

# **A Web Survey of Winter Sports Accidents Involving Equipment Failure**

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## **Abstract**

A web-based survey was designed to collect information on winter sports accidents with specific concentration on accidents involving equipment failures. The website and survey were designed and hosted online after thorough background research. The results showed that more time is required to collect enough data.

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# **1 - Introduction**

## *1 - Objective*

The main objective of this project is to provide data to make skiing and snowboarding safer. In the process of achieving our objective, numerous sub-objectives will be resolved. Included in these sub-objectives is the discovery of existence of injury mechanisms. By using the web to find out about injuries, statements of non-occurrences can be disproved. Another sub-objective is to gather and distribute data about ski and snowboard injuries via a website. The data are collected through a web based survey and then statistically analyzed. By hosting the collected information, the website serves as the main method of distributing the data for future research and analysis. Also included in the sub-objectives are checking the data for instances of equipment malfunction and determining how the web-based data acquisition might be skewed compared with that from more conventional epidemiological studies.

## *2 - Rationale*

This work is important because there are approximately 3 injuries per 1,000 skier/days and 4 injuries per 1,000 snowboarding/skiboarding days (Langran 2009). According to the National Ski Areas Association, there were 60.5 million skier/snowboarder visits in 2007. Assuming an average value of 3.5 injuries per 1,000 skier/snowboarding/skiboarding days, there were approximately 200,000 skiing/snowboarding/skiboarding injuries in 2007. This number is significant and needs to be reduced. Though some of these injuries can be attributed to a person's voluntary risk factors, it is not always their fault. Conditions of the mountain, such as icy surfaces, and the problem of equipment malfunction are often causes of skiing and snowboarding injuries (Allman Oliver 1991). The

information gained from the data may identify trends or suggest methods to raise awareness of and reduce injuries, particularly those related to equipment malfunction. Furthermore, the website developed for this project has the potential to become a database of winter sports injuries. The website will provide readily available raw data, which may be useful or at least intriguing to people in the injury or equipment industries as well as victims of winter sports accidents.

### *3 - State-of-the-art*

There are many other studies about winter sports injuries, but most of them have been conducted on-site, not on the Internet. Many of those studies are published in the yearly ISSS publication “Skiing Trauma and Safety”, a valuable source of sound statistical analysis and comparison data. There are very few Internet based surveys on skiing or snowboarding injuries. Dr. Mike Langran's survey at [www.ski-injury.com](http://www.ski-injury.com) is one example. However, this study is too recent to have published any results. The ISSS publication is by far the best source of good data and sound analysis on winter sports injuries.

The website [www.ski-injury.com](http://www.ski-injury.com), maintained by Dr Mike Langran, has a large amount of information about ski and snowboard injuries, including some raw data and statistical analyses. Furthermore, the website provides an “online injury report form” (new in 2009) which is modeled after the form Dr. Langran uses to conduct “pen-and-paper” surveys. Dr. Langran's website achieves the same goals of this project by providing both a web-based survey and an analysis of the collected data. However, Dr. Langran does not provide the raw data, but instead only releases some of the results of his analysis, “in order to avoid jeopardizing medical publications that are planned” ([ski-injury.com](http://ski-injury.com)). In contrast, this project seeks to provide all collected data without restriction, which will encourage open analysis and help expand the knowledge base, so that winter sports injuries may be better understood

by everyone.

Certain strategies specific to web-based surveys have been established. We will adhere to common practices found in the many HTML based web surveys on the Internet, so that respondents feel comfortable with the format. According to the “Online Survey Design Guide”, it is important for a web survey to use color and images to “provide visual cues that may simplify the web-based survey process” (Online Survey Design Guide). Colors, different fonts, and a consistent, visually pleasing layout all contribute to the ease of use. Also, it is important to organize the survey questions into logical pages, branching if necessary. Page scrolling should be kept to a minimum, and a progress indicator should be used to let the user know how much of the survey remains. The survey must provide detailed instructions. Without a human to administer the survey, every question must be carefully worded to avoid confusion. An explanation of a question's purpose may be appropriate in some cases. Finally, it is important to validate the user input to be sure that the user fills in all required fields. Input validation also prevents malformed responses.

There are a number of traditional surveys which have been conducted on ski and snowboard injuries. These “pen-and-paper” surveys are set up to identify the risk of injury on the slopes. Many of the best surveys conducted each year are reported in the ISSS publication “Skiing Trauma and Safety” or presented at the annual ISSS convention.

An important aspect of these surveys is their identification of the “population at risk”, the subset of the population which is exposed to the risk of being involved in a skiing/snowboarding accident. The population at risk is required to determine risk of injury. For example, in their “Update on Injury Trends in Alpine Skiing”, Johnson, Ettlinger, and Shealy collect both a sample of injured skiers, and “a concurrent sampling of the general skiing population...for comparison with the injured group” (Johnson 12). An accurate identification of the population at risk is vital for a survey to make claims about injury rates, or any assessment of risk. The injured population is compared to the

population at risk to determine the overall risk of injury. Risk is often expressed as “mean days between injuries” (MTBI), or alternatively as “injuries per 1000 skier days” (IPTSD). Because the web-based survey prevents us from easily identifying the population at risk, we will not attempt to make estimates or claims about injury rates or other factors dependent on knowledge of that population. Perhaps the most thorough study in the field of ski injuries is the Sugarbush North ski area survey, which has been collecting data since 1972. The results of this survey are annually reported in “Skiing Trauma and Safety”. Conducted by Carl Ettlinger, Dr. Jasper Shealy and Dr. Robert Johnson, this survey is the gold standard for statistical analysis of ski injury data. The Sugarbush survey provides a set of standard questions that may be used to model the questions asked in the Internet survey. It is useful to ask the same questions because a comparison of the results may help to identify sampling errors, and other unknowns that might emerge as a consequence of an Internet survey.

Other surveys provide data on ski injuries, but none have the scope or amount of data found in the Sugarbush study. The methods of these ISSS surveys helped to direct our statistical analysis approach, especially surveys in which the sample errors are unknown such as Tracy Dickson's “Behaviors and Attitudes Towards Snowsport Safety in Australia”. That survey employed an “anonymous online questionnaire” (Dickson 65) to gather data, which was analyzed despite the unknown sampling errors. The ISSS studies, especially the Sugarbush North study, provide this project with baseline data which may help to make sense of the information collected on the Internet. The Internet is an unreliable source of data because there is no way to accurately identify the population at risk, or account for sampling errors. For that reason, this project only seeks to identify injury mechanisms, risk factors for equipment malfunction, and negate claims of non-occurrence. All of those goals may be attained without determining the population at risk.

#### *4 - Approach*

The first step in approaching this project is to conduct thorough background research about winter sports injuries, epidemiology, statistical analysis, and survey design. We will then construct a website and survey based on our research, and host them on the Internet to collect pertinent information regarding winter sports injuries. Next we will develop a statistical analysis model. This model must be able to analyze raw data and compare any results to the results of other surveys. Finally, we will apply the analysis model to the actual collected data, and draw appropriate conclusions.

#### *5 - Background*

Skiing has been around for a long time with the most primitive forms of skis being discovered nearly five thousand years ago. Growing out of the need to move over snow, the necessity of skiing gave rise to the technology. “Skiing was a way of transportation, and the fact that the bindings on old skis were loose toe straps proved that the first skis were cross country skis. After all, these loose bindings wouldn't secure the skis on downhill run, so the first skiers were nordic skiers (Doyle).”

Downhill skiing was made possible only after the invention of a binding. A Norwegian named Sondre Norheim first came up with the idea around 1850. Norheim’s bindings tied his boots to his skis and are believed to resemble what are now known as telemark skis today. By 1870, Norheim introduced his “Telemark ski.” This ski was the first sidecut ski and would become the model of skis for nearly a century (Doyle).

Skiing continued to grow in popularity and began to span the winter season world-wide. In 1882 the Norske Ski Club was founded in the United States in Berlin, New Hampshire. This club, founded by Norwegian descendants, is currently the oldest U.S. ski club (Dawson 2002).



By 1896 Matthias Zdarsky improved the binding and the style of skiing, “pushing one ski at an angle down the fall line to control speed led to the development of downhill skiing. With more and more improvements, skiing became the popular recreational activity that we participate in today (Doyle).” By 1905 the National Ski Association was founded in Ishpeming, Michigan. After the Ishpeming Ski Club hosted a ski jumping tournament in 1904, president of the club Carl Tellefsen decided to host what he called a “national tournament” the following year in 1905. Ole Westgard of Ishpeming was named the first “national champion” for his performance, winning the first U.S. national ski title. After the success of the event, the five skiing clubs that had participated agreed to regulate the tournament with stricter rules governing judging and competition. On February 21, 1905, Tellefsen announced the National Ski Association and that he was elected president. The formation of this association was pivotal to the evolution of ski competition, because it “solidified the idea of a national ski competition ruled by a national ski organization and headed by a national president (<http://www.skiinghistory.org/halloffame.html> 2006).”

In 1910, the First International Ski Congress was held in Christiania, Norway. This congress would be the forerunner for the Federation Internationale de Ski, the International ruling body of skiing (Dawson 2002). The Federation Internationale de Ski (FIS) is currently the governing body of ski sports. The FIS oversees World Cup competitions and World Championships including alpine, nordic, and freestyle skiing and snowboarding. The First International Ski Congress that led to the FIS was pivotal in the development of skiing as an international sport.

The first slalom race, known as the Alpine Ski Cup Challenge, took place in Mürren, Switzerland on January 6, 1921. A slalom race is one which involves the maneuvering between gates that are closer together than they are in the Super-G. J.A. Joannides was named the winner of the inaugural event (Dawson 2002).

The First Winter Olympic Games were held in Chamonix, France in 1924. In these games,

only Nordic skiing events were held. The root of where skiing originated was very apparent; the Norwegians won eleven out of the twelve gold medals. Fellow countryman Thorleif Haug became the first triple gold medal winner with his performance in those games (Dawson 2002).

The Winter Olympics have become the probably the biggest stage for ski competition. Held every four years, the events included in the competition continue to increase. “The XXI Winter Olympics take place in Vancouver, British Columbia, Canada in February, 2010. Skiing events include alpine skiing (downhill, slalom, giant slalom, super G, and combined), freestyle skiing, cross country skiing, and nordic combined, which involves ski jumping and cross country skiing (Dolye).”

With the popularity of skiing and the innovation of people, the idea of ski boards became apparent. In 1961 Cliff Taylor created the first ski blades. His 76 cm long skis were the first of their kind. The major advantage of the shorter ski blades was the fact that they ensured greater control especially in bad conditions because your weight is concentrated over such a short surface (Roussel 2007). Though ski boarding has not made it to the Olympics, ski boarding is a less popular recreational activity.

Snowboarding on the other hand is a much more recent sport. “The first real invention was by M.J. Burchett in 1929. He took plywood and after he had cut a shape into it, he fixed his feet with horse reins (Molzer).” Sherman Poppers is often credited for the invention of the first functional snowboard-like apparatus. In 1965 he created “The Snurfer.” All the Snurfer consisted of was two skis bolted together. The idea of the surfboard like shape was put into practice when Dimitrije Milovich in 1975 first tried to surf down a mountain. Realizing that the surfboard was much too big, he soon developed the “Winterstick;” the first snowboard similar to snowboards as we know them today. By 1979, Jake Burton, working with Milovich’s design, founded Burton snowboards. He was able to revolutionize the sport and found what is still today one of the most successful snowboarding manufacturers by using real bindings, steel edges, and high backs for better control (Molzer).

Burton talked about how the prevalence of snowboarding and the feeling surrounding it changed quickly within the first couple years of the sport. ““At first we weren't even a nuisance, just a novelty,” Burton told *Esquire* writer David Katz about the early enmity between the two winter-sport camps. ‘Then we were a nuisance. Then a threat. Then we were the saviors of the ski industry’ (<http://www.notablebiographies.com/newsmakers2/2007-A-Co/Burton-Jake.html>).” Snowboarding was not even always allowed in ski areas. The rapid increase in the popularity of snowboarding can best be seen from the fact that “today 97% of all ski areas in North America and Europe allow snowboarding, up from 7% in 1985 (<http://www.nuttyaboutsports.com/ski/2006-2008>).” Vermont’s Stratton resort was the first to welcome snowboarders in 1984 thanks in large part to Burton’s efforts.

By 1987, there were estimated to be one hundred thousand snowboarders in the United States and Canada. In that same year, the U.S. Open Snowboarding Championship was held at Vermont’s Stratton resort. This event held the same importance for the growth of the sport as Tellefsen’s skiing “National Tournament” in 1905. Snowboarding was starting to grow. With the average of skiers increasing and overall numbers declining, the door was open for the growth of the sport of snowboarding (<http://www.notablebiographies.com/newsmakers2/2007-A-Co/Burton-Jake.html>).

Snowboarding did grow as a sport, but did not overtake or replace skiing as the main winter sport. “According to 2006 data reported by the [National Sporting Goods Association](#), 6.4 million people participated in Alpine or downhill skiing. Another 5.2 million people participated in snowboarding. Cross country or Nordic skiing had 2.6 million participants (<http://www.nuttyaboutsports.com/ski/2006-2008>). The National Ski Areas Association provides statistics to support the fact that skiing is still more prevalent, but that snowboarding is a growing sport, especially when you take into account the average age of snowboarders. According to their 2007 statistics, almost 80% of the reported 5.1 million snowboarders are under the age of twenty-four. Of

the 5.5 million reported skiers, 64% were of age 25 or older (National Ski & Snowboard Retailers Association 2009).

As snowboarding has become more and more popular, its role as both a recreational and competitive sport has grown. Snowboarding finally reached nation acclaim when it was first introduced to the Winter Olympics in 1998 in Nagano Japan with the events including half-pipe and giant slalom events (Schwartz 2008).

As these sports continue to grow, the participants are constantly trying to push their limits and the equipment. Relatively recent technology in manufacturing and material science has led to the advancement of winter sports equipment. Skis, boards, and bindings are improved by manufacturers to increase the users' ability, remain competitive, and to increase safety. These companies attempt to provide safe equipment, but sometimes it malfunctions.

Skiing and snowboarding are without a doubt dangerous sports. There are certain risks that you take into account every time that you step onto the mountain. When it comes to ski injuries there are many risk factors that have to be taken into account; some that are controllable and others that there is no control over. "Potential risk factors can be subdivided into many categories, such as skill, physical condition, social habits, psychological profile, ski equipment, and the ski run environment. Within the latter category, for example, it is useful to distinguish between degree of difficulty, crowdedness, sight, temperature, snow conditions, and so forth (Bouter Knipschild 1989)." With so many places that something can go wrong resulting in injury, it only makes sense that people have been spending years trying to conduct studies in attempts to make the sports safer.

Case studies have been formulated just to measure the risk factors of skiing. In one instance, members of the Atlanta Aki Club went on a week long ski trip. After the trip they were asked to fill out a survey. The survey consisted of one part to gather basic information (age, sex, level of ability, skiing experience, physical conditioning, amount of skiing during the trip, type of equipment,

and maintenance of bindings). The second part was devoted to anyone who sustained an injury that prevented skiing for one or more days or caused pain for two days or more. Not everyone filled out the survey, but in all 167 skiers responded with 24 of them sustaining injuries. All who were not injured served as the control group for this experiment (Allman Oliver 1991).

This study worked to investigate several factors that are often attributed to skiing injuries. The injured skiers and the control group were relatively similar when it came to traits questioned in part one of the survey. In this study, the major reason for injury was attributed to skiing conditions. Most of the injuries occurred in areas on the mountain where ice was a major factor. The preconceived notions of equipment related factors, voluntary risk factors, and fatigue proved to be almost non-factors. Of the injuries sustained while conducting this survey, the most common was a shoulder contusion or strain with a knee sprain being the second most prevalent (Allman Oliver 1991).

There have been numerous case studies in order to grasp the skiing population and the injury trends. One of these studies took place at Waterville Valley in New Hampshire. For over twenty-five years, the ski patrol kept records dealing with injuries that occurred at Waterville Valley. Factors such as reportability and diagnosis could not be controlled, so the results of the records were not absolute. But the results were adequate because of the constant reporting of the conditions and the population at risk. To add intrigue to the study, 1989 was the first year that a high-speed quad chairlift was introduced to carry skiers all the way from the base to the summit. The inclusion of this new chair lift would allow for skiers to spend more time on the slopes and hypothesized to increase the chance of injury due to both the increased time and fatigue (Lee Young 1991).

During the 1987/1988 season, there were a reported 838 injuries from 803 cases in roughly 264, 210 skier days. The next season with the introduction of the high speed quad chair lift, injuries rose dramatically to 1047 from 954 cases from a population of 288, 396 skier days. During both years of the study, injury data was reported using a standard National Ski Areas Association accident form by

the ski patrol and skier days were calculated based on ticket sales. Overall, the injury rate increased 10 to 15% due to the new chair lift. The statistics supported the data that there was a greater chance of being injured based on the fact that there would be more time spent on the mountain skiing rather than on or waiting for the chair lift. The other major injury point focused on the fatigue due to the increased time on the mountain. The statistics recorded did not support this conjecture as the distribution of time of day injuries remained virtually unchanged (Lee Young 1991).

Because they had been compiling data for a reasonable period of time, they were able to make comparisons with the rates and incidences of injury to different parts of the body as well as the type of injury. After the 1989 update knee injuries still accounted for 25% of all injuries, down from a high of 30% in the 1985/1986 season. Thumb injuries fell to only 10% after being at a high of 17% in 1981/1982. Lower leg injuries also declined from 13% to 5% from 1976-1989. Shoulder and head injuries were the only types that rose. Shoulder injuries rose from 7% to 10% and head injuries from 6% to 9%. The types of injuries remained relatively unchanged. The decline in injuries, specifically lower leg and knee injuries can be attributed to the improvements in ski bindings. The issue of the binding release was even looked at. One or both bindings released in 54% of the falls in which the skier was injured. In ankle, lower leg, and knee injuries, the binding released 49% of the time. Upper body and thigh injuries showed the binding to release 62% of the time. It was also interesting to note that the binding released 56% of the time on expert/intermediate skiers but only 47% of the time with beginners. This is due to the fact that beginning skiers are often more vulnerable to the slow forward twisting fall that causes the binding not to release. The expert/intermediate skier is more likely to be skiing faster and exert a greater force to allow the binding to release and cause injuries to the thumb, shoulder, or head (Lee Young 1991).

Harald Lystad conducted a five year survey to observe skiing injury trends in Hemsedal Norway. By encompassing a population of 883 injured skiers and 379 uninjured skiers he was able to

obtain his results. Again knee injuries were the most reported, accounting for nearly 23% followed by head injuries (17%) and shoulder injuries (10%). Of the common injuries that often show up in skiing epidemiology, the thumb injury was not very prevalent. The reason for non-reporting is probably that it often goes unreported and becomes a “day-after” injury. It was determined that one out of every three injuries occurred due to binding or boot malfunctions. This included both inadvertent release and non-release of the ski when it was supposed to. The skiers who had performed a self test of their binding setting before time, were drastically more unlikely to be effected by either the inadvertent or non-release (Lystad 1989).

Lystad also conducted another study that investigated collision injuries in Alpine skiing. From 1982-1986, a record was kept of all injured skiers who consulted a doctor. The injured population was divided into two groups: those who collided with skiers and those who collided with fixed objects. Skiers who fell on their own were excluded. A control group of random skiers were chosen from various lift lines in differing times of the year over the course of the study to get an accurate skiing population (Lystad 1989).

Of the overall injured population, 18% of the injuries were due to collisions. Of that 18%, 61% hit or was hit by another skier. The remaining 39% were in a collision with a fixed object such as a tree. There were no differences in head and lower extremity injuries between the skiers who hit another skier and those who hit a fixed object. The highest overall injury was a contusion. In the fixed object group, nearly 57% of the injuries were contusions. Age showed some interesting results. Children under 15 were more likely to collide with a skier that was older than them. Overall, children between 9-15 and men were overrepresented in the fixed object group, while those 15-19 and women were overrepresented in the skier collision group. However, there was no difference in male and female collisions (skier versus fixed) when compared to the control group. It was concluded that children under 10 are more prone to collision injuries. Children between 10-14 were more apt to head injuries

though because they were more often not wearing protective head wear like the children less than 10 years old were. Collisions between skiers were often more serious than collisions with a fixed object (Lystad 1989).

A study over the four Norwegian ski areas of Hemsedal, Hovden, Oppdal, and Trysil proved many of the same statistics as previously gathered. An injured population of 328 injured and 316 uninjured skiers were portrayed in this study. The injured skiers were defined as those who attended the medical center; there was one at each of the four ski areas. The uninjured population was selected randomly from the same lift lines throughout the ski season. The skiers filled out surveys asking all of the same basic questions, but in this study, the skiers' ability was classified by their performance of turns (Ekeland et al. 1989).

Of the types of injuries sustained, 30% were fractures with sprains and contusions also being common. Severity was not too high though, as only 25% received hospital attention. The knee accounted for 24% of injuries, the shoulder 15%, the head 14%, the thumb 9%, and lower leg fractures 6%. The mechanism of the injury was also studied as most occurred during falls, and collisions accounting for only 19% of the injuries. Improper boot-binding release versus non-release made up 41% of the injuries. Once again it was evident that skiers who had their bindings professionally adjusted were a lot less likely to have a binding malfunction. Only 46% of the injured skiers who received lower leg injuries reportedly had their bindings tested. Of the uninjured group, 60% had their bindings tested. It was also reported that ski lifts accounted for 3% of the total injuries (Ekeland et al 1989).

Alexis Bally and Francois Bonjour took a look into ski injuries that occurred in Switzerland. One of their objectives was to identify injury mechanisms. The process of doing this was difficult. "The ideal means of studying injury mechanisms would be to be 'at the right place at the right time' with a camera and measuring apparatus... To obtain worth-while data, a whole area would



have to be patrolled for such a long period of time that the cost would become prohibitive (Bally Bonjour 1989).” They realized that the best chance to study injury mechanisms was by talking to the injured skier and along with his medical file, creating an experiment to model the system. Despite their efforts, knowledge of injury mechanisms did not progress significantly. They attempted to gain knowledge of the injured skier’s movement in an initial phase, loss of balance, fall, and injury. Because of this road-block in identifying new mechanisms, they were forced to lean on some of the known injury mechanisms (Bally Bonjour 1989). This study proves the difficulty in identifying injury mechanisms.

One of the more prevalent injuries comes from equipment malfunction. This issue deals with the release mechanism of ski bindings. The release factor of the bindings is yet to be perfected. There is the issue of the bindings not releasing when they are supposed to and also the opposite of that, with the bindings inadvertently releasing. “Releasable bindings were developed to reduce the risk of lower leg injuries. However, the relationship between the incidence of specific alpine injury groups and the function and calibration of the release system has not been well understood (Ettlenger et al. 2006).” A controlled case study, know as the Sugarbush North Study has been in place since December 1972; conducted by Robert T. Johnson, Carl F. Ettinger, and Jasper F. Shealy. Together they have been collecting data in order to grasp the potential risks that come with skiing as well as trends and significance of the injuries. From 1972 though 2006, they had a reported 18,692 injuries from 17,193 skiers. Knowing that not all injuries are reported, they estimated that these injuries occurred over a period of roughly 6,780,940 skier-visits.

Within their study, they took a look into the problem of the non-release and inadvertent release of ski bindings, often resulting in serious knee injuries. “Case studies of 43 anterior cruciate ligament (ACL) sprains, 79 lower leg injuries, and 99 uninjured controls were conducted using data collected over seven years between December 1997 and April 2004. In terms of quantitative critical

defects, 17 % of the control group, 14 % of the ACL group, and 39 % of the lower leg group exhibited release levels more than 30 % above recommended. When qualitative critical defects were considered, 27 % of the control group, 25 % of the ACL group, and 54 % of the lower leg group were found to exhibit one or more defects capable of having a significant effect on equipment function (Ettlinger et al. 2006).” The case of the bindings not releasing when they were supposed to affected 14% of the people that had an ACL injury.

While previous studies tried to convey the entire skier population with a control group being the skiers who were not injured, Wolfhart Hauser took it a step farther by choosing only two groups that he could control. His purpose in doing this was to evaluate the risk difference in skiers who had a correct binding setting compared to those who were at a normal binding setting. He also wanted to take a look to see the differences in thumb injuries based on the skiers using normal poles and those with poles that had a special grip design in attempt to limit thumb injuries. By the end of the study, nearly 18,000 skier days had been evaluated (Hauser 1989).

Interested skiers contacted the Arbeitskreis Sicherheit beim Skilauf (IAS). They filled out general questionnaires regarding their age, skiing, ability, sex and other pertinent information. After being divided into two randomly chosen groups, one that had their bindings expertly set and another that had average binding settings, the experiment was set up and ready. Participants then reported on each day of skiing including what skiing area, the kind of skiing day, time on the slope, number of falls, and the binding release during those falls. To increase accuracy of the reporting to be done elaborately and correctly, the ability to win prizes was added as an incentive. Skiers with the proper binding settings showed only a 17.6% injury occurrence while those who had the average settings experienced 24.5% injury occurrence. The end result was the fact that proper binding settings are significant on a 99% level. Proper bindings were found to decrease all skiing injuries, not just lower leg injuries. This is due to the fact that many other skiing injuries can be caused by bindings

inadvertently releasing. The group with their bindings set properly experienced only 75.4 inadvertent releases per 1,000 skier days, compared to the 89.5 of the other group (Hauser 1989).

The other major injury that Hauser was looking at was skier's thumb. To do this he proceeded like he did with the binding settings. He had one group using poles designed to eliminate the problem, and another group using average poles. The frequency in the injury between the groups was then reported. Of the group using the specially designed poles, 2.8% reported injuring their thumb. The other group had a reporting rate of 4%. It is evident that the specially designed poles drastically help to reduce the risk of the skier's thumb injury (Hauser 1989).

There have also been studies done to analyze downhill and cross-country skiing injuries. Statistics show that the mean age of an injured downhill skier male is 20 and female 19. In cross-country skiing, the mean age rises to 27 and 28 respectively. The types of injuries were often the same, but the occurrence of each in downhill versus cross-country was different. Knee injuries are the prevalent injury in both cases. In downhill skiing, face and head, as well as finger and thumb injuries are 1.6 times higher, and lower leg injuries are 2.7 times higher than cross-country skiing injuries. The percentage of all knee injuries associated with cross-country skiing was 26% (Miller Shealy 1991). Severities of the injuries were also rated using the CP & C Severity Rating scale. In this scale, measured 1-8, 1 was of the least severe and 8 was the most severe – death. The median result showed that a severity rating of 2 in both downhill and cross-country skiing.

Looking at the type of injury by gender in the type of skiing showed some significant results. Males have a higher fracture percentage in downhill skiing than cross-country skiing while females show the opposite of that with a lower percentage. Males have a higher knee injury percent in cross-country skiing while females have the higher percent in downhill skiing. When analyzing these findings, it is important to note the population at risk. The population for cross-country skiing tends to be older and female. Males, however, are more dominant in the population of downhill skiing. It was

concluded after the study that due to the fact that the knee was the most injured in both downhill and cross-country skiing that possibly the release of the binding does not play such a major role in dealing with knee injuries in downhill skiing (Miller Shealy 1991).

Because snowboarding is a much newer sport, not many epidemiologic studies yet exist. Jasper Shealy and Paul D. Sundman began one of the first studies published in 1989. This study was conducted over Stratton Mountain in Vermont, Breckenridge in Colorado, and Loon Mountain in New Hampshire. In total 54 people reported 59 total injuries. The results of the snowboarding injuries were then compared to Shealy's statistics that he had gathered in his skiing epidemiologic studies (Shealy Sundman 1989).

Snowboarders reported an injury rate of 4.2 injuries per 1,000 snowboarding days. Skiing injuries were 3.2 injuries per 1,000 skier days. The numbers were comparable and the slightly higher number of snowboarder injuries could be accounted for the fact that it was a new sport with inexperienced riders who were more likely to be hurt. At the time not much was known about the overall population of snowboarders in terms of age, gender, etc. Of the injured population, 90.7% were males compared to the 60% males in injured skiers. The average age of an injured snowboarder was 19 years old, while the average age of a skier is 21.4 years old. The types of injuries were also compared to those of skiers. "In the case of body part, snowboarding has about the same upper and lower body part distributions as does alpine skiing. In snowboarding, at 36.9%, the ankle and foot are the most often injured regions of the body, followed by injuries to the hand, wrist, and fingers at 16.9%. In alpine skiing, the ankle and foot account for only 18%, and the hand, wrist, and fingers account for 11%. Skiing has 27% of its injuries to the knee; snowboarding has only 15.8% of its injuries to the knee (Shealy Sundman 1989)." Due to the fact that most people snowboard in a regular stance (left foot forward), there were twice as many injuries to the left leg than the right.

Realizing that they had such a small sample size and not much of an understanding of all of

the mechanisms of injury, Shealy and Sundman brought up a few interesting points when it came to snowboard bindings. Due to the high number of ankle, foot, and knee injuries, they suggested that maybe a releasable binding be created. They did understand that it was not that easy however because they did not yet understand the mechanism that led to the injury. They saw the evolution of bindings and even called for stiff boots in order to decrease lower leg and ankle injuries. Again, they knew little about the mechanism so the prevention or even reduction of these injuries seemed impossible.

Noticing the trends of hand, wrist, and finger injuries due to the loss of balance and the natural instinct to reach a hand out to stop falling, suggestions were put in place like the use of poles or the teaching of riders to not try to catch themselves when they are falling (Shealy Sundman 1989). This study was really one of the first of its kind and gives a basis for future snowboarding epidemiologic studies.

Skiing and snowboarding are inherently dangerous sports and the increased safety of the sports is constantly being looked at and attempted to be improved upon. As more and more information is gathered in skiing epidemiology and especially snowboarding epidemiology, this goal can be accomplished. Also, a better understanding of injury mechanisms will additionally help to reduce skiing and snowboarding accidents. This is what our project will try to accomplish, increase data on skiing and snowboarding epidemiology and gain a better understanding of injury mechanisms. With these results, the ultimate goal of making skiing and snowboarding safer will move closer to being accomplished.

## 2 - Methods

### *1 - Web Survey*

Background research revealed some guidelines which influenced the format and questions of the web based survey. It is relatively short, so participants do not lose interest. Also, a progress indicator will show them exactly how much is left. The questions are phrased to avoid confusion. A rationale for each question will be provided in a separate section of the website. The website will not be cluttered or difficult to navigate. The results will be displayed on a page showing interesting data, and all of the data will be available in another section of the site.

The questions in the survey are carefully designed to fill a role in our analysis. There will be “baseline” questions to help compare results to existing data. Age, gender, and other similar, basic data are recorded in previous studies, and can help determine patterns in the data. We can detect trends among certain age groups or among men and women separately. We can also use these basic pieces of information to check the user’s reported binding settings, to see if a trend occurs with inappropriate binding settings and certain injury types.

Questions also work in groups to collect data and check the submissions for legitimacy. The questions asking for the user to rate their ability, how many years they’ve been skiing/boarding, how many days per year they go, and the trail difficulty all work together. The combination of these answers can tell us what they think of their ability level based on how often they make trips to the slopes. Also, we can see whether the user was skiing or boarding at, above, or below their reported ability level. The set of conditions questions, weather, time and trail, also quite simply works together to give us a feel of what the mountain was like at the time of the incident. There are also small groups of questions that help us make sure the user is submitting a legitimate response. We ask similar questions far apart in the survey, to make sure we get similar answers. The open-ended questions at the end of the survey are compared with the selected multiple choice answers to make sure the same story

is being told. The multiple choice answers are easier to statistically infer conclusions from than endless open responses from all users.

“Sport-specific” questions are also necessary in the survey, first to set apart data for skiers and snowboarders, and second to allow for a branching survey. The branching survey takes the user to separate pages for the two sports, where sport specific questions are asked. For both sports there are questions about the make and model of the binding they were using at the time. This data is important to note trends in, as well as to disprove statements of non-occurrence pertaining to certain bindings on the market. It is not a goal of the website to single out certain companies or manufacturers of these bindings. The idea behind asking this question is to note if certain injuries are reoccurring with certain binding types or makes, so that safety precautions can be taken, or the next year’s model can be altered. It is also necessary to separate the two sports because of a ski binding’s ability to release during a crash. There are injuries caused by inadvertent release and the failure to release of ski bindings, which should be recorded. There are very few releasable bindings on the market for snowboards, so these questions would be virtually inconsequential for boarders. These pages also give us a chance to ask snowboarders their opinion regarding the design of a releasable binding for them, and if it would have possibly prevented injury.

“Injury-specific” questions are necessary to determine what kinds of risk the other factors in the survey present. An example of this is determining what kinds of injuries, if any, are associated with certain equipment failures. These questions should also help begin to identify the mechanism of some injuries. Where and how the crash started to happen are key starting points for determining the mechanism. The clockwise direction of the fall can give us an initial idea of where the force behind the injury may have come from. The question asking what caused the fall lets us know if any other factors were present, such as collisions with objects, catching an edge, etc. These objects and events, for the most part, have certain injuries that will show up with them. These trends are important to spot,

because relating the initial cause of the crash to the injury outcome is a large step in determining the injury mechanism. Basic injury questions also provide a means to correct sampling errors, to some degree, by measuring our sample and comparing it to other samples that are known to accurately describe the population at risk. This will be more thoroughly examined in the statistical analysis section.

Finally, “open-ended” questions, primarily in the final section allow participants to fully describe the crash and injury in their own words. The purpose of putting this section at the end of the survey is to make sure we get useful data, even if participants don’t completely finish the survey. Most users that make it to the last page will be interested enough to take a moment to tell their story. If the first page were all large text boxes, it would most likely deter many pseudo-interested surfers. These answers will become a database of accounts of accidents. It also may provide a means of checking our conclusions, if we can predict aspects of an accident based on the survey data and then confirm or deny them by reviewing the open-ended account of the incident. The rationale for asking each question, open-ended and other, may be found in Appendix B.

In order to make sure to get a valuable response for each question, it may be necessary to add popup explanations for some of the important ones. That way, a user has the ability to hover over, or click a question and get an explanation as to how to answer it without skewing their story or changing what really happened. This will help ensure that key points for mechanism and injury deciphering are provided by the users in open-ended explanations. Also, we will be able to make sure that users answer radio button questions appropriately, such as those asking about the crash, not the injury. Small pictures, text, or even video clips could be used in the popup clarifications. In a web based survey, there is no direct contact with the participant, other than text and images that are readily available on the site. After some data is taken and analyzed, it will be important to add these clarifications where we need them.



## *2 - Injury Mechanism*

For each submission of the survey there should be an identifiable injury mechanism. The injury mechanism differs from the cause of the fall. A skier could hit another person and lose control, but the part of the fall that injured them could have been when their ski didn't release and twisted their knee around. The initial collision may have caused no damage, other than a few bumps and bruises. The mechanism of the injury in that case would be a combination of the torque and forces acting on the knee from the ski, ground, or other objects.

The first question concerning the injury mechanism is obviously whether the user was snowboarding or skiing, as the two sports have many different expected injury types. The next part is where the injury occurred on the mountain, combined with the clockwise falling direction. These two pieces of data allow for us to determine the angle of the fall. The conditions also are taken into account here, as they can affect how the person started and finished falling. The multiple choice question asking what initially caused the fall is the next key piece of information in determining the injury mechanism. Based on where on the mountain they were, their clockwise falling direction, and what initially caused the fall, we should be able to picture exactly how the person was traveling and how it looked when they crashed. The open-ended descriptions will support or disprove these conclusions. Another obviously important piece of the injury mechanism comes from the questions asking which body part was injured. After we are able to begin to see how the skier/boarder was traveling and started to crash, knowing which body part was injured lets us know where there mechanism occurred. For instance, if a user indicated that they were on a shallow slope and lost control by catching an edge, we start to have an idea of what happened. If they had noted that they fell in the 3 o'clock direction on a snowboard riding regular, we can picture how the crash looked. We would most likely assume a wrist injury, or some other type of falling forward problem. Once they had indicated which body part

was hurt, and what type of injury was sustained there, we have a very good idea of the mechanism. If the user had selected wrist and sprain, it would be obvious, and expected, that they had simply fallen too hard on their hands. However, if they had selected lower back and bruise, it would require reading the open-ended responses to connect the two, as they had indicated that they had fallen in the other direction.

It can be difficult to determine the mechanism of an injury simply from multiple choice questions, as the number of factors involved in causing the crash and injury are limitless. The goal of our survey is to associate answers to multiple choice questions with those of the open-ended questions, where the user can accurately depict, in their own words, what happened. This will require more work and analysis than a simple multiple choice survey, but the open-ended answers will allow us, and future groups, to improve the possible answers in the survey. The more data that is acquired over time, the more specific and accurate we can make the multiple choice questions in determining the mechanism.

### *3 - Statistical analysis*

Our approach is to collect data that is comparable to the data collected by Johnson, Ettinger, and Shealy. The importance of having the comparable data is essential in order to determine the web influence of the survey. Rather than just focusing on the injury based on equipment, ability, and conditions, we expanded what we were looking for and also included a page on the injury mechanism. The inclusion of this data will become very important when it comes to our disproving statements of non-occurrences. Meyer snowboard bindings claims that no one has ever been hurt on their bindings. If in our survey they fill it out that they were using Meyer bindings and they broke their wrist, then the statement that no one has ever been hurt using their bindings can be disproved. It would be interesting to see how they filled out the injury mechanism section so that it could be fully understood what happened.

The biggest issue in our project was the fact that we were collecting data from the internet. There are fundamental flaws in this due to the fact that this poll is not directed toward the entire skiing and snowboarding population, but rather only those who were injured. Because of this digression we can not draw conclusions based on the overall risk of being injured while skiing or snowboarding. We can however make conclusions based upon non-response error and calculate how the data is misrepresented. If for example we notice that 20% of reported skiing injuries are knee injuries, and other data suggests that knee injuries account for roughly 40% of skiing injuries, then we can weigh the results with a factor of 2 to compensate for the underrepresentation. This idea of weighing the data can be used in many cases including age, gender, and experience to name a few.

Another strategy that we used was to create a dual level survey. By starting off with simple multiple choices to collect some information about the person, the conditions, and the type of injury, we will be able to collect reasonable data. If by chance the person stops filling out the survey and does not talk about the injury mechanism, although some important information that we were looking for would be left out, the data may not be completely useless. Hopefully in any case the beginning questions that are quick and easy to answer will be answered and this data can be used for analysis.

### **3 - Discussion**

The development of this web site could turn into a central source of where people can turn to for information regarding skiing and snowboarding injuries. The website has the ability to predict trends in injuries. The major issue with the site is the fact that it is geared to gather information only of the injured population and has no control group. Because of this discrepancy from previous epidemiological studies, the need for traditional epidemiological studies still exists. In order for the data to be relevant, it has to be compared to data that already exists and takes into account the uninjured population.

The major question that can be asked from the data that will be gathered is whether the incidences of injury types have increased or just the reporting of it. This is where the need for an uninjured population comes into play. In order to fully understand this, the data will have to be compared with existing studies and the overall skiing population.

One of the major purposes of the website is to disprove statements of non-occurrences. If for instance, a releasable snowboard binding is said to have never caused a knee injury, and a submission on the website says that the injured party was using that binding while injuring their knee, the statement can be disproved. The ability to do disprove statements of non-occurrences is a special feature of the website.

The understanding of skiing and snowboarding injury mechanisms could also be improved upon. That is another unique feature of the website. By gathering data to begin to understand the cause of the accident and then giving the injured party a chance to further explain the situation, the accident is more likely to be fully understood and the injury can be simulated to better understand the injury mechanism. The ability to understand injury mechanisms is very difficult, so due to the structure

of the questions featured on the site, knowledge of unknown mechanisms will be formulated.

Lastly the website will be a place where information of skiing and snowboarding injuries will be readily available. There have been numerous epidemiological studies on the subject, but sometimes can be difficult to find. By hosting the information on the internet it will be accessible at anytime from anywhere in the world.

## 5 - Conclusions

Our survey is young. Right now it has the ability to detect injury trends and disprove statements of non-occurrence. These two things are simple enough to determine based purely on the multiple choice answers. It will take not only time to perfect the survey and its ability to detect injury mechanisms simply from a few multiple choice answers, but also many submissions. The more data is collected, the more the site can be improved. Once a large amount of data is acquired, it will be easier to detect what known injury mechanisms were at work based on multiple choice answers.

As with many online surveys it is virtually impossible to accurately predict the side of the population that isn't responding, making most statistical analysis very difficult. We have no control group in our survey; we don't know how many safe skiing trips were made for each reported injury. At the same time, we don't know who was injured that isn't reporting. When certain injury types begin to appear more, we don't know if they are happening more or simply being reported more. There is no way to tell what sample of the injured population we are getting a response from. The data can be compared to other surveys with better defined control groups and populations, in order to get a better idea of what our data might mean. That being said, it is necessary to understand that the goal of the survey is to identify the existence of these injury trends and mechanisms, not to determine their statistical significance. Knowing that a few people permanently damaged their knees from a certain type of binding should be enough for the company to want to fix it, not that 1 out of every 1000 did.

An important aspect of the site will be its ability to share all gathered data with the public. The underlying idea behind the site was for it to be a database of these skiing and snowboarding injuries. The hope is that companies and the average skier will use the data to improve safety equipment, safety features of already existing skiing and boarding gear, and possibly safety features of the slopes themselves.

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## Appendix A – Source Code

```
<?php session_start(); ?>

<html>
<head>
  <link rel="stylesheet" type="text/css" href="http://www.hurtskiing.com/style/base.css" />

<?php
  if( !isset( $_POST['surveySubmit'] )){

    $_SESSION['page_num'] = 0;
    $_SESSION['question_num'] = 0;
    $_SESSION['qsave'] = 0;
    $_SESSION['body_select'] = "";
    $_SESSION["responses"] = array ("sport_select",
      "age",
      "height",
      "weight",
      "gender",
      "ability",
      "years_experience",
      "days_per_year",
      "location",
      "time",
      "conditions",
      "trail",
      "weather",
      "cause",
      "make",
      "model",
      "year",
      "bootsole",
      "poles",
      "bindings",
      "cause_by_release",
      "often",
      "fail_release",
      "din",
      "skier_type",
      "last_set_bindings",
      "adjust_time",
      "make_board",
      "model_board",
      "year_board",
      "stance",
      "feet",
      "bindings_board",
      "malfunction",
      "release_prevent_board",
      "yes_explained",
      "inj_location",
      "inj_type",
      "safety_equipment",
      "severity",
      "explain",
```

```

                "dir",
                "med_at_scene",
                "hospital",
                "med_later",
                "miss_work" );
    } else {
        if( $_POST['surveySubmit'] == 'Next' ){
            $_SESSION['page_num']++;
            $_SESSION['qsave'] = $_SESSION['question_num'];

            foreach ( $_SESSION["responses"] as $name ) {
                if ( isset($_POST[$name]) ){
                    $_SESSION["responses"][$name] = $_POST[$name];
                }
            }

        } else if( $_POST['surveySubmit'] == 'Submit' ){
            $_SESSION['page_num']++;
            mysql_connect("localhost", "hurtsk5_admin", "235-WB") or die(mysql_error());
            mysql_select_db("hurtsk5_database") or die(mysql_error());

            //submit data to table

            mysql_close("hurtsk5_admin");
        }
    }
?>

<? if( $_SESSION['page_num'] == 3 ) { ?>
<script language="JavaScript" type="text/javascript">
    function updateBodyImage(){
        var location = "";
        for( var c = 0; c < document.survey_form.inj_location.length; c++ )
            if( document.survey_form.inj_location[c].checked )
                location = document.survey_form.inj_location[c].value;

        document["injury_image"].src = "/images/body/body_" + location + ".png";
    }
</script>
<? } ?>
</head>
<body>

<form name="survey_form" action="survey.php" method="post" cellspacing="0" cellpadding="0" border="0">
<table cellspacing="0" cellpadding="0" border="0" class="layout">

    <tr><td></td></tr>

    <tr><td><div>
<? if( $_SESSION['page_num'] == 0 ) { ?>
    <h4>Use the 'Next' button to advance</h4>
    <h2>Please be sure to completely fill out each page before pressing the Next button.</h2>
    <h2>This survey requires javascript to be enabled.</h2>

<? } else if( $_SESSION['page_num'] == 1 ) { ?>
    <? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
    <h4>Were you skiing or snowboarding?</h4>

```

```
<input type="radio" name="sport_select" id="skiID" value="ski" />Skiing
<input type="radio" name="sport_select" id="snowbID" value="snowb" />Snowboarding
```

```
<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
```

```
<h4>Please tell us about yourself.</h4>
```

```
Age:<input name="age" type="text" id="age" tabindex="2" size="2" />
```

```
Height:<input name="height" type="text" id="heightID" tabindex="3" size="3" />
```

```
Weight:<input name="weight" type="text" id="weightID" tabindex="3" size="3" />
```

```
Gender:<input name="gender" type="text" id="genderID" tabindex="6" size="6" />
```

```
<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
```

```
<h4>Please rate your ability at the time of the incident.</h4>
```

```
<input type="radio" name="ability" id="beginnerID" value="beginner" tabindex="6" />Beginner
```

```
<input type="radio" name="ability" id="intermediateID" value="intermediate" />Intermediate
```

```
<input type="radio" name="ability" id="expertID" value="expert" />Expert
```

```
<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
```

```
<h4>How many years had you been skiing/boarding before this accident?</h4>
```

```
<input name="years_experience" type="text" id="years_experienceID" tabindex="7" size="6" />
```

```
<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
```

```
<h4>On average, how many days per year do you ski/board?</h4>
```

```
<input type="text" name="days_per_year" id="days_per_yearID" tabindex="8" size="6" />
```

```
<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
```

```
<h4>Where on the mountain did the incident occur?</h4>
```

```
<input type="radio" name="location" id="off_liftID" value="off_lift" tabindex="9" />Getting off the Lift
```

```
<input type="radio" name="location" id="slope_shallowID" value="slope_shallow" />Slope (Shallow)
```

```
<input type="radio" name="location" id="terrain_prkID" value="terrain_prk" />Terrain Park
```

```
<input type="radio" name="location" id="slope_steepID" value="slope_steep" />Slope (Steep)
```

```
<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
```

```
<h4>What were the conditions like that day?</h4>
```

```
<table>
```

```
<tr>
```

```
<td>Time:</td>
```

```
<td><input type="radio" name="time" id="morn_afternoonID" value="morn_afternoon"
```

```
/>Morning/Afternoon</td>
```

```
<td><input type="radio" name="time" id="twilightID" value="twilight" />Twilight</td>
```

```
<td><input type="radio" name="time" id="night_no_lightID" value="night_no_light" />Night (No Lights)</td>
```

```
<td><input type="radio" name="time" id="night_lightsID" value="night_lights" />Night (With Lights)</td>
```

```
</tr>
```

```
<tr>
```

```
<td>Conditions</td>
```

```
<td><input type="radio" name="conditions" id="icyID" value="icy" />Icy</td>
```

```
<td><input type="radio" name="conditions" id="powderID" value="powder" />Fresh Powder</td>
```

```
<td><input type="radio" name="conditions" id="slushID" value="slush" />Slushy</td>
```

```
<td><input type="radio" name="conditions" id="deep_snowID" value="deep_snow" />Deep Snow</td>
```

```
</tr>
```

```
<tr>
```

```
<td>Trail</td>
```

```
<td><input type="radio" name="trail" id="diamondID" value="diamond" />Diamond</td>
```

```
<td><input type="radio" name="trail" id="boxID" value="box" />Square</td>
```

```
<td><input type="radio" name="trail" id="circleID" value="circle" />Circle</td>
```

```
<td><input type="radio" name="trail" id="unknownID" value="unknown" />Not Sure</td>
```

```
</tr>
```

```
<tr>
```

```
<td>Weather</td>
```

```

        <td><input type="radio" name="weather" id="sunny_clearID" value="sunny_clear" />Sunny/Clear</td>
        <td><input type="radio" name="weather" id="cloudyID" value="cloudy" />Cloudy</td>
        <td><input type="radio" name="weather" id="snowID" value="snow" />Snowing</td>
        <td><input type="radio" name="weather" id="rain_sleetID" value="rain_sleet" />Rain or Sleet</td>
    </tr>
</table>

```

```

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>

```

```

<h4>What caused the injury?</h4>

```

```

<table>

```

```

    <tr>

```

```

        <td><input type="radio" name="cause" id="hit_skierID" value="hit_skier" />Hit another skier</td>

```

```

        <td><input type="radio" name="cause" id="hit_objectID" value="hit_object" />Hit an object</td>

```

```

        <td><input type="radio" name="cause" id="dirt_snowID" value="dirt_snow" />Dirt showing through snow</td>

```

```

    </tr><tr>

```

```

        <td><input type="radio" name="cause" id="failed_trick_railID" value="failed_trick" />Failed trick (Rail)</td>

```

```

        <td><input type="radio" name="cause" id="failed_trick_jumpID" value="failed_trick_jump" />Failed trick

```

```

(Jump)</td>

```

```

        <td><input type="radio" name="cause" id="failed_stopID" value="failed_stop" />Failed to stop</td>

```

```

    </tr><tr>

```

```

        <td><input type="radio" name="cause" id="control_edgeID" value="control" />Lost control (Caught edge)</td>

```

```

        <td><input type="radio" name="cause" id="control_iceID" value="control_ice" />Lost control (Ice)</td>

```

```

        <td><input type="radio" name="cause" id="control_speedID" value="Lost control (Speed)" />Lost control

```

```

(Speed)</td>

```

```

    </tr><tr>

```

```

        <td><input type="radio" name="cause" id="equipmentID" value="equipment" />Equipment failure</td>

```

```

        <td><input type="radio" name="cause" id="otherID" value="other" />Other</td>

```

```

    </tr></table>

```

```

If other, please explain:

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```

<textarea name="other_explained" id="other_explained" cols="25" rows="5"></textarea>

```

```

<?php } else if( $_SESSION['page_num'] == 2 && $_POST['sport_select'] == 'ski' ) { ?>

```

```

    <? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>

```

```

    <h4>Please tell us about the bindings you were using at the time of the accident.</h4>

```

```

    Make: <input name="make" type="text" id="makeID" tabindex="2" size="6" />

```

```

    Model: <input name="model" type="text" id="modelID" tabindex="3" size="6" />

```

```

    Year: <input name="year" type="text" id="yearID" tabindex="4" size="6" />

```

```

    Boot Sole Length: <input name="bootsole" type="text" id="bootsole" tabindex="5" size="6" />

```

```

    <? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>

```

```

    <h4>Were your poles involved in the injury?</h4>

```

```

    <input type="radio" name="poles" id="polesyesID" value="Yes" />Yes

```

```

    <input type="radio" name="poles" id="polesnoID" value="No" />No

```

```

    <? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>

```

```

    <h4>What type of bindings do you use?</h4>

```

```

    <input type="radio" name="bindings" id="nordicID" value="nordic" />Nordic/Telemark

```

```

    <input type="radio" name="bindings" id="alpineID" value="alpine" />Alpine

```

```

    <input type="radio" name="bindings" id="bladesID" value="blades" />Ski Blades

```

```

    <? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>

```

```

    <h4>Was the accident caused by inadvertant binding release?</h4>

```

```

    <input type="radio" name="cause_by_release" id="cause_by_releaseYesID" value="Yes" />Yes

```

```

    <input type="radio" name="cause_by_release" id="cause_by_releaseNoID" value="No" />No

```

```

    <? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>

```

```

    <h4>Does this happen often?</h4>

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<input type="radio" name="often" id="oftenYes" value="Yes" />Yes
<input type="radio" name="often" id="oftenNo" value="No" />No

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Did the binding cause injury by failing to release when it should have?</h4>
<input type="radio" name="fail_release" id="fail_releaseYes" value="Yes" />Yes
<input type="radio" name="fail_release" id="fail_releaseNo" value="No" />No

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>What was your DIN setting?</h4>
<input name="din" type="text" id="dinID" tabindex="2" size="6" />

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>What is your skier type?</h4>
<input type="radio" name="skier_type" id="skier_type1ID" value="I" />I (Ski Conservatively)
<input type="radio" name="skier_type" id="skier_type2ID" value="II" />II (Ski Moderately)
<input type="radio" name="skier_type" id="skier_type3ID" value="III" />III (Ski Aggressively)

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Who set your bindings last?</h4>
<input type="radio" name="last_set_bindings" id="selfID" value="self" tabindex="1" />Self/Friend
<input type="radio" name="last_set_bindings" id="instructorID" value="instructor" />Instructor
<input type="radio" name="last_set_bindings" id="coachID" value="coach" />Coach
<input type="radio" name="last_set_bindings" id="employeeID" value="employee" />Ski shop employee
<input type="radio" name="last_set_bindings" id="dkID" value="dk" />Don't know

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>How long had it been since your last binding adjustment?</h4>
<input name="adjust_time" type="text" id="adjustID" size="6" />

<?php } else if( $_SESSION['page_num'] == 2 && $_POST['sport_select'] == 'snowb' ){ ?>
<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Please tell us about the bindings you were using at the time of the accident.</h4>
<table><tr>
    <td>Make: <input name="make_board" type="text" id="make_boardID" tabindex="2" size="6" /> </td>
    <td>Model: <input name="model_board" type="text" id="model_boardID" tabindex="3" size="6" /> </td>
    <td>Year: <input name="year_board" type="text" id="year_boardID" tabindex="4" size="6" /> </td>
</tr></table>

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>What is your stance?</h4><table><tr>
    <td><input type="radio" name="stance" id="regID" value="reg" tabindex="1" />Regular</td>
    <td><input type="radio" name="stance" id="goofyID" value="goofy" />Goofy</td>
</tr></table>

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Which feet were strapped in at the time of the incident?</h4><table><tr>
    <td><input type="radio" name="feet" id="both_feetID" value="both_feet" tabindex="1" />Both </td>
    <td><input type="radio" name="feet" id="front_feetID" value="front_feet" />Front </td>
    <td><input type="radio" name="feet" id="back_feetID" value="back_feet" />Back </td>
    <td><input type="radio" name="feet" id="none_feetID" value="none_feet" />None</td>
</tr></table>

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Which type of binding were you using?</h4><table><tr>
    <td><input type="radio" name="bindings_board" id="Step_inID" value="Step_in" tabindex="1" />Step-in </td>
    <td><input type="radio" name="bindings_board" id="StrapID" value="Strap" />Strap </td>

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        <td><input type="radio" name="bindings_board" id="ToeID" value="Toe" />Toe </td>
        <td><input type="radio" name="bindings_board" id="FlowID" value="Flow" />Flow</td>
        <td><input type="radio" name="bindings_board" id="ReleasableID" value="Releasable" />Releasable</td>
    </tr></table>

```

```

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Was there a binding malfunction associated with causing the injury?</h4>
<table><tr>
    <td><input type="radio" name="malfunction" id="malfunctionyesID" value="Yes" tabindex="1" />Yes </td>
    <td><input type="radio" name="malfunction" id="malfunctionnoID" value="No" />No</td>
</tr></table>

```

```

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Do you feel that if your bindings had a release mechanism, it would have prevented the injury, but not necessarily
the fall?</h4>
<table><tr>
    <td><input type="radio" name="release_prevent_board" id="preventableyesID" value="Yes" />Yes </td>
    <td><input type="radio" name="release_prevent_board" id="preventablenoID" value="No" />No</td>
</tr><tr>
    <td align="right" valign="top">If yes, please explain:</td>
    <td><textarea name="yes_explained" id="yes_explainedID" cols="40" rows="5"></textarea></td>
</tr></table>

```

```

<?php } else if( $_SESSION['page_num'] == 3 ){ ?>
<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Which body part did you injure?</h4>
<table><tr>
    <td><table><tr>
        <td><input name="inj_location" type="radio" value="head" onclick="javascript:updateBodyImage()"
>Head</td>
        <td><input name="inj_location" type="radio" value="neck" onclick="javascript:updateBodyImage()"
/>Neck</td>
        <td><input name="inj_location" type="radio" value="shoulders" onclick="javascript:updateBodyImage()"
/>Shoulder</td>
    </tr><tr>
        <td><input name="inj_location" type="radio" value="upperarms" onclick="javascript:updateBodyImage()"
/>Upper Arm</td>
        <td><input name="inj_location" type="radio" value="elbows" onclick="javascript:updateBodyImage()"
/>Elbow</td>
        <td><input name="inj_location" type="radio" value="forearms" onclick="javascript:updateBodyImage()"
/>Forearm</td>
    </tr><tr>
        <td><input name="inj_location" type="radio" value="wrists" onclick="javascript:updateBodyImage()" />Wrist</
td>
        <td><input name="inj_location" type="radio" value="hands" onclick="javascript:updateBodyImage()"
/>Hand</td>
        <td><input name="inj_location" type="radio" value="fingers" onclick="javascript:updateBodyImage()"
/>Finger</td>
    </tr><tr>
        <td><input name="inj_location" type="radio" value="thumbs" onclick="javascript:updateBodyImage()"
/>Thumb</td>
        <td><input name="inj_location" type="radio" value="chest" onclick="javascript:updateBodyImage()"
/>Chest/Ribs</td>
        <td><input name="inj_location" type="radio" value="abdomen" onclick="javascript:updateBodyImage()"
/>Abdomen</td>
    </tr><tr>
        <td><input name="inj_location" type="radio" value="pelvis" onclick="javascript:updateBodyImage()" />Pelvis</

```

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td>
    <td><input name="inj_location" type="radio" value="hips" onclick="javascript:updateBodyImage()" />Hip</td>
    <td><input name="inj_location" type="radio" value="thighs" onclick="javascript:updateBodyImage()" />Thigh</
td>
    </tr><tr>
        <td><input name="inj_location" type="radio" value="knees" onclick="javascript:updateBodyImage()"
/>Knee</td>
        <td><input name="inj_location" type="radio" value="lowerlegs" onclick="javascript:updateBodyImage()"
/>Lower Leg</td>
        <td><input name="inj_location" type="radio" value="ankles" onclick="javascript:updateBodyImage()"
/>Ankle</td>
    </tr><tr>
        <td><input name="inj_location" type="radio" value="feet" onclick="javascript:updateBodyImage()" />Foot</td>
        <td><input name="inj_location" type="radio" value="upperback" onclick="javascript:updateBodyImage()"
/>Upper Back</td>
        <td><input name="inj_location" type="radio" value="lowerback" onclick="javascript:updateBodyImage()"
/>Lower Back</td>
    </tr></table></td>
    <td></td>
</tr></table>

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>What type of injury was sustained there?</h4>
<table>
    <tr>
        <td><input name="inj_type" type="radio" value="radiobutton" />Break/Fracture</td>
        <td><input name="inj_type" type="radio" value="radiobutton" />Bruise/Blunt Trauma</td>
        <td><input name="inj_type" type="radio" value="radiobutton" />Cut/Laceration</td>
        <td><input name="inj_type" type="radio" value="radiobutton" />Paralysis</td>
        <td><input name="inj_type" type="radio" value="radiobutton" />Grade 3 ACL/MCL</td>
    </tr>
    <tr>
        <td><input name="inj_type" type="radio" value="radiobutton" />Joint (Sprain, Twist, Dislocate)</td>
        <td><input name="inj_type" type="radio" value="radiobutton" />Strain</td>
        <td><input name="inj_type" type="radio" value="radiobutton" />Concussion/Spinal</td>
        <td><input name="inj_type" type="radio" value="radiobutton" />Death</td>
    </tr>
</table>

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Please indicate all safety equipment you had on at the time of the accident, associated with the injury you
received. For example, for a wrist injury it would be important to note if you were wearing a brace or not.</h4>
<textarea name="safety_equipment" cols="60" rows="4"></textarea>

<?php } else if( $_SESSION['page_num'] == 4 ){ ?>
    <? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
    <h4>Please rate the severity of the injury on a scale of 1 to 10, 10 being the worst.</h4>
    <br /><input name="severity" type="text" id="severityID" tabindex="2" size="6" />

    <? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
    <h4>Please take a moment to briefly explain how the injury occurred, from what made you fall to how you were when
you stopped.</h4>
    <textarea name="explain" cols="60" rows="4"></textarea>

    <? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
    <h4>Indicate in which clockwise direction you fell, with 12 o'clock being the front of your skis/board.</h4>
    <br /><input name="dir" type="text" id="dirID" tabindex="2" size="6" />

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<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>What medical attention was given at the ski area?</h4>
  <textarea name="med_at_scene" cols="60" rows="4"></textarea>

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Were you transported to a hospital?</h4>
  <table>
    <tr>
      <td><input name="hospital" type="radio" value="hosp_yes" />Yes</td>
      <td><input name="hospital" type="radio" value="hosp_no" />No</td>
    </tr>
  </table>

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>What medical attention was given/perscribed after leaving the scene?</h4>
  <textarea name="med_later" cols="60" rows="4"></textarea>

<? echo "<h1>" .++$_SESSION['question_num']. "</h1>"; ?>
<h4>Did you miss work or school because of the injury? If so, how long?</h4>
  <textarea name="miss_work" cols="60" rows="4"></textarea>

<?php } else { $_SESSION['page_num'] == 5; } ?>
</div></td></tr>

<tr><td><div>
  <? if( $_SESSION['page_num'] > 1 ){ ?> <input type="Submit" name="surveySubmit" value="Back" /> <? } ?>
  <input type="Submit" name="surveySubmit" value=<? if( $_SESSION['page_num'] == 4 ) echo "Submit"; else echo
"Next"; ?> />
</div></td></tr>

<tr><td></td></tr>

</table></form>
</body></html>

```