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Exploring the Utility of Web-based Ski and Snowboard Injury Studies

**An Interactive Qualifying Project Report
submitted to the Faculty of
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Degree of Bachelor of Science
by**

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Abstract

The objectives of this project are to design and test a website to learn to what extent it is possible to improve the understanding of the causes and mechanisms of ski and snowboard injuries using web-based surveys. A further objective is to share information gathered on the web site with the public and other researchers through the web with the intent to help reduce injuries. The kinds of data, provided by web-based studies, are not expected to replace conventional epidemiology for understanding risks. The two kinds of studies should be complimentary in reducing the risks of ski injuries. In conventional epidemiological studies, information is obtained on the population at risk and the risks of specific injuries and their trends can be determined (e.g., Johnson et al. 2000). Dickson (2007) proposed an on-line survey as a convenient way of getting data on snow-sport injuries. Langran, on his website www.ski-injury.com, disseminates information intended to mitigate snow sport injuries. On-line surveys allow information to be gathered from a large and diverse spectrum of snow sport experiences. On-line surveys also have the potential to improve the understanding of mechanisms of injuries and to identify factors influencing particular injury types.

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1. Introduction

1.1 Objectives

The overall objective of this project is to reduce ski and snowboard injuries. This objective will be achieved through two sub-objectives. These include designing and testing a website to improve the understanding of the causes and mechanisms of snow-sport injuries using web-based surveys. The second sub-objective is to share the information gathered with the public and other researchers with the intent to help reduce injuries. Through this project, the effectiveness of a web-based study compared to the effectiveness of an epidemiological study will ultimately be tested.

1.2 Rationale

Injuries occur in the world of snow sports each year at a rate of 42 according to the NSAA (National Ski Areas Association, <http://www.nsaa.org/nsaa/press/0506/facts-about-skiing-and-snowboarding.asp>, 2006). This rate applies to injuries that are reported as serious, meaning a spinal or severe head injury. In the 2004/2005 season, 45 serious injuries were reported, 24 were skiers (18 males, 6 females) and 21 were snowboarders (19 males, 2 females) (NSAA, 2006). On the other hand, ski and snowboard injuries can be minor as a sprain or bruise. Such injuries have a wide range of mechanisms; e.g., inadvertent release can cause serious knee damage when the binding fails to absorb energy without falling out, or wearing a pole strap incorrectly may cause excess force on the ulnar collateral ligament in the thumb, resulting in "skier's thumb." According to statistics from the NSAA, during the past 10 years about 38 people have died per year from these intense winter sports. In the 2004/2005 season, 30 reported fatalities were skiers and 15 were snowboarders, resulting in 45 total fatalities out of the 56.9 million skier/snowboarders reported for the season (National Ski Areas Association, <http://www.nsaa.org/nsaa/press/0506/facts-about-skiing-and-snowboarding.asp>, 2006).

It is hypothesized that acquiring more knowledge of these injuries and their mechanisms may lead to a reduction in injuries. First, an efficient way to gather this type of information must be created. Area based epidemiological studies (e.g., Shealy et al. 1997) have been used for years, and have been quite successful in describing injury trends at a particular location. This project explores the advantages and disadvantages of a web-based study compared to an epidemiological study. In the online survey, users are able to enter detailed descriptions of their injuries, so the causes of injuries can be explored thoroughly. Also, the easy access of web-based surveys allows the user to respond at their convenience, rather than only at a particular mountain where a study is taking place. This enables researchers to obtain more information about these types of injuries from a broad range of demographics. A disadvantage of this type of study is that it is voluntary, meaning that broadcasting must take place to expand knowledge of the survey's existence. It also translates to the fact that no claims on the frequency of

occurrence of skiing or snowboarding injuries can be made. Because of this downfall, another type of survey has been created for skiers and snowboarders who have not been injured. This will assist in the expansion of the demographic base. For example, out of all the ski patrollers who take the survey, it will be possible to determine the percentage that gets injured in this sport.

1.3 State of the Art

The following description of the Sugarbush North study appears verbatim, except for the dates, in several articles (Johnson et al. 1993, 1997, 1999, 2003):

“Between the 1972/73 and the 2002/2003 ski season, we operated ski injury clinics at the base lodge area operation between December 15 and April 15 of each season, or until the areas closed. All skiers who were non-ambulatory and evacuated from the slopes on toboggans were delivered directly to this facility by the ski patrol. All injured skiers who were capable of leaving the slopes under their own power were directed to this facility if they requested any form of medical assistance from any of the area’s employees. Injured skiers who arrived at the clinic by either means within 48 h of their injury were asked to participate in the study, but any skiers who arrived under their own power and had been injured more than 48 h previously were not included in the study. Injuries not requiring medical treatment, such as minor contusions, cuts and frostbite, were not included. Only a small percentage of those solicited refused to participate. All participants were asked a series of approximately 50 questions relating to their physical characteristics, skiing ability, habits, experience, description of the accident, and general information about the age, previous performance, and the maintenance of their ski equipment. The clinic’s location in the area’s base lodge and the standard procedures of the area’s ski patrol, which required that all evacuated skiers be unloaded from the toboggan and proceed to our facilities, ensured that the clinics saw a vast majority of the serious injuries that occurred at the ski area. This has been confirmed by parking lot interviews of skiers leaving the ski area during the last 13 years of the study, which showed only 27% of injuries sustained at the area are unreported, and at least two-thirds of those were minor. This compares favorably with other studies that have examined reportability.”

The key points are Vermont Ski Safety and the University of Vermont Orthopaedics Department are conducting an epidemiological study at Sugarbush Mountain, a ski resort in Warren, Vermont. In conventional epidemiological studies, information is obtained on the population at risk, and the risks of specific injuries and their trends can be determined. Injury records have been kept on everyone taken into the patrol room since 1973 at Sugarbush Mountain (e.g., “Skier Injury Trends – 1972 to 1994,” *Skiing Trauma and Safety: Eleventh*

Volume). The study is particularly successful because orthopedic residents from the University of Vermont are located on site. A first and, if appropriate, second diagnosis of the injury are recorded. Additionally, a separate facility for testing and evaluating equipment is located on site. During 1990-1997, parking lot interviews of skiers leaving the ski area confirmed that only 27% of injuries sustained at Sugarbush Mountain went unreported, and at least two thirds of these were minor (e.g., Shealy et al. 1997). This controlled study environment allows researchers to determine the nature and cause of all reported injuries.

Online surveys have the possibility to be even more successful than the Sugarbush North study, if done properly. In 2007, Dickson proposed this type of survey as a convenient way of getting data on snow-sport injuries. Mike Langran created a website, www.ski-injury.com, which disseminates information intended to lessen these types of injuries. The result of the project's website is similar to Langran's in that it gives information about injury mechanisms found in research. However, three detailed surveys have also been included to test the effectiveness of a web-based study.

The kinds of data, provided by web-based studies, are not expected to replace conventional epidemiology (e.g., Sugarbush Mountain study) for understanding risks. The two kinds of studies should be complimentary in reducing the risks of ski injuries.

1.4 Our Approach

As a continuation of the previous intermediate qualifying project, the website "hurtskiing.com" will be edited and reformed to contain new injury mechanism data and injury reduction data. The site contains information on injury types tied to their specific mechanism, found through research, and advice for staying safe while skiing or snowboarding. This site is also designed for easy navigation and accessibility. Additionally, new surveys will be posted and advertised to specific groups for a wide range of responses.

The surveys will be designed to examine the causes and mechanisms of injuries, and to improve the understanding of these specific mechanisms. They are also designed to test research based hypotheses for thumb, head, and wrist injuries. It is designed in a flowing manner as to not be redundant, to minimize survey fatigue, and to have the purpose of the question clearly known.

2. Method

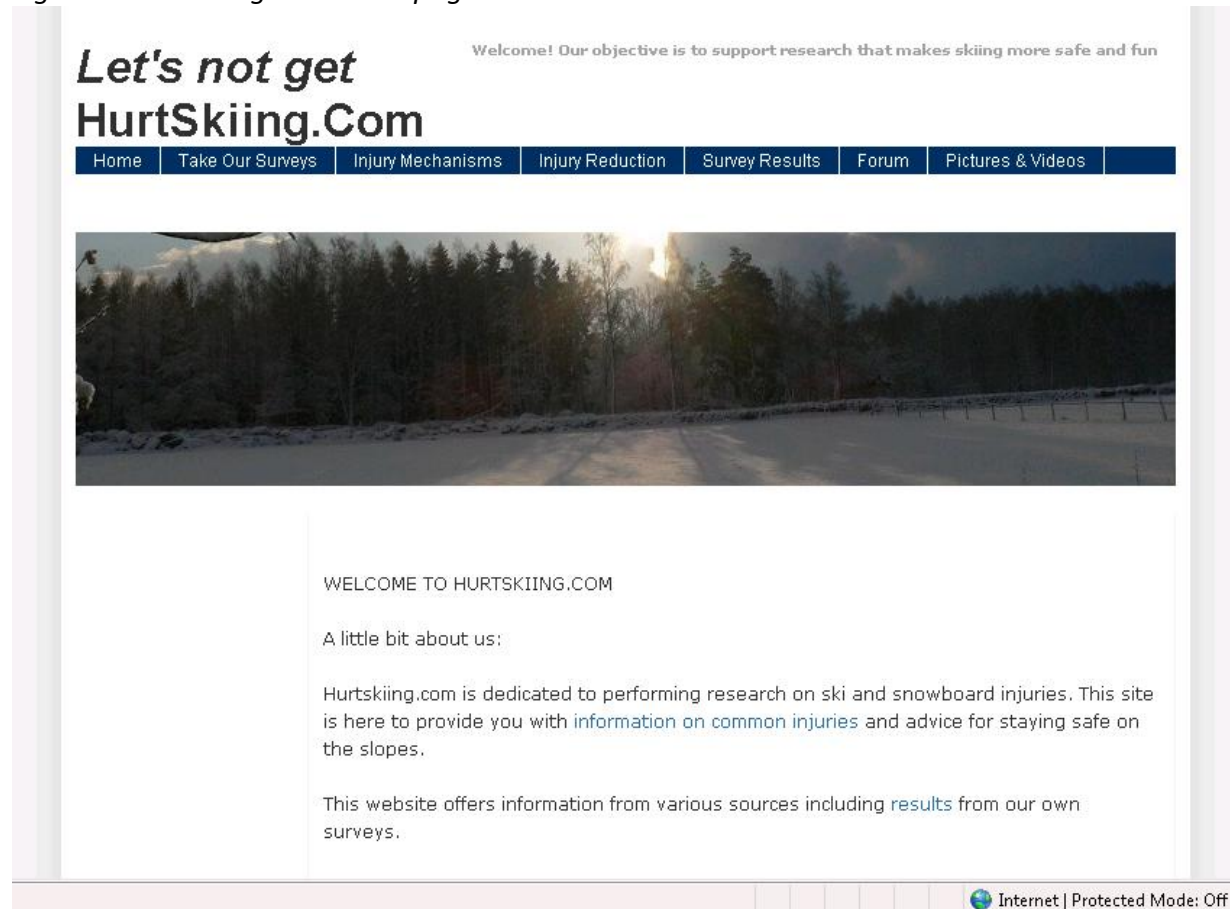
2.1 Updating the Website

This interdisciplinary qualifying project is a continuing project. Changing the website to keep up with our understanding of injury mechanisms and trends is important. To improve the website from the previous interdisciplinary qualifying project, the first step was to make it more appealing and easy to navigate for the user. This involves having a design with good aesthetics as well as practical ways of surfing through the sections the website offers.

2.1.2 Changing the Design

The home page as it is right now is illustrated below:

Figure 1: HurtSkiing.com Homepage



See Appendix A: Figure 2 for the original website homepage.

Changes made:

- Main option bar placed horizontally at top
- Added description and objective of website in home page
- Added links to different sections within the description
- “Injury Mechanisms” and “Injury Reduction” sections added to the website
 - These sections were added in order to provide the visitors with information on common injury mechanisms, as well as advice on how to avoid some of these injuries. Our team’s objective is to reduce skiing and snowboarding injuries, so informing the actual crowd on the dangers and how to avoid them contributes to that goal.

2.1.2 Modifying the Survey

The original survey consisted of approximately 20 questions and gathered general injury data. The case is that there are many potential injuries that skiers and snowboarders can sustain, and all of them have different mechanisms. It was clear that a new survey had to be made with the ability to examine more mechanisms. This would require a large variety of questions relating to each specific mechanism.

2.2 Creating New Surveys

An original draft of the survey was designed. Using a diagram, the flow of the survey was determined by showing how different answers to questions lead to different parts of the survey. This diagram is called the “Survey Tree” and can be found in Appendix A: Figure 3. A rationale for each question was written to identify how each question contributes to the objectives. The point was to keep the survey as short as possible while also being as thorough as possible. Basically, if the survey had as many questions the team could think of, there would be the risk of people getting survey fatigue and not answering every question. With the question rationale and the survey tree, it made the purpose of each question and where it led clear.

2.3 Organization of the Survey

The surveys were organized into different sections. These are:

- Background information

This section contains general information questions, such as gender, age, ability level, and experience of the skier or snowboarder.

- Conditions

This section consists of questions relating to the conditions at the time of injury, such as the time of day the accident occurred, the weather, and the type of trail.

- Injury type

This section includes a list of injury types from which each choice would take you to a different set of questions pertaining to that injury.

- Injury mechanism

Once the injury type is selected, the injury mechanism needs to be examined. All related questions for the analysis of that mechanism are at this point. The entire survey was separated for skiers and snowboarders after the background information and designed to only ask questions of injuries and mechanisms pertaining to either skiing or snowboarding.

- Description, end of survey

Lastly, the users are asked to include any additional comments they would like to share in an event the questions didn't cover a key point to their injury. They are also asked to give an email address, so they may be contacted in further information is desired.

2.4 Survey Efficiency

Our team considered what would be the best way to gather as much information as possible. We came up with three possible types of respondents to the survey. These are:

1. Injured people
2. Uninjured people
3. Injured people unable to respond for themselves

The first two types are self-explanatory, but the third type gives a user the ability to provide us with the injury data of someone who cannot answer the survey themselves. This specifically applies to children or a deceased person. The survey was then broken up into three separate surveys to aim at particular respondents. One for each of the types mentioned above:

1. Injured Person Survey- If someone has been injured while skiing or snowboarding.
2. Uninjured Person Survey- If a skier or snowboarder has never been injured in the sport. This survey helps contribute to our demographic base.
3. People Unable to Respond for Themselves- For people who know someone that has been injured skiing or snowboarding, but are unable to participate in the survey by themselves.

A power point was made for each of the surveys, exactly how it would be on the website. These can be found in Appendix A: Figures 4, 5 and 6. The power points were proofread and tested on members of the WPI ski team.

The most simple and short survey was the uninjured person one. Very few questions are asked as it is only meant for contribution to our demographic base.

For the people unable to respond for themselves, it is assumed that the person responding might not have the knowledge to answer every question applying to the injury at hand. An “I don’t know” option is inserted into the majority of the questions in this survey. This assures that incorrect or misleading results will not be given. Later on, this option was added into the initial survey as well.

2.5 Database Systems

For the databases, SQL (Structured Query Language) was used:

At first it seemed that the easiest thing to do was create a database for each survey, but that would make it difficult to compare the results. This is why two databases were created. The structure of each these databases are explained in Appendix C.

1. Injured database

The injured database gathers and displays information of both people responding for themselves and people who are not. A field in the database had to be made for every question.

The questions were similar for both, but the survey became complicated. It would be very inefficient to have a different field for questions that repeat themselves in different parts of the survey. For instance, the question of whether the subject was involved in a collision appears in different mechanisms, but despite the mechanism the answer refers to the same field in the database. This makes it easier to read the database, manually and artificially. It was also important to go through the whole survey, identify all questions and see where they repeat themselves to make sure that in the coding they refer to the same point in the database. In the end, the total amount of field came to be 57 and can all be found in Appendix B.

2. Uninjured database

The database for uninjured people consisted of 15 fields as the questions were very limited. The organization of this database was not as complicated as the main one.

2.6 Advertising the Survey

The survey was advertised to small test groups, the Tau Kappa Epsilon Fraternity and the WPI Ski Team. The results were analyzed and small trends were noticed allowing the formation of hypotheses.

Several questions were added to the online survey based on the hypotheses (see Table 1) and the website was then advertised to Worcester Polytechnic Institute students. This causes trends to be sometimes over-represented (e.g., gender of respondents).

2.7 Formation of Hypotheses

The hypotheses chart is shown below:

Table 1: Hypotheses Chart

Hypotheses	Injuries they address	Mechanism	Solution?
Wearing a helmet increases the likelihood of receiving a head injury.	Head injury -concussion	- Providing a sense of invulnerability - Sensory deprivation (hearing/seeing) - Poor helmet design	- designing a helmet that reduces sensory deprivation - warning on helmet that it does make you “invincible”
There is a higher % chance of breaking wrist in the first few days of snowboarding.	Wrist injury -break -sprain	- People fall the most when they are learning to snowboard and catch themselves with their hands	- wrist guards recommended at rental/ski shops
People hurt their thumbs when they wear pole straps the wrong way.	Thumb injury -sprain in ulnar collateral ligament	- pole straps are sometimes worn incorrectly causing excessive force to the thumb when you land on it	- sign on ski lift with picture showing the correct way to wear poles
People are more likely to injure their ACL if they do not use the knee binding	Knee injury -tear in ACL	- this binding protects against Phantom Foot mechanism - there are not many of these bindings on the mountain	- recommended in rental/ski shops - people are more likely to use the binding if they have previously injured their ACL

This is a table representing our hypotheses, the injuries they address, the mechanisms that cause the injuries, and a possible solution.

A series of five testable hypotheses were developed after a round of preliminary testing to determine the effectiveness of the survey to reduce snow sport injuries. Four hypotheses are shown in Table 1. These were tested by adding new questions to the survey based on each hypothesis.

- All respondents were asked if they were wearing a helmet at the time of injury. They were also asked if they believed the helmet caused any sensory deprivation or if it caused a sense of recklessness.
- For those who injured their wrist snowboarding, they were asked how many days they had been snowboarding before the injury.
- Skiers who injured their thumb were asked how they were wearing their pole straps. A picture was shown (Appendix A: Figure7) to determine whether or not they wore the pole straps correctly.
- Those who injured their ACL skiing were asked if they were using the KneeBinding.

Because of the newly added survey questions, the demographics of the respondents for these hypotheses are the skiers and snowboarders who took the survey after the questions were added and the website was emailed out to WPI undergraduates.

A fifth hypothesis was also developed from testing the survey, but does not fit in the chart. It is that younger people are more likely to utilize the website and surveys. This is assumed because it was started by a college group and solicited to college groups. It is also assumed because younger generations are more apt to use the internet.

For this hypothesis, everyone who responded to the survey was included in the demographic base, because everyone was asked their age.

2.8 Retrieving Data from Website

Figure 8 is screen shot of the database illustrating the structure and how the data is gathered. Each column represents a different question in the survey and each row represents a different respondent. Answers to the questions are given in a code which is shown in Appendix B. Information was taken from the database and manually transferred to excel files in which the statistics were developed.

Figure 8: Screen Shot of Database

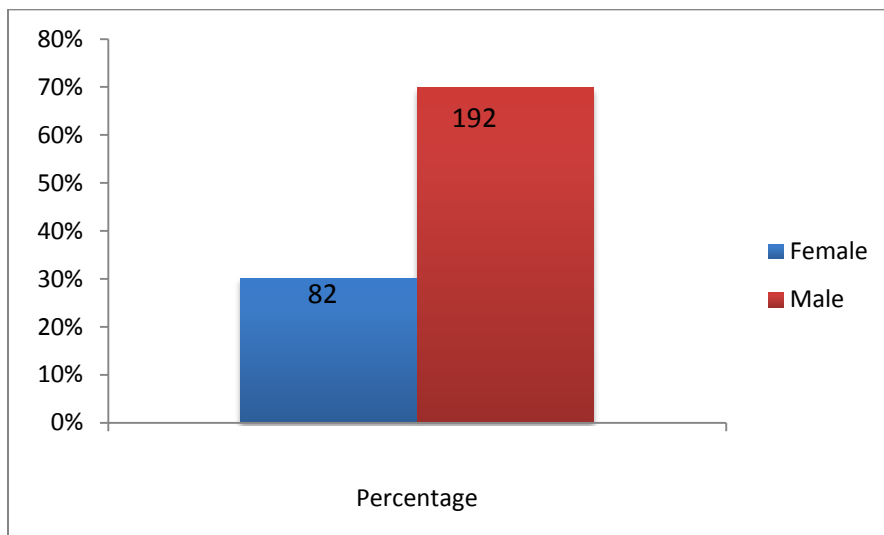
			id	date	unableorhimself	gender	age	activity	ability	rented	cond	act_type	tod	weather	snow_cond	trail	diff
<input type="checkbox"/>			4d875bb4094b4	2011-03-21 10:08:12	H	F	20	SK	A	N	Y	F	M			GS	K
<input type="checkbox"/>			4d84fd773a5da	2011-03-19 15:01:30	H	M	21	SK	A	N	Y	F	M			SA	D
<input type="checkbox"/>			4d8490114579e	2011-03-19 07:14:43	U	M	11	SK	A	Y		R	K	SU	P		K
<input type="checkbox"/>			4d61750030583	2011-02-20 15:09:48	H	M	20	SK	A	N	Y	R	A		S	AL	C
<input type="checkbox"/>			4d61896d2198c	2011-02-20 16:36:49	H	M	22	SK	A	N	N	R	A		G	GL	B
<input type="checkbox"/>			4d618d4bb5915	2011-02-20 16:53:21	H	M	23	SN	I	N	Y	R	A	S	P	G	S
<input type="checkbox"/>			4d61919a8c0b0	2011-02-20 17:11:55	H	M	21	SK	A	N	Y	F	K		K	AL	K
<input type="checkbox"/>			4d61a0e708754	2011-02-20 18:16:58	H	M	21	SN	A	N	Y	R	A	C	I	G	S

3. Results

3.1 General

Results were taken and recorded at two distinct points; once before the hypotheses were made and again after. Overall, there were a total of 274 people who responded to the injured and uninjured surveys. Figure 9 illustrates that females make up 30% (82 out of 274) of survey takers and males make up 70% (192 out of 274) of survey takers. The demographic base for this group is everyone who took the survey. The large group of male respondents is probably due to the 3:1 ratio of males to females at WPI. Males have double the chance of being represented in the injured or injured survey. Considering that gender should not affect injury mechanisms and their statistics, the analysis proceeded without assigning weights to males and females.

Figure 9: Gender of Respondents



This graph represents the amount of respondents that were male or female.

3.2 Helmet Statistics

As stated in the methodology, it was tested whether or not helmets increase the likelihood of injury by giving people a sense of invulnerability or causing sensory deprivation. All injured respondents were asked if they wore a helmet at the time of injury. The demographic base for this group is the people who took the survey after hypotheses questions were added.

- 46 out of 63 injured people (73%) wore helmets
- 10 out of 14 people with head injuries (71%)wore helmets

Everyone who wore a helmet at the time of their injury was asked:

1. If they thought the helmet made them ski more recklessly

2. If they thought the helmet cause them any sensory deprivation
 - 42 out of 46 people wearing helmets (89%) did not feel that they skied more recklessly with a helmet on
 - 41 out of 46 people wearing helmets (91%) did not believe that the helmet caused them any sensory deprivation

Although only 2 people out of 46 wearing helmets (11%) thought the helmet made them ski more recklessly, it does not mean that this is not the case. Skiers and snowboarders might be more careless subconsciously with a helmet on. They might not perceive the extra safety but might still ski faster than they would were they not wearing a helmet.

Similarly, only 1 person out of 46 people wearing helmets (9%) believed that sensory deprivation was caused. People may not realize how fast they are going with the extra protection on. They also may not be able to hear as well if the helmet covers their ears.

3.3 Wrist Injury Statistics

Snowboarders with wrist injuries were asked how many days they had been snowboarding before they received the injury. This question was used to test the hypotheses that wrist injuries in snowboarders occur within the first three days of snowboarding.

- 7 out of 11 snowboarders with wrist injuries (63.6%) reported that the injury occurred within 3 days of learning how to snowboard

3.4 Knee Statistics

The hypothesis that using the KneeBinding will decrease a skier's chance of injuring their ACL was tested by asking everyone who reported a knee injury if they had been using the KneeBinding. The demographic base for this group is the injured people who took the survey after hypotheses questions were added. Only one skier had been using the KneeBinding, but this person did not know what part of their knee they injured.

- 10 out of 30 reported ski injuries were knee injuries (33%)
 - ACL: 4 out of 10 reported knee injuries (40%)
 - MCL: 2 out of 10 reported knee injuries (20%)
 - Tibial Plateau: 2 out of 10 reported knee injuries (20%)
 - Lateral/Medial Meniscus: 1 out of 10 people (10%)

***1 skier did not know what part of the knee they injured

3.5 Age Statistics

The age of respondents to the surveys has also been evaluated. The demographic base for this group is anyone (injured or uninjured) who responded to the survey.

Table 2: Age Evaluation

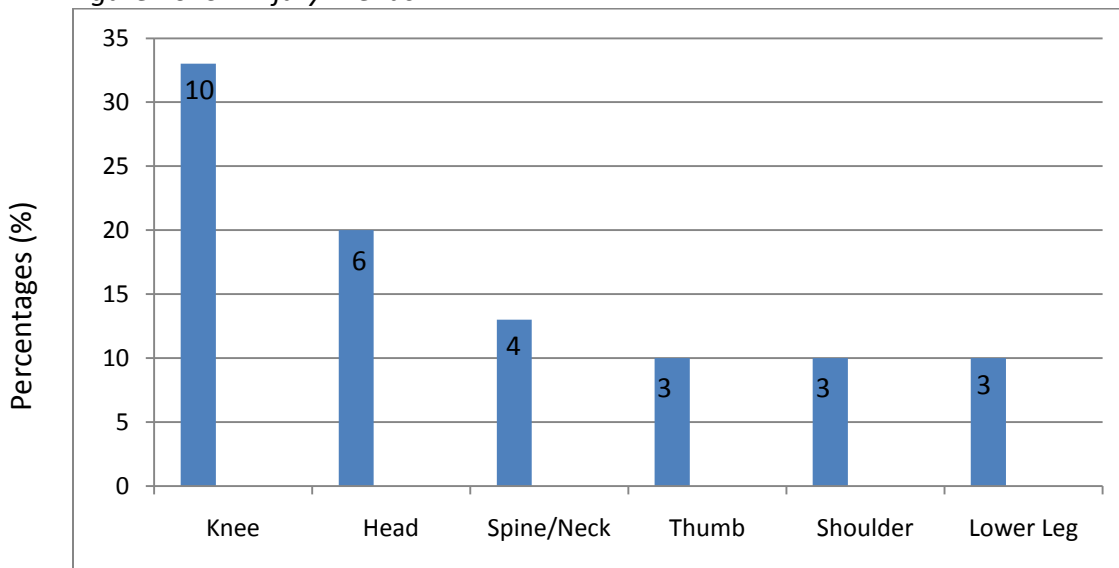
	<20 years	20-25 years	>25 years	Total
Injured Respondents	37.3% 25 people	58.2% 39 people	4.5% 3 people	67 people
Uninjured Respondents	39.1% 81 people	59.4% 123 people	1.5% 3 people	207 people

This table represents the ages of the injured and uninjured respondents.

3.6 Skiing and Snowboarding Injury Trends

Figure 10 shows the injury trends of skiers who responded to our survey. The demographic base for this group is the injured skiers who took the survey after hypotheses questions were added. There are a total of 30 skiers who responded with ski injuries. Each bar gives the percentage of injured respondents according to their specific injury. 96% of reported ski injuries are represented on the graph. Arm injuries account for the other 4% of the reported ski injuries not included on the graph.

Figure 10: Ski Injury Trends



This graph gives the percentage (and number) of skiers that injured a specific body part.

Figure 11 shows the injury trends of snowboarders who responded to our survey. The demographic base for this group is the injured snowboarders who took the survey after hypotheses questions were added. Each bar gives the percentage of injured respondents according to their specific injury. A total of 37 snowboarders responded with snowboard injuries. 95% of the reported snowboard injuries are represented on the graph. Lower leg

injuries account for 3% of the reported snowboard injuries not included on the graph, and arm injuries account for the other 2%.

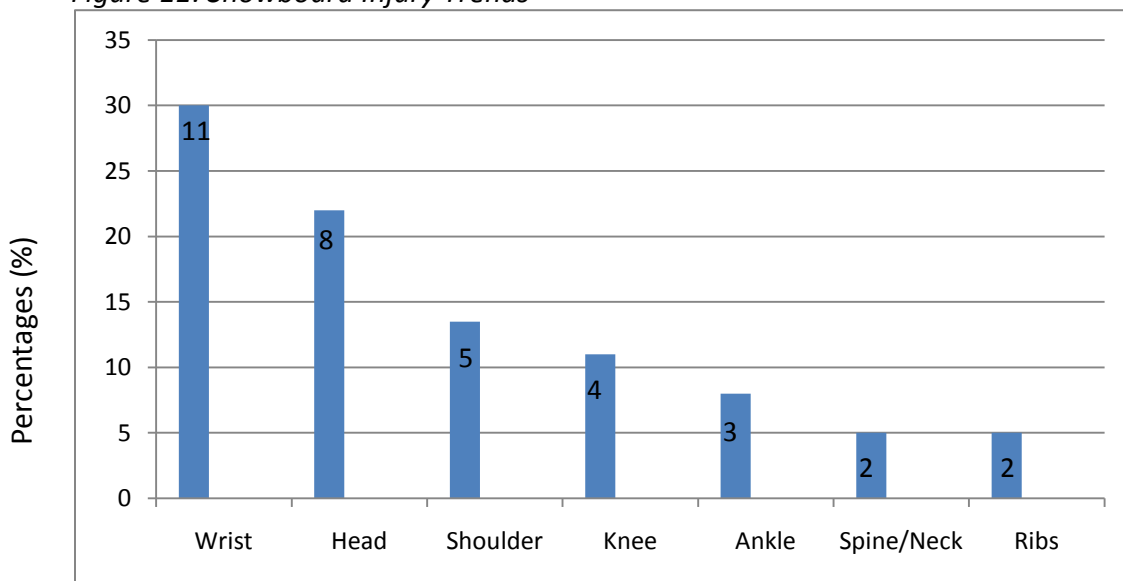
Of the 37 injured snowboarders, 8 had been injured while only one foot was strapped into the binding (21.6%). These results are not shown on the graph but are listed below.

- Head: 3 out of 8 (37.5%)
- Knee: 2 out of 8 (25%)
- Ankle: 2 out of 8 (25%)
- Shoulder: 1 out of 8 (12.5%)

Of the 37 injured snowboarders, 29 had both feet strapped in when the injury occurred (78.4%). These results are not shown on the graph but are listed below.

- Wrist: 11 out of 29 (38%)
- Head: 5 out of 29 (17%)
- Shoulder: 4 out of 29 (13.8%)
- Knee: 2 out of 29 (6.9%)
- Spine/neck: 2 out of 29 (6.9%)
- Ribs: 2 out of 29 (6.9%)
- Ankle: 1 out of 29 (3.5%)
- Lower leg: 1 out of 29 (3.5%)
- Arm: 1 out of 29 (3.5%)

Figure 11: Snowboard Injury Trends



This graph gives the percentage (and number) of snowboarders that injured a specific body part.

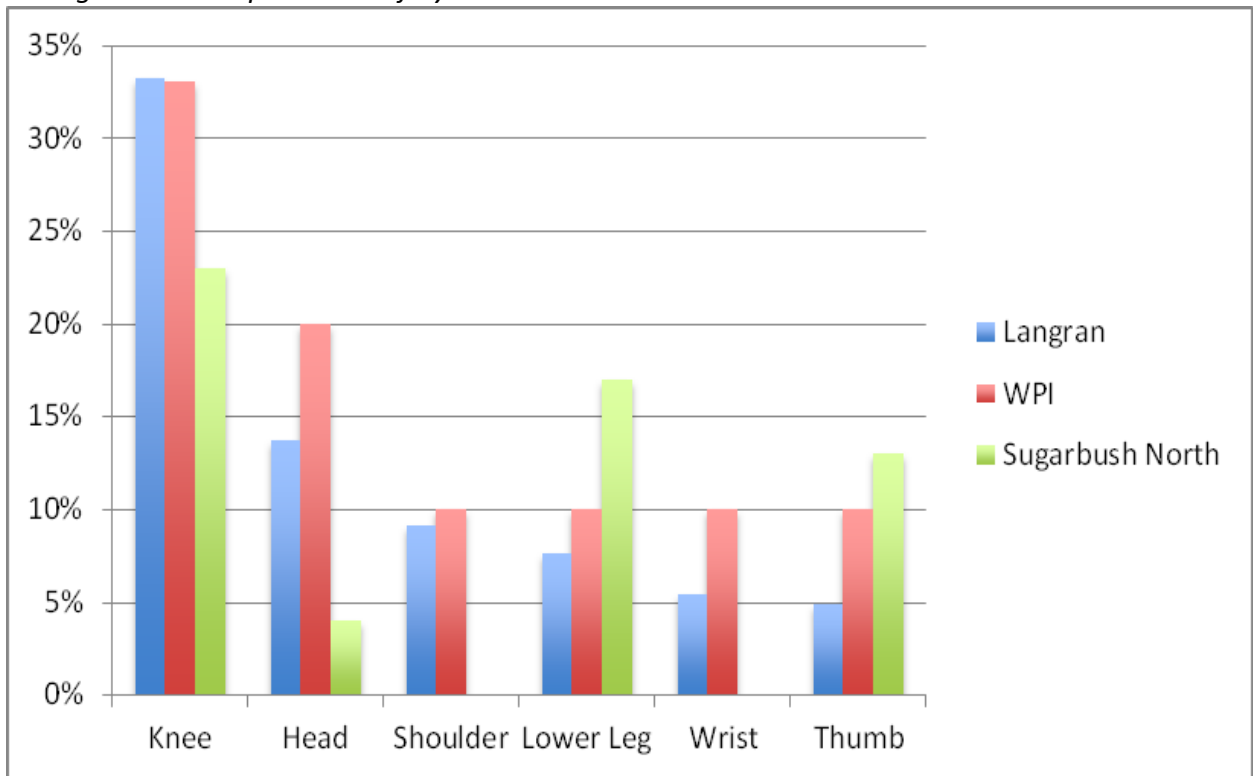
4. Discussion

The primary objective of this project is to reduce ski and snowboard injuries. An online survey has the potential to be as valuable as an epidemiological study in understanding the mechanisms of ski and snowboard injuries. This online survey, however, has the disadvantage of being under-advertised. The obtained results have some uncertainties because they deal with statistics of small numbers. These are addressed when unusual trends are noticed. Nonetheless, results were collected and analyzed based on certain hypotheses. This allows for comparison with statistics in literature, specifically from the Sugarbush Mountain study and Langran's website.

Figure 12 gives the skiing injury trends collected from three different studies. These include Mike Langran's online study, the epidemiological study at Sugarbush North, and our survey. It compares the percentages of skiing injuries that are knee, head, shoulder, lower leg, wrist, and thumb injuries from each study. The data from our survey is from the 2010/11 ski season, the data from Langran's study is from 1999 to the 2005/05 ski season (Langran 2010), and the data from the Sugarbush North study is from 1972 to the 1990/01 ski season (Johnson et al. 1990). Although the compared results are from a wide range of seasons, the similarities in certain injury trends can still be seen. Langran's and our collected percentage of knee injuries are both around 33 %, as well as the percentage of shoulder injuries both being around 10 %. The Sugarbush North study gives 13% for thumb injuries which closely matches our 10% for thumb injuries. It should be noted that there were no statistics given for shoulder or wrist injuries in the Sugarbush North study.

This comparison can also be used to show trends of increasing or decreasing injury types throughout the years the studies have been conducted. The commonality of head injuries is the lowest in the 1980's, increasing into the early 2000's, and the highest from this past ski season. It can also be seen that there has been an increase in knee injuries. At the same time there has been a decrease in lower leg injuries. This might be due to equipment advances.

Figure 12: Compared Ski Injury Trends



This graph compares our ski injury trends for specific body parts with those from the Sugarbush North study and Langran’s online website.

For the hypothesis that helmets increase the likelihood of an injury, injured skiers and snowboarders were asked if they were wearing a helmet. They were also asked if they thought the helmet made them ski or snowboard more recklessly or if it caused any sensory deprivation. This hypothesis was developed after the first round of survey testing because many people who reported head injuries were wearing helmets. In our survey, 73% of injured respondents were wearing helmets. This closely matches Shealy’s recorded 75% of injured skiers wear helmets.

Skiers and snowboarders may not realize it, but when wearing a helmet they are susceptible to feel an exaggerated sense of security, which can increase the amount of risk taking behavior, such as skiing faster or skiing in trees (Shealy 2011). According to our results, the majority (91%) of skiers and snowboarders wearing helmets did not think wearing a helmet increased their recklessness. Similarly, 89% of respondents wearing helmets did not think it caused any sensory deprivation.

This is where an online survey is not as effective. In order to measure how a helmet affects someone’s skiing style data must be gathered on site with a velocity recorder. An average

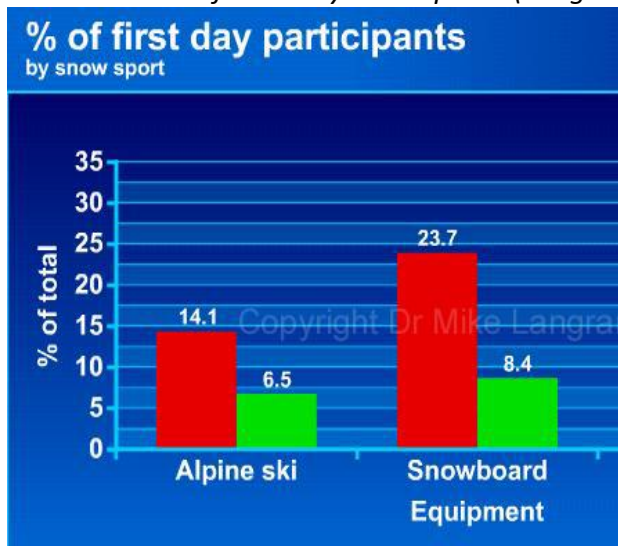
speed can be found for a population of people with helmets, and people without them. Then the results can guarantee more trustworthy results to this matter.

Possible ways to reduce head injuries could be to design a helmet that reduces sensory deprivation. Another is to attach a label on helmets that warn the skier or snowboarder of being too reckless. Posting this type of information on our website can also provide viewers with the same knowledge.

For the hypothesis that snowboarders are more likely to injure their wrist within the first three days of snowboarding, they were asked how many days they had been snowboarding before the injury occurred. In another study done by Mike Langran, 43% of snowboarders were injured when they were snowboarding for the very first time (see Figure 13). Only 12% of the uninjured control population was snowboarding for the first time. It is also noted that experienced boarders are less likely to injure their wrist by a factor of 2.5(Langran 2010). Our survey shows a slightly larger proportion of 63.6% of snowboarders injuring their wrist within the first three days of snowboarding.

Possible ways to reduce this type of injury would be for wrist guards to be recommended at rental shops for beginner snowboarders. Also, our website could further urge people to wear wrist guards if they are thinking about learning how to snowboard.

Figure 13: Percent of First Day Participants (Langran 2010)



This graph is from Langran’s website. It gives the percent of cases and controls for skiers and snowboarders on their first day.

For the hypothesis that using the KneeBinding will decrease the chance of an ACL injury, all skiers who injured their ACL were asked if they used the KneeBinding. “The KneeBinding offers a unique system that allows the binding to release laterally (side to side) at the heel, and it is

this specific feature which is believed to offer the ACL protection in the Phantom foot fall” (Langran 2010).

From our results, no one who injured their ACL was using the KneeBinding. It is a newly invented binding, so it is still uncommon among skiers. Further testing or more results are needed to statistically test the KneeBinding hypothesis. It cannot be concluded that using this binding will decrease the risk of an ACL injury.

Possible ways to reduce ACL injuries in the future could be to recommend the KneeBinding in rental and ski shops, and to advertise it to those who have previously injured their ACL and to keep them from doing so again.

Skiers who injured their thumbs were asked how they were wearing their pole straps. In the survey, they are shown a picture of the right way to wear it so that it could be determined if the pole strap caused their thumb injury. This was to test the hypothesis that wearing pole straps incorrectly may cause skier’s thumb.

In our results, only three people responded with thumb injuries. One of these people was wearing their pole straps incorrectly. This group is under-represented within the injured skier population from our demographics. With this few amount of respondents, not much can be concluded about the frequency of the skier’s thumb injury mechanism.

5. Conclusion

When the main objective of this project is taken into consideration, and whether or not it was accomplished, attention has to be given to the sub-objectives. By concluding whether those were satisfied, the big picture will be clear.

- The website was designed to improve understating of the causes and mechanisms of snow-sport injuries, and to test the effectiveness of a web-based survey.
- This aim was achieved as the website got hundreds of visitors, who surfed through it and participated in the surveys.
- The results verified our expectations as far as trends of injuries and the analysis of mechanisms are concerned.
- Information gathered was shared to the public as intentioned, and is available to any individual.
- Therefore our two sub-objectives were achieved, but it is not possible to deduce whether or not ski and snowboarding injuries were reduced.
- The effectiveness of a web-based survey was demonstrated through the acquisition of information from people in various locations.
- Thus, even though more evidence might be needed to claim the diminishing of injuries, there is still potential for the website to grow further.

Future ideas

This will be a continuing project, and will be handed down to future groups that will pursue the project in their own manner. There were some ideas for the project that were not able to be achieved in a timely manner. Note these are just recommendations for the future group, and not obligatory.

- Using a code for solicited groups to make tracking injury trends to specific groups, for example WPI's ski team, easier and determining demographics of respondents easier.
- Have each question on the survey contain a link, which opens to the rationale of the question. This could lead to exploring the hypothesis of whether or not people will be more apt to answer a question if they know the reason it is being asked.

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Appendix A


Figure 2: HurtSkiing.com Old Homepage

Let's not get HurtSkiing.Com

Welcome! Our objective is to support research that makes skiing more safe and fun!



Welcome!	Welcome
The Survey	Our mission
Results	HurtSkiing.com is dedicated to performing research on snow sport injuries and providing a place for you, the injured, to connect. Feel free to explore our forum.
Forum	Click here to take the survey
Videos	Thank you for visiting HurtSkiing.com!
Papers	

Advertising:
Ads by Google 
[Brain Injury Law Firm](#)
Contact an Injury Lawyer near you about your Brain Injury. It is Free

This is a screen shot of the previous homepage before it was edited.

Figure 3: Survey Tree

This is a flow diagram of the survey questions.

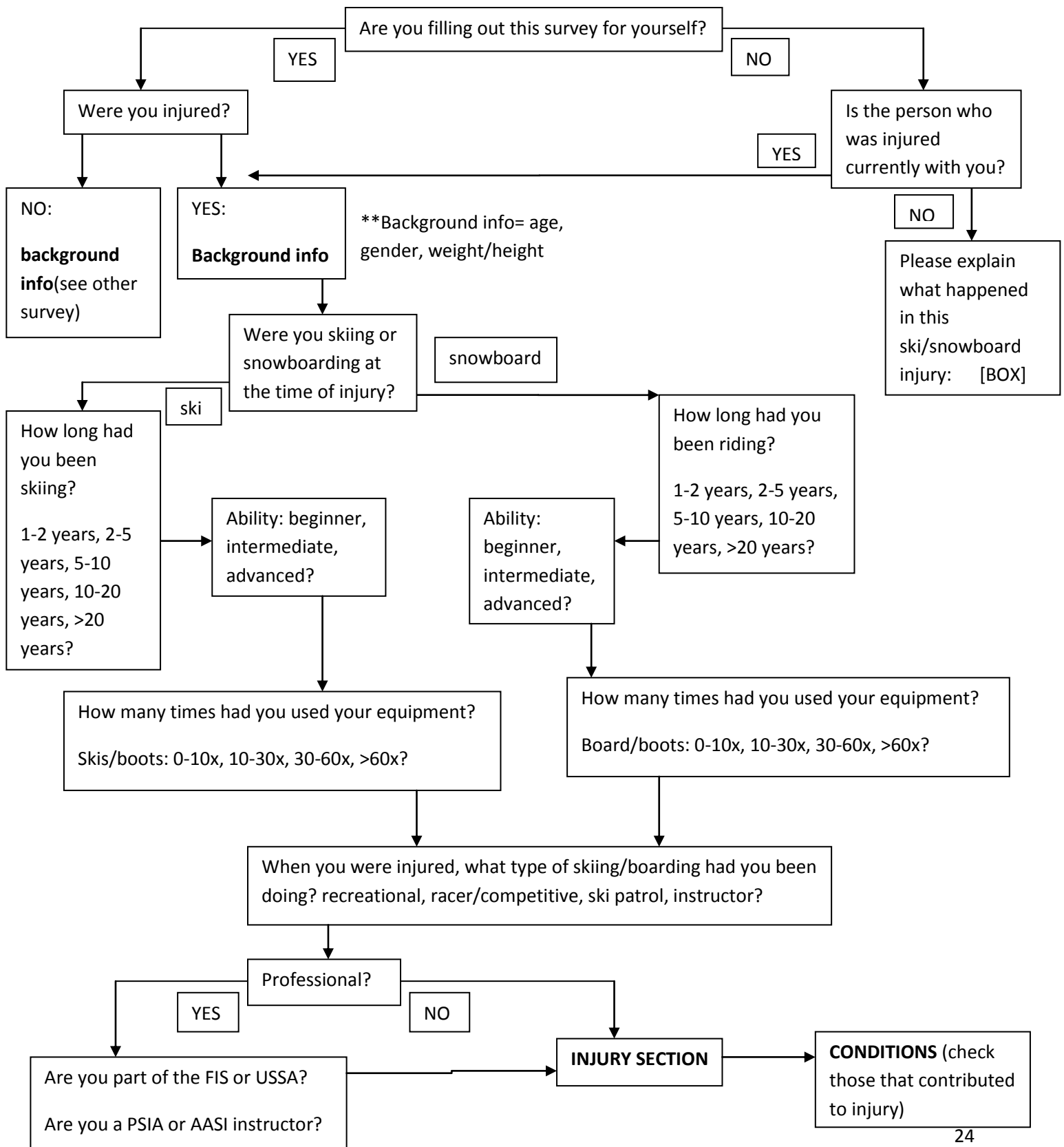


Figure 4: Injured Person Survey Power Point

The power point shows the questions and the pathway of the survey for injured respondents.

<p style="text-align: right;">1</p> <p style="text-align: center;">Injured Persons Survey</p>	<p style="text-align: right;">2</p> <p style="text-align: center;">Background Information</p> <ul style="list-style-type: none"> • Male or Female? • Age? • Were you skiing or snowboarding at the time of injury? <ul style="list-style-type: none"> – Ski- go to page 3 – Snowboard- go to page 4
<p style="text-align: right;">3</p> <p style="text-align: center;">Skiing</p> <ul style="list-style-type: none"> • Ability? beginner/intermediate/advanced • Classify yourself: Type 1, Type 2, Type 3 skier **(hyperlink) See categories** • Do you think your equipment was at fault for your injury? Y/N • Is your equipment rented? Y/N <ul style="list-style-type: none"> – If no, how often was your equipment serviced? <ul style="list-style-type: none"> • Never, every few years, once a year, more than once a year – How was your equipment transported? <ul style="list-style-type: none"> • Top of car, trunk, ski bag – Do you feel that your equipment was in good shape? Y/N • When you were injured what type of skiing had you been doing? <ul style="list-style-type: none"> – Recreational, racer/freestyle, ski patrol, instructor <p>Go to page 5</p>	<p style="text-align: right;">4</p> <p style="text-align: center;">Snowboarding</p> <ul style="list-style-type: none"> • Ability? Beginner, intermediate, advanced • Classify yourself: Type 1, Type 2, Type 3 boarder **(hyperlink) See categories** • Do you think your equipment was at fault for your injury? Y/N • Is your equipment rented? Y/N <ul style="list-style-type: none"> – If no, how often was your equipment serviced? <ul style="list-style-type: none"> • Never, every few years, once a year, more than once a year – How was your equipment transported? <ul style="list-style-type: none"> • Top of car, trunk, board bag – Do you feel that your equipment was in good shape? Y/N • When you were injured what type of boarding had you been doing? <ul style="list-style-type: none"> – Recreational, racer/freestyle, ski patrol, instructor <p>Go to page 5</p>
<p style="text-align: right;">5</p> <p style="text-align: center;">Professional?</p> <ul style="list-style-type: none"> • Yes • No <p style="text-align: right;">Go to page 6</p> <ul style="list-style-type: none"> • Do you compete in FIS or USSA sanction competitions? Y/N • Are you a PSIA or AASI instructor? Y/N • Are you a ski patroller? Y/N <ul style="list-style-type: none"> – If yes, are you paid or a volunteer? Paid/volunteer <p>Go to page 6</p>	<p style="text-align: right;">6</p> <p style="text-align: center;">Conditions (at time of injury)</p> <ul style="list-style-type: none"> <input type="checkbox"/> Time of day- morning, midday, twilight, night <input type="checkbox"/> Fatigue level- fresh, starting to tire, tired, exhausted <input type="checkbox"/> How long had you been out?- first runs, middle, last runs <input type="checkbox"/> Weather- sunny/bright, cloudy/fat, snowing, raining, foggy, snow guns <input type="checkbox"/> Did you stretch/warm up before you started skiing? <input type="checkbox"/> Snow conditions- packed granular, slick/race course, icy, powder, slush <input type="checkbox"/> What type of trail was it? General alpine, park, moguls, cross country trail, slalom race course, GS race course, SG and downhill, glades, backbow, loading/unloading, other <input type="checkbox"/> What was the trail difficulty? Green circle, blue square, black diamond, double black diamond, I don't know <input type="checkbox"/> What was your speed? Slow, medium, fast, very fast/tuck <p>**Check the conditions that attributed to your injury in the box on the left side of the question**</p> <p>Skiers: Go to page 7 Boarders: Go to page 8</p>

7

Skiing Injuries

• What part of your body did you injure?

- Knee- (33.4% of skiing injuries) *Go to page 9
 - ACL, MCL, LCL, PCL, lateral/medial meniscus-tear
- Head- (13.5% of skiing injuries) *Go to page 10
- Shoulder- (9.5% of skiing injuries) *Go to page 11
- Lower leg- (8.6% of skiing injuries)] *Go to page 12
- Ankle- (6.1% of skiing injuries)]
- Thumb- (4.4% of skiing injuries)] Go to page 13
- Spine/neck *Go to page 14
- Arm
- Elbow
- Wrist *Go to page 15
- Ribs
- Back
- Hip
- Thigh
- Femur
- Foot *Go to page 12

8

Snowboarding Injuries

• What part of your body did you injure?

- Wrist- (24.9% of snowboarding injuries) *Go to page 16
- Head- (14.3% of snowboarding injuries) *Go to page 17
- Shoulder- (13.1% of snowboarding injuries) *Go to page 18
- Knee- (11.8% of snowboarding injuries)] *Go to page 19
- Ankle- (5.9% of snowboarding injuries)]
- Back- (4.6% of snowboarding injuries) *Go to page 20
- Spine/neck *Go to page 20
- Arm
- Elbow
- Ribs *Go to page 21
- Hip
- Thigh
- Femur
- Lower leg *Go to page 19
- Foot

9

Knee Mechanisms

• What was the type of injury?
 – laceration, fracture, contusion, dislocation, tear

• Grade of injury? Grade 1, 2, or 3
 hyperlink: See Knee injury Grades

• ACL
 – Did you attempt to recover from a fall or off balance position while still moving? Y/N
 – Did you attempt to sit down after losing control? Y/N
 – Did you land on the tails of your skis after hitting a jump? Y/N
 – Did you catch an edge? Y/N
 – Did your ski binding inadvertently release? Y/N
 * Ypg. 23
 – Were you involved in a collision? Y/N
 * Ypg. 24

[BOX]

• MCL
 – Where you in the snow flow position? Y/N
 * If yes, did you detect wind causing excessive force on your knee? Y/N
 – Did you catch an edge, throwing your ski and leg outward? Y/N
 – Did your ski binding inadvertently release? Y/N
 * Ypg. 23
 – Were you involved in a collision? Y/N
 * Ypg. 24

[BOX]

• Tibial Plateau
 – After hitting a jump did you land badly on a flat surface? Y/N
 – Did you catch an edge? Y/N
 – Did your ski binding inadvertently release? Y/N
 * Ypg. 23
 – Were you involved in a collision? Y/N
 * Ypg. 24

[BOX]

• Lateral/Medial Meniscus
 – Did you catch an edge? Y/N
 – Did your ski binding inadvertently release? Y/N
 * Ypg. 23
 – Were you involved in a collision? Y/N
 * Ypg. 24

[BOX]

10

Head Mechanisms

- Type of injury:
 - concussion, fracture, laceration, contusion
- Concussion grade? 1/2/3
 hyperlink: see concussion grades
- Were you wearing a helmet? Y/N
- Did you catch an edge? Y/N
- Did your ski binding inadvertently release? Y/N
 – Y –go to page 23
 – N – go to page 22
- Were you involved in a collision? Y/N
 – Y –go to page 24
 – N –go to page 22

11

Shoulder Mechanisms

- Type of injury:
 - sprain, dislocation, fracture, tear, contusion
- Did you catch an edge? Y/N
- Did your ski binding inadvertently release? Y/N
 – Y –go to page 23
 – N – go to page 22
- Were you involved in a collision? Y/N
 – Y –go to page 24
 – N –go to page 22
- Did you fall directly onto your shoulder? Y/N
- Did you fall onto an outstretched hand? Y/N

12

Lower leg/Ankle/Foot Mechanisms

- Type of injury:
 - sprain, laceration, fracture, tear, contusion
- Did you catch an edge? Y/N
- Did your ski binding inadvertently release? Y/N
 – Y –go to page 23
 – N – go to page 22
- Were you involved in a collision? Y/N
 – Y –go to page 24
 – N –go to page 22
- Did a flat landing off a jump contribute to your injury? Y/N

<p style="text-align: right;">13</p> <h2 style="text-align: center;">Thumb Mechanisms</h2> <ul style="list-style-type: none"> • Type of injury: <ul style="list-style-type: none"> – sprain, dislocation, fracture, tear • Did you catch an edge? Y/N • Did your ski binding inadvertently release? Y/N <ul style="list-style-type: none"> – Y –go to page 23 – N –go to page 22 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 22 • Were you wearing pole straps? Y/N <ul style="list-style-type: none"> – Y –go to page 25 – N –go to page 22 	<p style="text-align: right;">14</p> <h2 style="text-align: center;">Spine/Neck Mechanisms</h2> <ul style="list-style-type: none"> • Type of injury <ul style="list-style-type: none"> – Fracture, whiplash, compression • Which vertebra was affected? <ul style="list-style-type: none"> – Cervical (neck), thoracic, lumbar, sacral, coccygeal • Did you catch an edge? Y/N • Did your ski binding inadvertently release? Y/N <ul style="list-style-type: none"> – Y –go to page 23 – N –go to page 22 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 22 • Did a flat landing off a jump contribute to your injury? Y/N
<p style="text-align: right;">15</p> <h2 style="text-align: center;">Arm/Elbow/Wrist/Ribs/Back/Hip/ Thigh/Femur Mechanisms</h2> <ul style="list-style-type: none"> • Type of injury: <ul style="list-style-type: none"> – fracture, laceration, contusion, dislocation, sprain, tear • Did you catch an edge? Y/N • Did your ski binding inadvertently release? Y/N <ul style="list-style-type: none"> – Y –go to page 23 – N –go to page 22 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 22 	<p style="text-align: right;">16</p> <h2 style="text-align: center;">Wrist Mechanisms</h2> <ul style="list-style-type: none"> • Type of injury: <ul style="list-style-type: none"> – sprain, dislocation, laceration, fracture, tear • Did you catch an edge? Y/N • Did you have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 26 – N –go to page 22 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 22 • Did you attempt to catch your fall with your wrist? Y/N
<p style="text-align: right;">17</p> <h2 style="text-align: center;">Head Mechanisms</h2> <ul style="list-style-type: none"> • Type of injury: <ul style="list-style-type: none"> – concussion, fracture, laceration, contusion • Concussion grade? 1/2/3 **hyperlink: see concussion grades** • Were you wearing a helmet? Y/N • Did you catch an edge? Y/N • Did you have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 26 – N –go to page 22 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 22 	<p style="text-align: right;">18</p> <h2 style="text-align: center;">Shoulder Mechanisms</h2> <ul style="list-style-type: none"> • Type of injury: <ul style="list-style-type: none"> – sprain, dislocation, fracture, tear, contusion • Did you catch an edge? Y/N • Did you have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 26 – N –go to page 22 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 22 • Did you fall directly onto your shoulder? Y/N • Did you fall onto an outstretched hand? Y/N

<p style="text-align: center;">Knee/Ankle/Lower leg/Foot Mechanisms 19</p> <ul style="list-style-type: none"> • Type of injury: <ul style="list-style-type: none"> – sprain, laceration, fracture, tear, contusion • Did you catch an edge? Y/N • Did you have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 26 – N –go to page 22 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 22 • Did a flat landing off a jump contribute to your injury? Y/N 	<p style="text-align: center;">Back and Spine/Neck Mechanisms 20</p> <ul style="list-style-type: none"> • Type of injury <ul style="list-style-type: none"> – Fracture, whiplash, compression • Which vertebra was affected? <ul style="list-style-type: none"> – Cervical (neck), thoracic, lumbar, sacral, coccygeal • Did you catch an edge? Y/N • Did you have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 26 – N –go to page 22 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 22 • Did a flat landing off a jump contribute to your injury? Y/N
<p style="text-align: center;">Arm/Elbow/Ribs/Hip/Thigh/Femur Mechanisms 21</p> <ul style="list-style-type: none"> • Type of injury <ul style="list-style-type: none"> – fracture, laceration, contusion, dislocation, sprain, tear • Did you catch an edge? Y/N • Did you have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 26 – N –go to page 22 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 22 	<p style="text-align: center;">**End of each page** 22</p> <ul style="list-style-type: none"> • If you feel necessary, please provide a description of events leading to your injury. [BOX] • Optional: Please provide your email address for possible further investigation on the mechanisms of ski and snowboard injuries. [BOX] • Thank you for completing this survey!
<p style="text-align: center;">Inadvertent Release 23</p> <ul style="list-style-type: none"> • What is your weight/height [BOX] • What was your ski binding set at? [BOX] • What is the make/model [BOX] 	<p style="text-align: center;">Collision 24</p> <ul style="list-style-type: none"> • Were you moving or standing? Moving/standing <ul style="list-style-type: none"> – If standing, where were you when you were hit? Edge of trail/middle of trail/other • Did the trail design contribute to the collision? Y/N <ul style="list-style-type: none"> – (optional) If yes, please upload a trail map of the ski resort and inform us where the collision occurred.

Pole Straps 25 <ul style="list-style-type: none"> • Were the straps running over the top of your hand or underneath it? Top/bottom/other 	One foot strapped in 26 <ul style="list-style-type: none"> • If yes, did your injury occur when you were loading or unloading, or on flats? Loading/unloading/flats
--	---

Figure 5: Uninjured Person Survey Power Point

The power point shows the questions and the pathway of the survey for uninjured respondents.

1 Uninjured Persons Survey	Background 2 <ul style="list-style-type: none"> • Male or Female? • What is your age? • Do you Ski or Snowboard? <ul style="list-style-type: none"> – Ski- go to page 3 – Snowboard- go to page 4
Skiing 3 <ul style="list-style-type: none"> • Ability? Beginner, intermediate, advanced • Do you rent your equipment? Y/N <ul style="list-style-type: none"> – If no, how often is your equipment serviced? <ul style="list-style-type: none"> • Never, every few years, once a year, more than once a year – How is your equipment transported? <ul style="list-style-type: none"> • Top of car, trunk, ski bag – Do you feel that your equipment is in good shape? Y/N • Classify yourself: Type 1, Type 2 , Type 3 skier **(hyperlink) See categories** <p>Go to page 5</p>	Snowboarding 4 <ul style="list-style-type: none"> • Ability? Beginner, intermediate, advanced • Do you rent your equipment? Y/N <ul style="list-style-type: none"> – If no, how often is your equipment serviced? <ul style="list-style-type: none"> • Never, every few years, once a year, more than once a year – How is your equipment transported? <ul style="list-style-type: none"> • Top of car, trunk, ski bag – Do you feel that your equipment is in good shape? Y/N • Classify yourself: Type 1, Type 2 , Type 3 boarder **(hyperlink) See categories** <p>Go to page 5</p>

5

Professional?

- Yes
- No

- Do you race in FIS or USSA sanction races? Y/N
- Are you a PSIA or AASI instructor? Y/N
- Are you a ski patroller? Y/N
 - If yes, are you paid or a volunteer? Paid/volunteer

Thanks for completing our survey!

Figure 6: People Unable to Respond for Themselves Power Point

The power point shows the questions and the pathway of the survey for injured respondents that are unable to respond for themselves.

<p>1</p> <h2 style="font-size: 1.2em;">People unable to respond for themselves</h2>	<p>2</p> <h2 style="font-size: 1.2em;">Background Information</h2> <ul style="list-style-type: none"> • Male or Female? • What was their age? • Were they skiing or snowboarding at the time of injury? <ul style="list-style-type: none"> – Ski- go to page 3 – Snowboard- go to page 4
<p>3</p> <h2 style="font-size: 1.2em;">Skiing</h2> <ul style="list-style-type: none"> • Ability? beginner/intermediate/advanced • Was their equipment rented? Y/N <ul style="list-style-type: none"> – If no, was their equipment in good shape? Y/N/I don't know • When they were injured, what type of skiing had they been doing? <ul style="list-style-type: none"> – Recreational, racer/freestyle, ski patrol, instructor <p>Go to page 5</p>	<p>4</p> <h2 style="font-size: 1.2em;">Snowboarding</h2> <ul style="list-style-type: none"> • Ability? beginner/intermediate/advanced • Was their equipment rented? Y/N <ul style="list-style-type: none"> – If no, was their equipment in good shape? Y/N/I don't know • When they were injured, what type of snowboarding had they been doing? <ul style="list-style-type: none"> – Recreational, racer/freestyle, ski patrol, instructor <p>Go to page 5</p>

Conditions (at time of injury)

5

- Time of day- morning, midday, twilight, night
- How long had they been out?- first runs, middle, last runs
- Weather- sunny/bright, cloudy/flat, snowing, raining, foggy, snow guns
- Snow conditions- packed granular, slick/race course, icy, powder, slush
- What type of trail was it? General alpine, park, moguls, cross country trail, slalom race course, GS race course, SG and downhill, glades, back bowl, loading/unloading, other
- What was the trail difficulty? Green circle, blue square, black diamond, double black diamond, I don't know

****Check the conditions that attributed to the person's injury in the box on the left side of the question****

Skiers: Go to page 6 Boarders: Go to page 7

Skiing Injuries

6

- What part of their body did they injure?
 - Knee- (33.4% of skiing injuries) *Go to page 8
 - ACL, MCL, LCL, PCL, lateral/medial meniscus- tear
 - Head- (13.5% of skiing injuries) *Go to page 9
 - Shoulder- (9.5% of skiing injuries) *Go to page 10
 - Lower leg- (8.6% of skiing injuries) *Go to page 11
 - Ankle- (6.1% of skiing injuries)] *Go to page 11
 - Thumb- (4.4% of skiing injuries)] Go to page 12
 - Spine/neck/back *Go to page 13
 - Arm
 - Elbow
 - Wrist *Go to page 14
 - Ribs
 - Hip
 - Thigh
 - Femur
 - Foot *Go to page 11

Snowboarding Injuries

7

- What part of their body did they injure?
 - Wrist- (24.9% of snowboarding injuries) *Go to page 15
 - Head- (14.3% of snowboarding injuries) *Go to page 16
 - Shoulder- (13.1% of snowboarding injuries) *Go to page 17
 - Knee- (11.8% of snowboarding injuries) *Go to page 18
 - Ankle- (5.9% of snowboarding injuries)] *Go to page 18
 - Back- (4.6% of snowboarding injuries) *Go to page 19
 - Spine/neck *Go to page 19
 - Arm
 - Elbow
 - Ribs *Go to page 20
 - Hip
 - Thigh
 - Femur
 - Lower leg *Go to page 18
 - Foot

Knee Mechanisms

8

- What was the type of injury?
 - laceration, fracture, contusion, dislocation, tear
 - Grade of injury? Grade 1, 2, or 3 *Go to page 11
 - **hyperlink: See Knee injury Grades**
- ACL
 - Did they attempt to recover from a fall or off balance position while still moving? Y/N
 - Did they attempt to sit down after losing control? Y/N
 - Did they land on the tails of their skis after hitting a jump? Y/N
 - Did they catch an edge? Y/N
 - Did their ski binding inadvertently release? Y/N * Ypg.22
 - Were they involved in a collision? Y/N * Ypg.23
- MCL
 - Were they in the snow flow position? Y/N
 - If yes, did their skates widen causing excessive flex on their knee? Y/N
 - Did they catch an edge, throwing their ski and leg outward? Y/N
 - Did their ski binding inadvertently release? Y/N * Ypg.22
 - Were they involved in a collision? Y/N * Ypg.23
- Tibial Plateau
 - After hitting a jump did they land badly on a flat surface? Y/N
 - Did they catch an edge? Y/N
 - Did their ski binding inadvertently release? Y/N * Ypg.22
 - Were they involved in a collision? Y/N * Ypg.23
- Lateral/Medial Meniscus
 - Did they catch an edge at high speeds? Y/N
 - Did they catch an edge? Y/N
 - Did their ski binding inadvertently release? Y/N * Ypg.22
 - Were they involved in a collision? Y/N * Ypg.23

Head Mechanisms

9

- Was this injury fatal? Y/N
 - If no, type of injury:
 - * concussion, fracture, laceration, contusion
 - Concussion grade? 1/2/3
 - **hyperlink: see concussion grades**
- Were they wearing a helmet? Y/N
- Did they catch an edge? Y/N
- Did their ski binding inadvertently release? Y/N
 - Y -go to page 22
 - N - go to page 21
- Were they involved in a collision? Y/N
 - Y -go to page 23
 - N -go to page 21

Shoulder Mechanisms

10

- Type of injury:
 - sprain, dislocation, fracture, tear, contusion
- Did they catch an edge? Y/N
- Did their ski binding inadvertently release? Y/N
 - Y -go to page 22
 - N - go to page 21
- Were they involved in a collision? Y/N
 - Y -go to page 23
 - N -go to page 21
- Did they fall directly onto your shoulder? Y/N
- Did they fall onto an outstretched hand? Y/N

Lower leg/Ankle/Foot Mechanisms

11

- Type of injury:
 - sprain, laceration, fracture, tear, contusion
- Did they catch an edge? Y/N
- Did their ski binding inadvertently release? Y/N
 - Y –go to page 22
 - N – go to page 21
- Were they involved in a collision? Y/N
 - Y –go to page 23
 - N –go to page 21
- Did a flat landing off a jump contribute to their injury? Y/N

Thumb Mechanisms

12

- Type of injury:
 - sprain, dislocation, fracture, tear
- Did they catch an edge? Y/N
- Did their ski binding inadvertently release? Y/N
 - Y –go to page 22
 - N – go to page 21
- Were they involved in a collision? Y/N
 - Y –go to page 23
 - N –go to page 21
- Were they wearing pole straps? Y/N
 - Y –go to page 21
 - N –go to page 21

Spine/Back/Neck Mechanisms

13

- Was this injury fatal? Y/N
 - If no, type of injury
 - Fracture, whiplash, compression
 - Which vertebra was affected?
 - Cervical (neck), thoracic, lumbar, sacral, coccygeal
- Did they catch an edge? Y/N
- Did their ski binding inadvertently release? Y/N
 - Y –go to page 22
 - N – go to page 21
- Were they involved in a collision? Y/N
 - Y –go to page 23
 - N –go to page 21
- Did a flat landing off a jump contribute to their injury? Y/N

Arm/Elbow/Wrist/Ribs/Hip/Thigh/Femur Mechanisms

14

- Type of injury:
 - fracture, laceration, contusion, dislocation, sprain, tear
- Did they catch an edge? Y/N
- Did their ski binding inadvertently release? Y/N
 - Y –go to page 22
 - N – go to page 21
- Were they involved in a collision? Y/N
 - Y –go to page 23
 - N –go to page 21

Wrist Mechanisms

15

- Type of injury:
 - sprain, dislocation, laceration, fracture, tear
- Did they catch an edge? Y/N
- Did they have one foot strapped in? Y/N
 - Y –go to page 24
 - N –go to page 21
- Were they involved in a collision? Y/N
 - Y –go to page 23
 - N –go to page 21
- Did they attempt to catch their fall with their wrist? Y/N

Head Mechanisms

16

- Was this injury fatal? Y/N
 - If no, type of injury:
 - concussion, fracture, laceration, contusion
 - Concussion grade? 1/2/3
 - **hyperlink: see concussion grades**
- Were they wearing a helmet? Y/N
- Did they catch an edge? Y/N
- Did they have one foot strapped in? Y/N
 - Y –go to page 24
 - N –go to page 21
- Were they involved in a collision? Y/N
 - Y –go to page 23
 - N –go to page 21

<p style="text-align: center;">Shoulder Mechanisms 17</p> <ul style="list-style-type: none"> • Type of injury: <ul style="list-style-type: none"> – sprain, dislocation, fracture, tear, contusion • Did you catch an edge? Y/N • Did you have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 21 • Were you involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 23 – N –go to page 21 • Did you fall directly onto your shoulder? Y/N • Did you fall onto an outstretched hand? Y/N 	<p style="text-align: center;">Knee/Ankle/Lower leg/Foot Mechanisms 18</p> <ul style="list-style-type: none"> • Type of injury: <ul style="list-style-type: none"> – sprain, laceration, fracture, tear, contusion • Did they catch an edge? Y/N • Did they have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 21 • Were they involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 23 – N –go to page 21 • Did a flat landing off a jump contribute to their injury? Y/N
<p style="text-align: center;">Back and Spine/Neck Mechanisms 19</p> <ul style="list-style-type: none"> • Was this injury fatal? Y/N <ul style="list-style-type: none"> – If no, type of injury <ul style="list-style-type: none"> • Fracture, whiplash, compression – Which vertebra was affected? <ul style="list-style-type: none"> • Cervical (neck), thoracic, lumbar, sacral, coccygeal • Did they catch an edge? Y/N • Did they have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 21 • Were they involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 23 – N –go to page 21 • Did a flat landing off a jump contribute to their injury? Y/N 	<p style="text-align: center;">Arm/Elbow/Ribs/Hip/Thigh/Femur Mechanisms 20</p> <ul style="list-style-type: none"> • Type of injury <ul style="list-style-type: none"> – fracture, laceration, contusion, dislocation, sprain, tear • Did they catch an edge? Y/N • Did they have one foot strapped in? Y/N <ul style="list-style-type: none"> – Y –go to page 24 – N –go to page 21 • Were they involved in a collision? Y/N <ul style="list-style-type: none"> – Y –go to page 23 – N –go to page 21
<p style="text-align: center;">**End of each page** 21</p> <ul style="list-style-type: none"> • If you feel necessary, please provide a description of events leading to their injury. [BOX] • Optional: Please provide your email address for possible further investigation on the mechanisms of ski and snowboard injuries. [BOX] • Thank you for completing this survey! 	<p style="text-align: center;">Inadvertent Release 22</p> <ul style="list-style-type: none"> • What is their weight/height [BOX] • What was their ski binding set at? [BOX] • What is the make/model? [BOX]

Collision

23

- Were they moving or standing?
Moving/standing
 - If standing, where were they when they were hit?
Edge of trail/middle of trail/other
- Did the trail design contribute to the collision?
Y/N
 - (optional) If yes, please upload a trail map of the ski resort and inform us where the collision occurred.

One foot strapped in

24

- If yes, did their injury occur when they were loading or unloading, or on flats? Loading/unloading/flats

Figure 7: Pole Strap Worn Correctly



This is a picture of the right way to wear a pole strap.

Appendix B: Programming Files

4 main programming languages where used:

- 1) HTML (HyperText Markup Language)
- 2) PHP (PHP Hypertext Preprocessor)
- 3) CSS (Cascading Style Sheets)
- 4) Javascript

2 main types of files were made and modified:

- 1) CSS files
- 2) PHP files

Interface design:

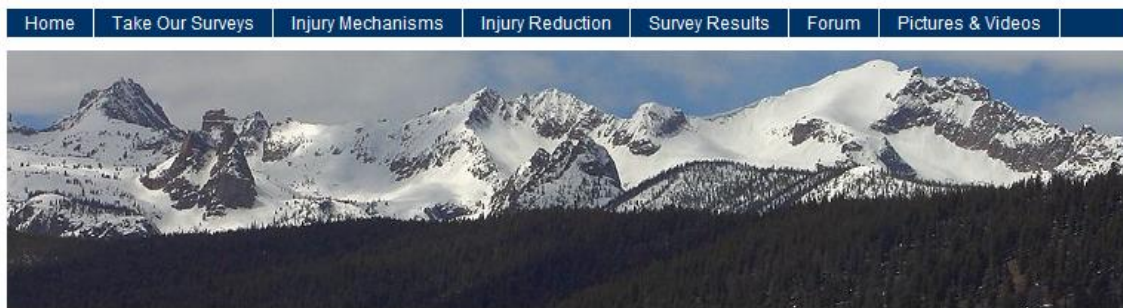
A website layout had to be defined and made. This was programmed in CSS and is located in the file “default.css”. This file was not modified. Proper credits are given to Andreas Viklund (<http://andreasviklund.com>). The file is free to be used for any purpose as long as credits are given for the original design work.

Header of website:

Let's not get
HurtSkiing.Com

Welcome! Our objective is to support research that makes skiing more safe and fun

Also includes the main menu and a slideshow of pictures



File name: "full header.php"

The 7 menu options and what file they refer to:

- 1) Home → "index.php"
- 2) Take Our Surveys → "survey menu.php"
- 3) Injury Mechanisms → "sectioninjurymechanisms.php"
- 4) Injury Reduction → "injury reduction.php"
- 5) Survey Results → "survey results.php"
- 6) Forum → "/forum/view forum.php"
- 7) Pictures & Videos → "video.php"

Footer of website:

Copyright © MMX Gregory Barrett & John Paul Syriopoulos dot com. CSS Design by Andreas Viklund.

File name: "footer.php"

Survey design:

All the files used for the survey are in PHP with embedded HTML source code.

Survey questions and their objects are designed in HTML with "forms"

An example for this is would be "injured_backgroundinfo.php"

The HTML part of the code is:

```
<p><strong>INJURED PEOPLE SURVEY</strong><br />
</p>
<p><em>Background Information</em></p>
<form id="form1" name="form1" method="post" action="injured_backgroundinfo.php">
<label for="malefemale">Gender:</label>
<select name="malefemale" id="malefemale">
<option>Male</option>
```

```
<option>Female</option>
```

```
</select>
```

```
<label for="agebox"><br />
```

```
<br>
```

```
Age:</label>
```

```
<input type="text" name="agebox" id="agebox" />
```

```
<p>Were you skiing or snowboarding at the time of injury?</p>
```

```
<table width="200">
```

```
<tr>
```

```
<td><label>
```

```
<input type="radio" name="radskiorsn" value="SK" id="radskiorsn_0" />
```

```
    Skiing</label></td>
```

```
</tr>
```

```
<tr>
```

```
<td><label>
```

```
<input type="radio" name="radskiorsn" value="SN" id="radskiorsn_1" />
```

```
    Snowboarding</label></td>
```

```
</tr>
```

```
</table>
```

```
<p>Please provide your email address for further possible investigation on the mechanisms of ski and snowboard injuries</p>
```

```
<p>
```

```
<label for="txtemail"></label>
```

```
<input type="text" name="txtemail" id="txtemail" />
```

```
</p>
```

```
<p>
```

```
<label for="snowradio"></label>
<input type="hidden" name="completed" value="true">
</p>
<p>
<input type="submit" name="btnnext" id="btnnext" value="NEXT" />
</form>
</p>
```

This appears in the website as shown in the picture below and is all included in one “FORM”:

INJURED PEOPLE SURVEY

Background Information

Gender:

Age:

Were you skiing or snowboarding at the time of injury?

Skiing

Snowboarding

Please provide your email address for further possible investigation on the mechanisms of ski and snowboard injuries

When the “NEXT” button is pressed the “form” submits itself and the information is processed in PHP.

This can be seen in the part of the code [that appears in blue](#).

The PHP part of the file handles the events, methods and conditions.

The PHP code for the same file is:

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

```

include("include/fullheader.php");

if ($_POST["completed"]=="true")

}

    $date = date("Y-m-d H:i:s");

    if ((($_POST["agebox"]) && ($_POST["radskiorsn"]))) {

        $unable = "H";

        $link = mysql_connect("localhost", "hurtsk5_survey", "235-WB") or die(mysql_error());

        mysql_select_db("hurtsk5_database") or die(mysql_error());

        mysql_query("INSERT INTO injured (id, date, unableorhimself, gender, age, activity, email)
VALUES ('" . $_SESSION["id"] . "', '" . $date . "', '" . $unable . "', '" . $_POST["malefemale"] . "', '" .
$_POST["agebox"] . "', '" . $_POST["radskiorsn"] . "', '" . $_POST["txtemail"] . "')", $link);

        mysql_close($link);

        if($_POST["radskiorsn"]=="SK"){

            echo "<script type='text/javascript'>window.location = \"injured_skiingfirst.php\";</script>";

        } else if($_POST["radskiorsn"]=="SN"){

            echo "<script type='text/javascript'>window.location =
\"injured_snowboardingfirst.php\";</script>";

        }

    } else{

        $_SESSION["id"] = uniqid();

        if ($debug)

            {echo $_SESSION["id"];

                echo "address: ", getenv("REMOTE_ADDR"), "<br><br>";
            }
    }
}

```



```
}}
```

```
?>
```

MySQL is used to read the information from the form and then copy it in the separate fields of the database. This is depicted in the **red part of the code**.

Home page:

Contains information on the purpose and goals of the website and links to its features.

```
WELCOME TO HURTSKIING.COM
```

```
A little bit about us:
```

```
Hurtskiing.com is dedicated to performing research on ski and snowboard injuries. This site is here to provide you with information on common injuries and advice for staying safe on the slopes.
```

```
This website offers information from various sources including results from our own surveys.
```

```
We encourage you to TAKE OUR SURVEYS and explore our forum.
```

File name: "index.php"

Appendix C: Databases

Programming language: SQL

Name of database: Injured

Data collected from the following surveys:

1) Injured people

2) Unable to respond for themselves

Number of fields: 52

Below all fields are outlined and the types of variables used for each field.

Note: in the type of variable the length of the object is shown in the parenthesis

Field Name	Type	Description
id	varchar(30)	id given to every separate entry in order to distinguish sessions of users
date	datetime	what day and what time the data was submitted
unableorhimself	varchar(1)	Distinguish between people unable to represent themselves and people that can
gender	char(1)	Male or Female
age	int(11)	What is the age of the person? (number with a constraint to 3 digits for age).
activity	varchar(2)	Was the person Skiing or Snowboarding?

ability	varchar(1)	Ability of skier/snowboarder. Advanced, Intermediate, Beginner
rented	varchar(1)	Was the equipment they used at time of injury rented or theirs?
cond	varchar(1)	Was the equipment in good condition?
act_type	varchar(1)	What type of activity was the person doing? (Recreational, racing, freestyle etc...)
tod	varchar(1)	Time of day (morning, noon, afternoon, evening, night).
weather	varchar(14)	What were the weather conditions at time of injury (snowing, foggy, raining, sunny, cloudy).
snow_cond	varchar(1)	What were the snow conditions at time of injury (packed, granular etc...)
trail	varchar(2)	What type was the trail at which injury was sustained? (
diff	varchar(1)	What was the difficulty of the trail?

hlmt	varchar(1)	Was the person injured wearing a helmet at time of injury?
sens	varchar(1)	Did the helmet cause any sense deprivation?
reck	varchar(1)	Did the person ski/snowboard more recklessly because of the helmet?
knbind	varchar(1)	Was the person injured using the knee binding?
wrstpro	varchar(1)	Was the person injured wearing wrist protectors?
wrstkind	varchar(20)	What kind of wrist protector?
daysbef	int(1)	How many days had the person been snowboarding before injury.
injuredpart	varchar(2)	In which part of the body was the injury sustained?
kneemech	varchar(1)	If the knee was injured: What knee mechanism specifically caused the injury?
fatal	int(11)	Was the injury fatal? (only for unable to represent themselves)

injurytype	varchar(2)	What was the type of injury (depending on part of body) ex: fracture, tear, concussion etc...
edge	varchar(1)	Did the person catch an edge? (applies for specific injuries only)
collision	varchar(1)	Did the person collide with some object?
one_foot	varchar(1)	Was one foot strapped in?
inadvertent_release	varchar(1)	Did the bindings have an inadvertent release?
injurygrade	int(11)	What was the grade of the injury (applies for specific injuries only)
flatlanding	varchar(1)	Did the person experience a flat landing?
fallonshoulder	varchar(1)	Did the person fall on his/her shoulder?
fallonhand	varchar(1)	Did the person fall on his/her hand?
fallonwrist	varchar(1)	Did the person fall on his/her wrist?
helmet	varchar(1)	Was the person injured wearing a helmet?
polestraps	varchar(1)	Was the person wearing polestraps?

strapsright	varchar(1)	Was the person injured wearing the pole straps the right way?
vertebra	varchar(2)	Which vertebra was affected? (for spine,neck,back injuries)
recoveryattempt	varchar(1)	Did the person attempt to recover from falling/losing control?
sitdownattempt	varchar(1)	Did the person attempt to sit down while losing control?
taillanding	varchar(1)	Did the person land on the tail of the equipment?
snowplowposn	varchar(1)	Was the person in the snowplow position?
widenedstance	varchar(1)	Did the person's stance widen when injured?
hispeededge	varchar(1)	Did the person catch an edge while travelling at a high speed?
height	int(11)	Height of the person
weight	int(11)	Weight of the person
bindingssetting	text	What where the bindings set at?

makemodel	text	What was the make/model of the equipment?
movingstanding	varchar(1)	Was the person moving or standing at time of injury (for collision only)
hitloc	varchar(1)	At what location was the person when he/she got hit? (edge of trail, middle, other)
trailcontribution	varchar(1)	Did the trail contribute to the injury?
loadunloadflats	varchar(1)	Did the injury occur when loading, unloading or on flats? (applies when one foot strapped in only)
desc	varchar(255)	Description the person wants to give with any additional information considered helpful
email	varchar(255)	Email of person in the case of follow up questions/surveys
complete	int(11)	Did the person complete the whole survey or stopped halfway through?

Programming language: SQL

Name of database: Uninjured

Data collected from the following survey:

1) Uninjured people

Number of fields: 15

Below all fields are outlined and the types of variables used for each field.

Note: in the type of variable the length of the object is shown in the parenthesis

Field Name	Type	Description
id	varchar(30)	id given to every separate entry in order to distinguish sessions of users
date	datetime	what day and what time the data was submitted
gender	varchar(6)	Male or Female
age	int(3)	What is the age of the person? (number with a constraint to 3 digits for age).
sport	varchar(2)	Does the person mainly Ski or Snowboard?
ability	varchar(1)	Ability of skier/snowboarder. Advanced, Intermediate, Beginner

type	int(1)	Classification on what type of skier/snowboarder the person is
equiprent	int(1)	Does the person rent the equipment or use his/her own
equipsvc	varchar(1)	How often is the equipment serviced?
noprotection	int(1)	Does the equipment have any form of protection when transported? (on top of car)
equipgoodshape	int(1)	Is the equipment in good shape?
professional	int(1)	Is the person a professional skier/snowboarder?
instructor	int(1)	Is the person certified as an instructor?
patrol	int(1)	Is the person a ski patroler?
complete	int(1)	Did the person complete the whole survey?

Appendix D

These charts show the code for reading the databases.

Injured part	Refers to	Knee injuries	Refers to	Injury type	Refers to
KN	knee	A	ACL	LA	laceration
HE	head	M	MCL	FR	fracture
SH	shoulder	R	lateral/medial meniscus	CT	contusion
LL	lower leg	T	tibial	DI	dislocation
TH	thumb	Equipment condition	Refers to	T	tear
AR	arm	Y	good shape	CO	concussion
WR	wrist	N	not good shape		
RI	ribs				
Weather	Refers to	snow conditions	Refers to	Injury type	Refers to
B	sunny/bright	G	packed granular	LA	laceration
C	cloudy/flat	R	slick/race course	FR	fracture
S	Snowing	I	icy	CT	contusion
R	Raining	P	powder	DI	dislocation
F	Foggy	S	slush	T	tear
G	snow guns	K	I don't know	CO	concussion
K	I don't know				

Act type	Refers to	tod (Time of day)	Refers to	Difficulty	Refers to
R	recreational	M	morning	C	green circle
F	racer/freestyle	A	afternoon	S	blue square
S	ski patrol	E	evening	B	black diamond
I	instructor	N	night	D	double black
Gender	Refers to	K	I don't know	K	I don't know

M	male
F	female

Trail	Refers to	Unable or himself	Refers to
AL	general alpine	H	Himself
PA	park	U	Unable to respond for himself
M	moguls		
C	cross country		
SA	slalom race course		
GS	GS race course		
SG	SG and downhill		
GL	glades		
BB	back bpw;		
L	loading/unloading		
K	I don't know		

