee sprain, knee fracture (essentially of the tibial plate), leg fracture (tibia and/or fibula) and lesion of

the knee ligaments, regard almost 38,6% of the occurrences. This means that in about 2 cases out of 5 the lesion regards a small area of the body, that goes from the knee to the part of the leg immediately below it.

Table 18. First Aid admittance distribution by sex and diagnosis (first 10 diagnosis)

MALE		FEMALE	
Diagnosis	**%**	**Diagnosis**	**%**
Head trauma	14,6	Knee sprain	29,3
Knee sprain	10,8	Head trauma	11,6
Shoulder dislocation	9,7	Wrist fracture	4,6
Leg fracture	5,9	Leg fracture	4,0
Shoulder fracture	4,0	Pelvis bruise	3,3
Trunk bruise	3,8	Knee fracture	3,1
Wrist fracture	3,7	Face bruise	2,7
Arm fracture	2,4	Shoulder dislocation	2,3
Pelvis bruise	2,4	Femur fracture	2,2
Face bruise	2,2	Knee ligament injury	2,2

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

Concerning in particular the location of the trauma it is interesting to note the following point: if one takes the waistline as center point of the body and referring to the main lesions observed as reported in table 17 (lesions which for both sexes represent about 2/3 of the total), it clearly emerges that for males 8 times out of 10 the lesion suffered regards the upper part of the body; while for women such distribution is much more balanced (table 19).

Tabella 19. First Aid admittance distribution by sex and body part (first 10 diagnosis)

Body part	**male**	**Female**
Upper	81,0	55,9
Lower	19,0	44,1
Total	100,0	100,0

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

Starting out with the assumption that the individuals for whom hospitalization has been prescribed are those that have suffered more serious traumas (or potentially such, considering brain concussion suspicion), one notices a relation between the difficulty of a ski slope and the potential seriousness of the trauma. As shown in table 20, the quota of accidents one can ascribe as occurring on medium-high difficulty ski slopes increases progressively as the sample of the cases narrows down to those progressively more serious. Of the total number of accidents, in fact, 64% take place on red or black ski slopes; but this percentage increases (70,8% of the cases seen in emergency facilities) and increases even more (76,7% of the hospitalized cases).

Tab. 20. Hospitalizations distribution by difficulty ski slope

Difficulty of ski slope	All accidents	First aid	Hospitalization
ski instruction school	7,4	7,8	5,3
Blue slope (easy)	28,6	21,3	18,0
Red slope (medium)	56,0	60,2	64,1
Black slope (hard)	8,0	10,6	12,6

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

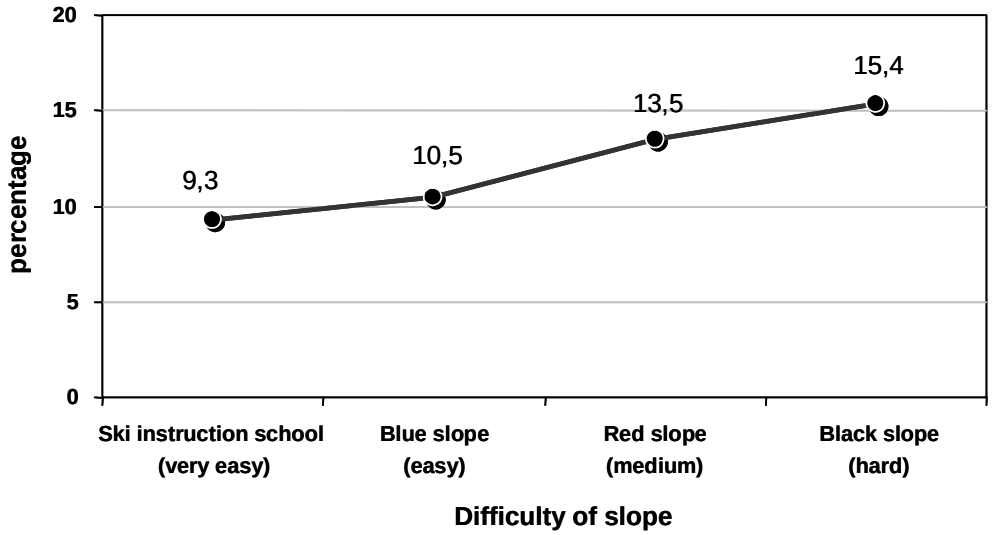
Another important epidemiological evidence we obtained by comparing data on accidents and health information data is that, using the requirement for hospitalization as a measure of the seriousness of the trauma, the quota of cases observed in the First Aid station which turned out needing hospital admittance grows progressively with the difficulty of the ski slope (table 21).

Tabella 21. Hospitalizations and First aid distribution by difficulty of ski slope

Difficulty of ski slope	Hospitalization	First aid	% hospit. on First aid admission
Ski instruction school	12	129	9,3
Blue slope (easy)	37	352	10,5
Red slope (medium)	134	993	13,5
Black slope (hard)	27	175	15,4

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

One starts out with a quota of 9,3% for those entering the Emergency facility because of an accident occurring at the ski instruction school to a quota of 15,5% for Emergency entries following an injury on a black ski slope (figure 29). The degree of difficulty of the ski slope seems to increase the risk of suffering a serious trauma.



SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

Figure 29. % hospitalization on First aid admissions by difficulty of slope

It seems thus that speed – probably higher on the more challenging ski slopes – can even in this case, be an relevant risk factor affecting the seriousness of the traumas themselves. After all this should not be very surprising since, whether one likes it or not, the laws of physics are what they are and apply to everyone. The well known equation of kinetic energy $E = \frac{1}{2}mv^2$ indicates that energy, which is what is released with a fall or an impact, is not linearly proportional to speed, but to its square (omitting mass which is a constant). In other terms, if one doubles the speed, the energy to discharge is 4 times higher (figure 30).

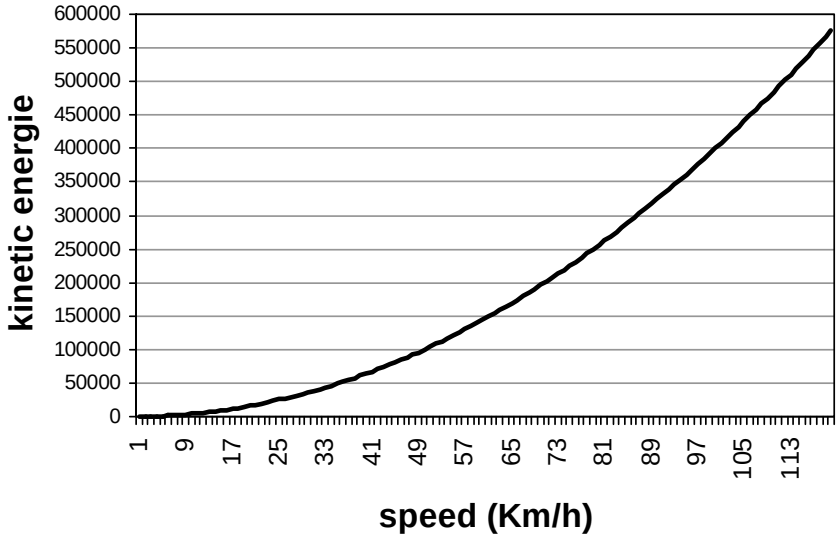


Figure 30. Relation between kinetic energie and speed

Obviously the more energy needs to be discharged with an impact the more the consequences will tend to be serious. On the other hand the sample of individuals hospitalized differs from the overall sample of individuals rescued on the ski slopes, as it presents a proportion of traumas from collisions with other individuals almost double compared to the norm (21,1% vs 11,3%), with a slight majority of males (67,9% M, 32,1% F). On the other hand among those hospitalized the proportion between skiers and snowboarders is identical to the number of accidents, for which, once again, the results do not seem to highlight an intrinsically greater danger of one type of equipment versus the other.

We have previously reviewed which were the most frequent lesions cared for at the outpatient clinic or at the Emergency facility (knee sprain and brain concussion). It should be of interest to analyze the picture of the most serious traumas, those which require hospitalization. The most frequent reason for admittance is the closed type fracture of tibia and fibula, which involves more than one skier (or snowboarder) out of 5 of those admitted (table 22). Reviewing the picture shown on table 9 referring to the first 18 types of lesions according to frequency of occurrence (equal to ¾ of the entire number of lesions observed upon hospital admittance), it clearly emerges how the fractures, especially regarding tibia and fibula together (with diaphysis fracture – closed and exposed – and proximal epiphysis, one exceeds 30% of admittances), are the most common lesions. With regard to fractures, beyond tibia and fibula, the other part of the body involved is the femur which on the whole turns up in more than 1 case out of 10.

Hospitalizations are prevalent for brain traumas, especially brain concussions, at times with brief loss of consciousness, even in this case present in more than 1 admittance out of 10.

Table 22. Most frequent diagnosis reported in First aid Centers in Province of Trento

%	Diagnosis (according ICD9 CM)
21.29	Diaphysis fracture, closed (fibula and tibia)
7.43	Concussion without loss of consciousness
6.44	Proximal epiphysis fracture, closed (fibula and tibia)
5.45	Transcervical fracture of the neck of femur, closed, of the intracapsular section, not specific.
4.46	Diaphysis fracture (neck of femur)
3.96	Pertrochanteric fracture, closed (neck of femur)
3.47	Concussion with short loss of consciousness
2.97	Diaphysis fracture, closed (only tibia)
2.48	Closed fracture of humerus
2.48	Proximal epiphysis fracture, closed (only tibia)
2.48	Diaphysis fracture, exposed (fibula and tibia)
1.98	Closed fracture of vertebral column (dorsal) without mention of spinal cord lesion
1.98	Closed fracture of the surgical neck humerus
1.98	Other, ill-defined trunk traumas
1.49	Closed fracture of vertebral column (lumbar) without mention of spinal cord lesion
1.49	Closed fracture of the ilium (pelvis)
1.49	Pertrochanteric fracture, closed (neck of femur), intertrochanteric section
1.49	Intracranial injury of other and unspecified nature

SOURCE: National Institute of Heath elaboration on Epidemiological Observatory of the Province of Trento data

5. PREVENTION AND EVALUATION

5.1 Prevention

As we have been able to ascertain, each accident is the result of a series of causes (risk factors) which, in some cases, it is possible to control.

Preventing the accidents that occur in the ski areas is an idea bearing a sense of priority and urgency in view of the underlying spirit of law 363/03. With regard to this it is necessary, besides (other things), to promote a culture that tends to invest with responsibility the entire population of mountain lovers to maintain their own health and others' through correct behavior.

Up to now there have not been proper programs for preventing accidents on the ski slopes, and any action was however rare and sporadic, oftentimes linked to local initiatives and not open to broad regional or national initiatives, but mainly addressed to providing information on a the correct use of the ski slope. However, viewing their information campaigns directed to encourage a safe behavior, the persuasiveness of the information transmitted is not clear, as the information seems to have only worked partially or not at all on the actual modification of people's behavior.

The education towards a correct behavior on the ski slope has as its objective the promotion of acquiring knowledge with the goal of making people responsible towards correct behavioral choices. It therefore does not only have the goal of providing knowledge, but more an so an operational goal. It's final purpose therefore is not only that of "ensuring one knows more", but to act differently, to assume a different way of behaving towards the defense of one's own and others' health.

There is no doubt that information is an essential component of education, but essential does not mean that it is the only goal, nor that it is sufficient. Health certainly constitutes a value, but it only takes on a prominent position when the individual is convinced that it is seriously and immediately endangered. Beyond this circumstance, health is a value as many others and in a scale of values its position can change in accordance to individuals and to the different moments of one's life.

The fact of not considering oneself as potentially at risk of ski or snowboard accidents constitutes one of the most common aspects at the base of the underestimating danger and behaving in an unsafe manner on the ski slopes. Besides the perception of danger, even the evaluation of the seriousness of the consequences which an accident entails conditions the chance that an individual's driving behavior is more or less correct.

In this way for example, as we have often mentioned, for an adolescent, who does not see himself as being at risk of an accident, the arguments on the necessity of using a helmet for protection, in order to avoid the possibility of fractures or serious lesions in accidents on the slope, might fall on deaf ears.

Considering prevention as a set of actions, direct and indirect, which allow a better control of the phenomenon, we will try successively to formulate a global accident prevention strategy on the ski slope setting up a clear hierarchy of the rescue actions and indicating , where possible, probable correlations or interactions between the suggested actions. In this field it is important to work out a subdivision permitting a logical and hierarchical classification of the possible actions that have different affects depending on the level, on the incidence and on the frequency of the phenomenon.

From now on we will use the term "prevention" with the meaning given it by

the World Health Organization which considers four levels used in the DFPV model (figure 1) and which we will here review:

I) 1° level: actions taken to avoid the accident occurring;
II) 2° level: actions taken to minimize the consequences of the accident while it is occurring;
III) 3° level: actions taken to minimize the consequences or the accident after it has occurred (brief-medium time span);
IV) 4° level: actions taken to minimize the outcomes of the accident;

This subdivision is very useful, as it permits a logical and hierarchical classification of the possible actions, and as it helps to understand how they interact with each other and how they bring about different repercussions, depending on the level, on the incidence and on the frequency of the phenomenon.

A more analytical form of possible preventive actions proposed by Haddon in 1970, follows:

1) First of all avoid that a situation, as a potential source of risk. develop;
2) Reduce the probable risk that is about to develop;
3) Prevent the occurrence of a risk which already exists;
4) Modify the rate or the spatial distribution of the manifestation of the risk from its beginning;
5) Separate in time and space the risk from what needs to be protected;
6) Separate the risk and what needs to be protected by setting up physical barriers;
7) Modify the most relevant fundamental characteristics of the risk;
8) Render the things to be protected more resistant to the damage/s deriving from the risk;
9) Begin to contrast the damage already done caused by the environmental risk;
10) Stabilize, repair and rehabilitate the object damaged.

We will now briefly describe the prevention levels provided for by the DFPV model.

I. ***First Prevention level:*** *regards in particular Information, Education and Training. The objective is to avoid that the accident occur.*

At this level we find all actions directed at avoiding that the event take place. As an example the following points belong to this realm:

- ✓ The adjustment of speed and downhill routes to one's own physical conditions, to one's own technical level and to the environmental conditions (visibility, snow conditions, crowding of the slopes, etc.);
- ✓ Educational campaign promotion towards respect of the behavioral norms on ski slopes as decreed by law 363/03;
- ✓ Information action through mass media;
- ✓ Correct training to reach the technical skill necessary to use one's equipment;
- ✓ The elimination or appropriate signaling of the stretches in which the ski slope shows an anomalously high incidence of accidents;
- ✓ Periodic check up of one's ski or snowboard equipment

To this level we many also include what expressly indicated in article 21, heading IV, of law 363/03 dealing with surveillance and control highlighting: "…the State Police, the State Forest Rangers Corps, the Carabinieri Military Police and the Finance Police Corps, as well as the local police, in carrying out their surveillance service and emergency assistance in the skiing areas, making sure that the regulations of the aforementioned law are respected and to impose the appropriate sanctions on those who do not respect the law with regard".

These actions can modify the incidence of the phenomenon and, in the medium and long term range they act indirectly also on the prevalence of the risk factor-

II. ***Second Prevention level****: Safety Measures*.

This level regards actions meant to minimize the consequences of the accident while it is occurring. Amongst the measures to be considered at this level is the use of the helmet and, if it is the case, of a series of protective measures especially for one's back and for the most pressed articulations. These actions can only modify weakly the incidence of accidents, but can substantially reduce the aforementioned distribution of serious lesions.

Within the distribution of lesions they can modify the incidence of particular situations (i.e.: serious brain concussions).

III. ***Third Prevention level****: First Aid, Emergency Facility*

Includes all those actions which minimize the immediate consequences of the accident following it's occurrence. First Aid and Emergency facility act essentially in this sector. At this level the actions do not modify the incidence but modify the general picture of the injury outcomes and contribute in limiting mortality.

This third level is to be considered formed by two sub-levels, First Aid and Emergency facility. First aid represents in many cases the only possibility to render critical situations controllable before the individual may be cared for by a physician and thus it concerns the general population and specialized operators. At this level Italy may consider itself as a country in the forefront, thanks to the widespread presence on the ski slopes of the Police and Carabinieri patrols – bodies to which the recent 363/03 law has also assigned surveillance duties besides the traditional ones of first aid – and to other organizations that provide their experience for first aid activities. Between first aid and emergency facility we find many structures for rescue action (i.e.: helicopter ambulance, equipped ambulance, etc.) which rapidly transport a specialized physician to the site of the accident. The development of these structures together with a prospective rationalization of the strategic distribution of Emergency facilities, could represent for our country a noteworthy step ahead.

IV. ***Fourth Prevention level****: Rehabilitation*

Regards all those actions directed at limiting or removing the outcomes caused by the accident. The actions of the fourth level mainly regard rehabilitation.

Fortunately in the area of ski slope accidents, compared to the number of participants and the total number of days skied every

year, not many times do permanent traumas occur. At this level the actions do not, obviously, modify the incidence but can positively modify prevailing distribution of the handicap and, thus, limit the incidence of the handicap itself (for example the risk of running into traffic or domestic accidents); furthermore these actions reduce the prevailing picture of temporary disability and positively modify the morbidity connected with the presence of the observed disabilities.

It is to be underlined that the strengthening of this sector should be evaluated in light of the modification of the entire picture which can be obtained through carrying out actions mentioned in the previous levels. Efficient actions at the first level, for example, modify the incidence of the phenomenon and thus in a medium-long time frame, also carry not banal effects on the prevalence of the handicap.

Culture influences greatly the perception itself of the world, the interpretation of events, the reception of messages, the comprehension of information and of languages. The educator, the legislator, the researcher must therefore be aware of the fact that their way of examining, interpreting and presenting problems, influences the possibility of communicating effectively with the people.

It is necessary to be very much aware that the preventive actions, as classified in the aforementioned levels, must be considered as being interactive in a comprehensive picture in which only isolated actions would have no sense. The actions of the first level must be considered also for the repercussions they bare on the levels following, and vice versa, for example it is important to point out that the objectives of the first level do not only consist in avoiding the accident, but also in reducing its seriousness, diminishing the intensity of the risk factors.

5.2 Evaluation

This is a crucial point of the schematized approach through the DFPV model, as only a correct evaluation allows to seriously determine the effectiveness and efficiency of the preventive actions promoted. Evaluations of this type have not yet been carried out in Italy, but we will try to trace a methodology for evaluative analysis regarding the use of the helmet.

It is good to keep in mind that the lack of complete information on the phenomenon of ski slope accidents, and of the current use of the helmet, determines serious problems when one wishes to evaluate the socio-sanitary impact of this phenomenon on the community. Notwithstanding this the knowledge developed in the epidemiological field especially in the prevention area can already allow us, starting from the data currently available, to produce reasonable evaluations. In particular, in light of the efficiency with regard to costs and reduced time of activation, we will consider an aspect of particular interest for public health: the use of the helmet. This choice seems strongly motivated in light of the fact that still today it represents the most efficient preventive action to immediately reduce the occurrence of brain concussions. It still regards the field of action with most possibility of intervention, in as much as still today one records a rather restricted use of the helmet , limited especially to some age groups within the population

(individuals below the age of 14, as indicated in law # 363/03) or to some specific groups (athletes or adults who anyway take the athletes as a model).

The benefits with regard to the decrease of brain traumas that would be determined by increasing the proportion of the use of the helmet may be evaluated essentially in two ways:

With a surveillance at a number of health facilities as sample (First Aid centers, hospitals, outpatient clinics in the area, etc.)

With predictive mathematical models

In the first case, one compares the possible variation in the use of the helmet amongst skiers (variation for example brought about by the introduction of an obligation by law) with the variation in the number of admittances to the Emergency facility for brain concussion (because of the high number of the incidents it is the most sensitive indicator). One has in this way all the elements for an evaluation based on the direct observation of a phenomenon.

Not always, however, does this regal way turn out to be practicable considering the economic and time resources available and the general sensitivity with regard to a problem which – fortunately – represents a marginal aspect in the expenditure of health resources if compared to the real and true social plagues as traffic or domestic accidents.

In this case, the biomechanical knowledge of the phenomenon and the mathematical construction of models can constitute a valid alternative for the evaluation of the efficiency of the use of the helmet.

In this site we will demonstrate the application of a very simple predictive mathematical model, the model IPP (Taggi, 1984), which allows one to estimate, based on the knowledge of risk relative to the lesion as a consequence of the non use of the helmet and the knowledge of the variation of the use of the same device, what the reduction in the occurrence of health costs will be for the community. Such a model, applied in the road traffic sector and already tested when the law became effective obliging minors riding motorbikes to wear helmets (1986) and later on for the law on the obligation of using safety belts (1989), proved having a good predictive ability with a margin of error of only a few percentage points.

The model which can be used for any illness or type of trauma is the following:

$$\delta = \frac{P_2\alpha + (100 - P_2)}{P_1\alpha + (100 - P_1)} - 1$$

where:

$\delta =$ percentage of predicted reduction

$\alpha =$ brain lesion risk referring to those who do not use the helmet versus those who do

$P_1 =$ prevalence of the initial use of the helmet

$P_2 =$ prevalence of the final use of the helmet

Table 23 shows the results obtained with the IPP model, formulating different hypothesis of use of the helmet before and after. In order to carry out the calculations one has chosen as relative risk a value of α=0,5 based on what has emerged from a work on meta-analysis done on the most recent

epidemiological studies carried out abroad (6,7,8,9), while as initial percentage of helmet use ("before") a conservative value equal to 10%. As can be observed the estimated percentage decrease, even with variations and with the inevitable limits of the model, represent indications of definite interest for Public Health.

Table 23. Estimated percentage decrease of head traumas (HT) according different hypothesis of helmet use.

Helmet use (prevalence)		Estimated decrease	Benefit
Before	**After**	**(%)**	**(estimate: 3300 ht)**
10%	30%	-10,5	347
10%	40%	-15,8	521
10%	50%	-21,1	696
10%	60%	-26,3	868
10%	70%	-31,6	1.043
10%	80%	-36,8	1.214
10%	90%	-41,1	1.356
10%	100%	-47,4	1.564

Considering the data of the rescue actions carried out by the Alpine Training Center Police in the skiing seasons 03/04, 04/05 and 05/06, excluding the cases of rescue action for head or face lesions which did not involve further medical check-ups in out-patient clinics or at Emergency facilities, an average of 9,5% of the rescue actions the injured person suffered a lesion of the head or face, lesion for which the rescuers recommended a verification at an out-patient clinic or at the Emergency facility. Giving new parameters to the 35.000 rescue actions per year estimated by SIMON, one can estimate about 3.320 cases of brain concussions, some of which could have been prevented if one had used the appropriate helmet for protection.

This estimate is in line with that obtained from the Trento in depth research center data, where the 13.3% of the Emergency facility injured entries (or of the out-patient clinics where Emergency facilities are not available in the area) have suffered a head lesion. Projecting this proportion to the annual total estimate for medical treatment in the out-patient or Emergency facilities (25.000) one gets an estimate of 3.250 cases of brain concussions.

In light of these two converging estimates, we can indicate 3.300 as the number of head lesion cases per year liable of being prevented through the use of the helmet.

Whatever is the opinion about the opportunity or not of imposing by a specific law the use of a safety device, the application of the provided norm of article 8, heading III of the law 363/03 which expects the obligation of utilizing the helmet for protection for minors of 14 years of age, is certainly an important step, dictated by common sense, for the prevention of injuries incurred while skiing. However, one should comment how best practices (perhaps recommended and not necessarily imposed by law) can consist in utilizing the helmet regardless of one's age, since, as already demonstrated in the first SIMON report, the majority of accidents which have as a consequence a head or face lesion is concentrated amongst 20 and 49 year olds (51,2% against 18,3% of the cranial-facial injuries which occur in the age group between 0 and 14 years of age, where/for which about 15% of the injuries occur).

CONCLUSIONS

The type of accidents and lesions observed shed light on the importance of an adequate physical preparation in facing a day on skis. Skiing is an extremely enjoyable sport which takes place in a very attractive environment; however it should not be taken carelessly. The efforts our body undergoes, together with the climactic conditions that the high mountain may render uncomfortable, requires, besides a great sense of responsibility, also a deep respect of one's own body. To ignore the messages it sends (tiredness, aching muscles, feeling cold, hunger, etc.) exposes one to useless risks, often avoidable with a pause or with adequate protection. Beyond what common sense may suggest, in fact, there are ample scientific proofs which demonstrate how effectively there are some efficient prevention means. If there is no doubt that the helmet and safety bindings are very efficient preventive means, to reduce both the risk of brain concussion as of knee sprains (but also lesions to one's ligaments and leg fractures), the fact remains that such instruments must be correctly used and maintained. A helmet not fitting on well or which has been hit, a binding not adjusted well, can constitute in themselves a source of danger.

The law 363/2003 which obliges the use of the helmet for those under 14, if fully applied, will certainly contribute in reducing a phenomenon which, one should underline, is not limited only to children. While fully respecting one's personal habits, it would be, thus, a best practice that the helmet were used by all skiers, increasing this way, the quota of protected individuals.

Nevertheless one should point out an obligation which research must have, that is of trying to improve even the present. From this point of view the recent intergovernmental decree, dated 2 March 2006 (Technical characteristics of the protective helmets prescribed for individuals under 14 years of age taking part in mountain skiing and snowboarding), which, in compliance with what prescribed by the law 363/03 sets up the criteria of homologation of the helmet, in reasserting in article 1 that the helmets in order to be homologated must follow the criteria established by the European norm (UNI EN 1077) of 1998, article 5 which says: "The ministry of Health recognizes the opportunity of promoting, together with the Ministry of infrastructures and transportation, research programs and studies finalized towards the improvement of the technical characteristics of helmets for the protection of the cephalic extremity of individuals below 14 years of age, with the purpose of contributing to the adaptation of the international norm to the technical progress in the area of helmet safety referred to in article 1".

One thus recognizes the necessity also on behalf of the legislator to continue with the studies/in one's studies towards the creation of more efficient protective structures than those currently in use. The criteria for the homologation of helmets seem without doubt in line with the practice of athletic/competitive skiing; but it is legitimate to ask oneself if the requirements of an amateur skier are the same as those of a competitive skier. In particular as highlighted by the SIMON system, a rather noticeable quota of impact caused lesions, in the case of collisions between skiers, regards the head. It might not be banal to ask oneself, for example, how many of these lesions are caused by a collision with a helmet, event which does not happen in competitions, in as much one is alone on the ski slope, fighting against time. Probably it currently does not regard a very large quota of occurrences,

nor is it easy to hypothesize precisely how many there will be in the future foreseeing an increase in the use of the helmet (which would make the head more protected for all; but the other parts of the body more at risk); but that does not mean one has already reached the state of the art for what regards passive safety devices. This is one of the challenges which research must be and is able to accept.

ACKNOWLEDGEMENTS

The activity of an integrated surveillance system as SIMON assumes the collaboration of a great number of institutions, agencies and organizations which view – so as to say – the world of the mountains each one from his/her own "versant" (or mountain side) of competence. The ISS has had the chance of being able to catalyze the interaction between these distinctive visions of the phenomenon; however without the contribution and, before that, without the passion of the many individuals that operate in the mountains, daily in touch with the world of skiing, with great difficulty could the SIMON system have been able to produce in time the synthesized results of this volume.

From this point of view, a special acknowledgement goes to the State Police, in the person of Dr. Giuseppe Volpe, director of the Alpine Training Center , and to the Carabinieri Corps, in the person of Lieutenant Colonel Peter Paul Tarfusser, Commander of the Carabinieri Alpine Training Center, for the contribution to the current report and more generally to the SIMON system, both for the quality and quantity of data provided to the system, as for the precious suggestions which permitted to study in greater depth the themes considered.

Thanks, furthermore to Dr. Silvano Piffer of the Epidemiological Observatory of the autonomous Province of Trento for having made it possible to accomplish the experimentation of the connection between the accident data and the health-care data, thanks to which we have been able to define in a precise manner external causes and health related consequences of the accidents on the ski slopes.

A contribution of great import to the SIMON system was provided by Dr. Giuseppe Masazza, Chief Medical Officer of the TOROC (Olympic Committee of the XXth winter Olympics of Turin, 2006) whose expertise in traumatic medicine and sports medicine made it possible to analyze in depth the best practices of intervention within the field of mountain accident rescue actions.

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Monograph and contributions

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