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Web Based Snow-Sport Injury Reduction

An Interactive Qualifying Project Report

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Abstract

The goal of this project was to use a method of identification and education, in conjunction with the internet, to reduce snow sport related injuries. The project specifically focused on several common injury types that included, knee injuries, thumb injuries, wrist injuries and head injuries. The group was successful in designing and implementing the necessary surveys and studies to achieve this goal. The group saw participation in all of the individual injury studies with a total number of 103 responses and 372 website visits.

1. Introduction

1.1 Objectives

The objective in this project was to reduce ski and snowboard injuries. There are many types of ski injuries that occur every season and many of them are a result of improper technique or faulty equipment and could be avoided with adequate education.

1.2 Rationale

According to the National Ski Areas Association the number of skier days (ski and snowboard visits per season) is approximately 10 million. Of these 10 million visits, 2.63 in every 1000 people experience a severe injury. That brings the total number of injuries per year to an estimated 26,300 injuries (NSAA, 2010). This statistic contains many injury types and injury mechanisms. In order to reduce these, the group addressed several common injury types.

1.2.1 Knee Injuries:

Knee injuries, specifically ACL tears, have proven to be one of the most prevalent alpine skiing injuries. From 1972 to 2006 ACL injury rates increased 106% (New York Times, 2008). The surgery to repair an ACL has an average cost of $11,500 (Am. Journal of Sports Medicine, 1997). The cost to Americans as a whole is approximately 250 million dollars a year. Though the number has dropped over the past few years, the number of injuries per year is still approximately 20,000.

By reducing or preventing these types of injuries individual skiers could save thousands of dollars, as well as what could be months of rehabilitation. The recovery time for an ACL tear on average is 9-12 months (University of Minn. Orthopaedics, 2008).

1.2.2 Thumb Injuries

Thumb injuries make up anywhere from 5% (Langran, 2010) to 10% (The American Journal of Sports Medicine, 1993) of injuries in alpine skiing. The number of injuries has been decreasing for the past 2 decades, due to the mean days between injury increasing from 4,905 in 1992 to 8,522 in 2010 (Langran,2010). This decrease in thumb injuries is believed to be from the smaller size ski pole handles that are being used today, which place less stress on the thumb during a fall.

1.2.3 Wrist injuries.

A Snow Sports Safety Study states that 25% of all snowboard injuries affect the wrist joint, 70% of those are fractures (Langran, 2011). There are an estimated 95,000 wrist fractures each year among snowboarders worldwide (Young, 1999). Each of these injuries usually costs between $7,000 and $10,000 and take anywhere from six weeks to six months to heal. In a recent survey called *Epidemiology of Snowboarding Injuries: 1988-1995*, the amount of snowboard injuries and ski-patrol reports were evaluated. From these reports 3,696 snowboard injuries occurred in 617,081 visits at two medium-sized resorts in Southern California. The snowboarders' wrist injury as a percent of all injuries was 19.4% for males and 26.4% for females (Christie, 1996).

1.2.4 Head injuries and Helmet safety.

Of all snow-sport injuries, head injuries are the most frequent cause of hospital admission and death (Cusimano 2010). In 2009 hospital emergency rooms, doctors' offices, and clinics treated 353,346 injuries related to these winter sport activities. The medical, legal, work loss and pain and suffering costs were more than $9.28 billion (U.S. Consumer Product Safety Commission, 2009).

Although Injury patterns differ with experience, one of the most common causes of injury is collision with fixed objects (U.S. Consumer Product Safety Commission, 2009). The National Ski Areas Associations (NSAA) reports that injuries are more common among beginners and fatalities are more likely to occur in above-average skiers and snowboarders who are moving at high speeds. On average, 40% of the annually reported skiing and snowboarding-related head injuries could have been prevented or minimized with helmet use (Shealy, 1985). For a severe head injury the lifetime costs are over $3 million; for moderate injury, $941,000; and for mild trauma $85,000 (Novack, 2000).

1.3 State of the Art

1.3.1 Knee Injury Reduction:

Current ACL trends are being tracked by the Epidemiological study being conducted at Sugarbush Mountain in Vermont. The team of scientists has conducted over 35 years of research on the cause of these types of injuries. By examining the events leading up to the injury, they have developed a pamphlet and a DVD on injury prevention methods. The research group saw a 50% reduction in knee injuries after instruction on proper falling techniques (New York Times, 2008). The group has shared their knee friendly tips with over 20 ski area's instructors aiming to decrease the rate of these injuries.

In addition to the instruction of proper technique, a new product named '*Knee Bindings'* has been introduced to the market. These bindings use a combination of design factors to eliminate the valgus forces that cause the Phantom Foot Mechanism. The bindings use a lateral heel release to prevent the twisting force that causes these types of injuries.

1.3.2 Education on Thumb Injuries

Dr. Mike Langran has been conducting a study on thumb related injuries in Scotland since 1999. This study consists of collecting data from individual skiers and snowboarders who visit Scottish Ski areas as well a health clinic known for treating skiing causalities. This study excludes any non-severe

injury and keeps track of certain skier demographics such as gender, age, and experience (Langran, 2010).

1.3.3 Education and evaluation of snowboarding related wrist injuries.

A wrist injury sustained by snowboarders is commonly caused by falling onto an outstretched hand. The Scaphoid fracture and the Colles' fracture are the two most common types of fractures in the sport ("ABC-of-Snowboarding", 2011).

The July 15th 2005 issue of the *American Journal of Epidemiology* published research by Hagel and colleagues. They studied 19 ski areas to determine the protective effect of wrist guards on injury. They found that wearing wrist guards reduced the risk of a hand, wrist or forearm injury by 85%. They also found non-significant evidence of possible increased risk of injury to the shoulder or upper arm as a consequence of wearing wrist guards (Langran, 2011).

1.3.4 Education and evaluation on head injuries and helmet safety.

A traumatic brain injury (TBI) is defined as an external force to the head that changes the normal function of the brain. Traumatic brain injuries can be mild, moderate or severe, depending on the amount of damage to the brain. Mild cases may result in a change in consciousness, while severe cases may result in prolonged periods of unconsciousness, coma or death (Novack, 2000).

Severe head trauma accounts for only 15% of all skiing and snowboarding related injuries, but is the most frequent cause of severe disability and death (American Association of Neurological Surgeons, 2011). According to the NSAA's 2011 National Demographic Study, 61% of skiers and snowboarders wear helmets while on the slopes. This is a 57% increase from the 2009-2010 season. Putting on a helmet before skiing or snowboarding reduces the chances of a head injury by 35% (NSAA, 2011).

The goal of the helmet is to absorb force and disperse energy of a blunt trauma. Although helmets do not decrease the risk of injury, they can decrease the severity (US Consumer Product Safety Commission, 2009). In recent studies, helmeted skiers, who have obtained head injuries, have had better outcomes than skiers who do not wear helmets. They have had less temporary or permanent brain damage than those not wearing helmets. If an accident were to occur, a helmet can decrease the risk of serious injury (Thompson, 1996).

1.3.5 Use of Website for education and intervention on injuries.

The internet has proved to be a useful tool for tracking trends in a population at risk. Recently GOOGLE used their tracking capabilities to identify trends in influenza outbreaks. Google.org compiled and evaluated billions of Internet searches from five years of Google.com data. From the data, a model was created capable of estimating the probability that a visit to a physician (in a particular region) was related to an influenza-like illness (an ILI) (Davis, 2009).

Using this model, the researcher team at Google.org applied its predictive power in to Google searches during the 2007-2008 influenza season. The resulting estimates were shared with the US Center for Disease Control (CDC) and both the timeline and accuracy of the predictions were assessed. It was found that the Google's search method was able to consistently and rather successfully estimate ILI percentages (across all nine regions of CDC analysis) one to two weeks earlier than reports published by the CDC's US Influenza Sentinel Provider Surveillance Network (Davis, 2009).

2. Approach

Though the focus of the injury reduction is split amongst several injuries, a common method for addressing the objective was employed.

1. Identify injury trends
2. Educate and intervene on bad practices where adequate information was available to reduce the injury mechanism.

The use of this "identify and intervene" method, in conjunction with a web-based medium, is unique to this project. The use of the internet for tracking trends is being developed and employed by others. To our knowledge, no one else is using this combination of identification and education for snow-sports injury reduction.

3. Methods

3.1 Knee Injury Prevention Study:

To organize the knee injury study, it was necessary to outline what information the group wanted to collect. When these goals were defined it was possible to construct a flowchart to organize the survey. The construction of the Knee Injury evaluation was completed using the same online service, *Qualtrics™* that was used for all of the surveys generated for the project.

3.1.1 Components of both Knee Queries:

Provides data on the:

- Number of injuries
- Number of ACL injuries
- Current injury types (common knee injuries)
- Current awareness of the Phantom Foot Mechanism
- Willingness of participants to purchase informational DVD.
- Awareness of alternative binding technology.

3.1.2 Components unique to Knee Injury Query I:

If responders reply at the end of the season with yes/no on Knee injuries then the hypothesis that the instruction and safety quiz/survey can reduce injuries may be tested by comparing the control data from the non-instruction vs. the instruction injury trends. A “no” response would indicate that the instruction may have had some impact on injury reduction, while a “yes” response to an injury would indicate that the trend in injuries was not affected by the provided instruction.

3.1.3 Components unique to Knee Injury Query II (control group):

The two knowledge based questions provide a benchmark for non-instruction knowledge of the Phantom foot mechanism and technique to avoid it. If responders at the end of the season reply for yes/no on Knee injuries the survey provides a control for injury trends without instruction.

The first Knee Study was provided with a brief write-up of information and tips to avoid ACL tears to be read before the survey. The query was composed of questions which overlapped the control

group. It collected information about injuries which they had already sustained; the first three questions are the same as Questions 1, 2, and 3a. The remaining questions are outlined below.

3.1.4 Knee Injury Query I:

Question:		Response
1	**Have you experienced a previous knee injury?**	**Fill**
2a	**Was it an ACL tear?**	**Fill**
2b	**Have you heard of the Phantom Foot Mechanism related to ACL injuries?**	**Fill**
3a	**What type of injury did you experience?**	**Fill**
4	**Which component is not included in the conditions for the Phantom Foot?**	a. Skier's uphill arm back b. Hips below knees c. Weight on the inside edge of the downhill ski. d. Upper body facing up the slope
5	**When falling, what which of the following is not good technique?**	a. Use hands to prevent impact with the trail b. Feet together c. Position downhill thigh in line with downhill ski, eliminates twisting in knee
6	**Why do conventional bindings cause ACL injuries?**	a. The lack of a lateral heel release causes a strong twisting force in the knee. b. The lack of an upward heel release causes twisting in the knee. c. The conventional binding has no influence on ACL injuries.
7	**Which of the following should be exercised during a fall?**	a. Avoid fully straightening legs during a fall. b. Arms back to remain balanced. c. Keep feet spread apart to provide a more balanced distribution of weight. d. Try to regain balance and continue skiing.
8	**Would you be willing to purchase the *Knee Bindings* if they were proven to reduce ACL injuries?**	Yes/No

Figure 1: Knee Injury Query I

Safety Quiz Alpine Skiing Knee injuries: (safety data provided)

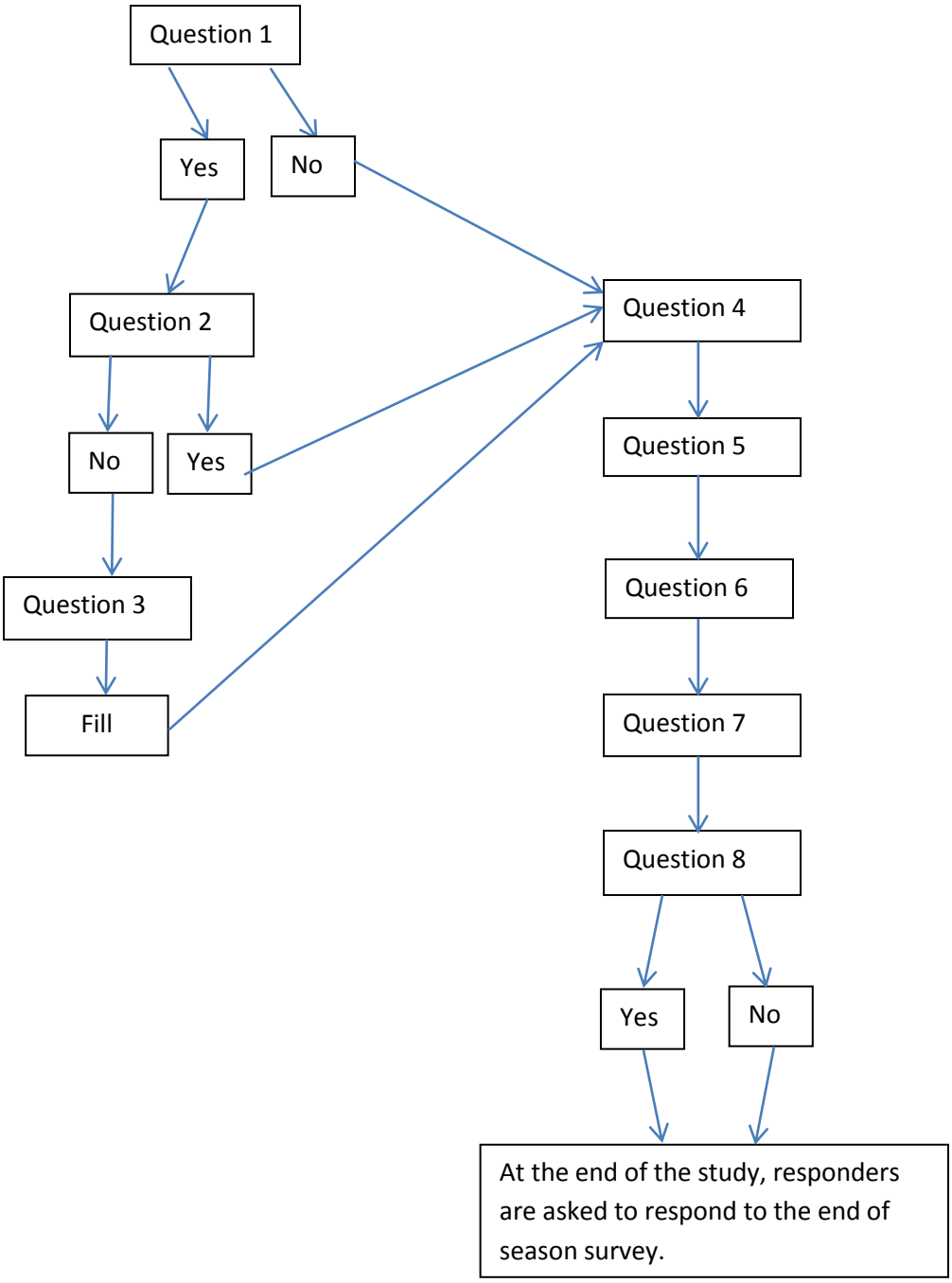

Figure 2: Safety Quiz I, Alpine Skiing Knee Injuries

The first Knee Study was provided with a brief write-up of information and tips to avoid ACL tears to be read before the survey. The query was composed of questions which overlapped the control group. It collected information about injuries which they had already sustained; as such the first three questions are the same as Questions 1, 2, and 3a. Questions 4 through 7 are checks for comprehension of the provided reading material. It will check the participant's comprehension of the provided material. Question 8 references information provided on *Knee Binding* technology as well as the way which these

bindings prevent ACL injuries and is aimed at measuring the willingness of participants to buy these bindings.

3.1.5 Knee Injury Query II

Question:		Response
1	**Have you experienced a previous knee injury?**	**Fill**
2a	**Was it an ACL tear?**	**Fill**
2b	**Have you heard of the Phantom Foot Mechanism related to ACL injuries?**	**Fill**
3a	**What type of injury did you experience?**	**Fill**
3b	**Which component is not included in the conditions for the Phantom Foot?**	a. Skier's uphill arm back b. Hips below knees c. Weight on the inside edge of the downhill ski. d. Upper body facing up the slope
3c	**Would you be willing to purchase and informative DVD if it could help you prevent ACL injuries while skiing?**	**Fill**
4	**When falling, what which of the following is not good technique?**	a. Use hands to prevent impact with the trail b. Feet together c. Position downhill thigh in line with downhill ski, eliminates twisting in knee
5	**Have you ever heard of *Knee Bindings?***	**Fill**

Figure 3: Knee Injury Query II

Safety Quiz Alpine Skiing Knee injuries: (no safety data provided)

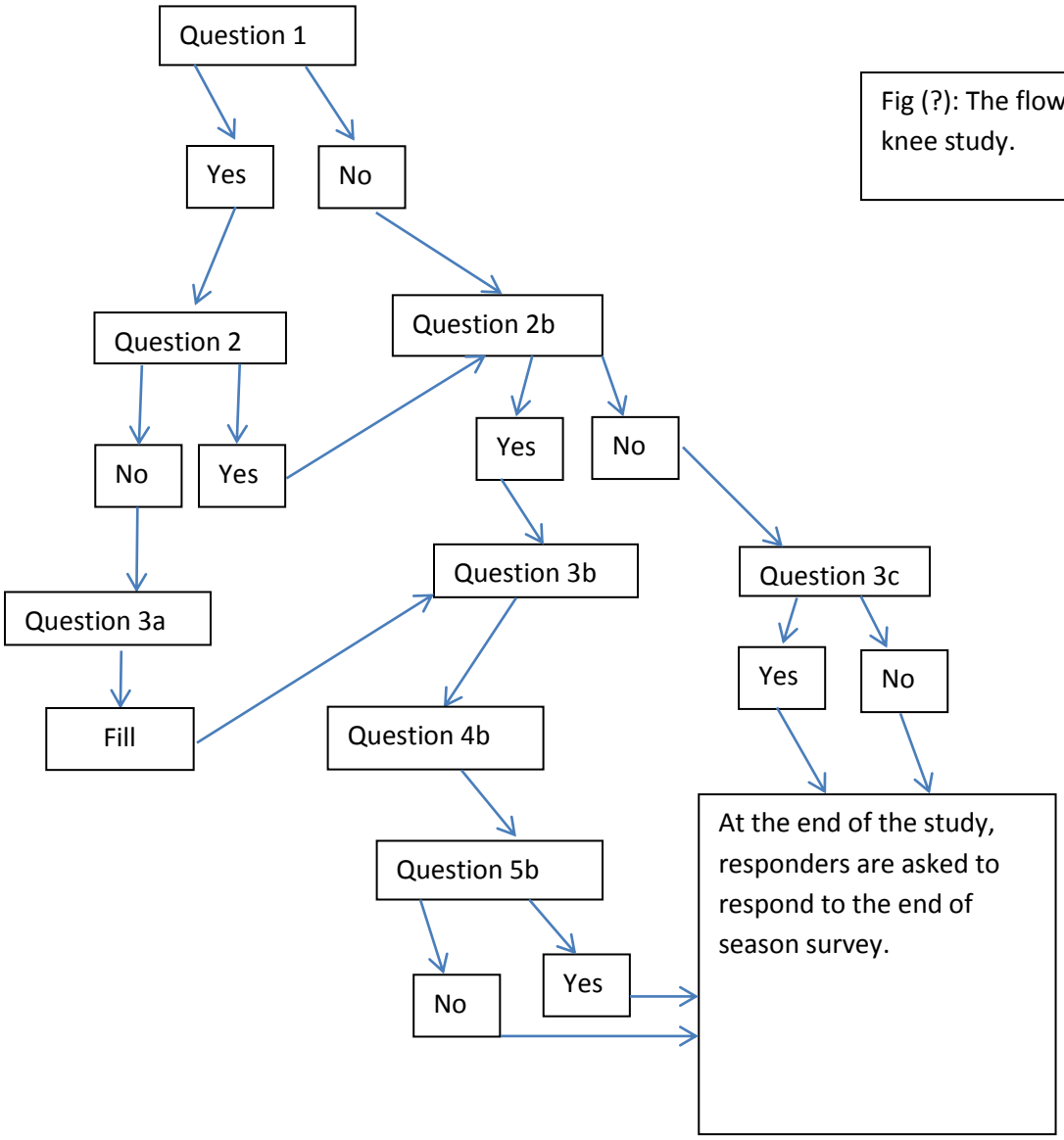

Fig (?): The flow chart for the first knee study.

Figure 4: Safety Quiz II, Alpine Skiing Knee injuries:

3.1.6 End of season response:

At the end of the season the responders were asked to reply if they had received a Knee Injury during the season as well as which study they took part in. Using this information to compare the results of injury rates between the two studies, the hypothesis could be tested.

3.2 Education on Thumb Injuries specifically on proper pole grip.

The goal of the thumb injury survey was to obtain certain information from responders. The desired information included:

- The number of injuries.
- Was the responder skiing or snowboarding?

- The cause of the injury.
- If the responder was a skier, were they using ski poles at the time of the injury?
- How were the ski poles held at the time of the injury?

The first question asked “Have you injured your thumb while skiing or snowboarding?” This was used to provide data on the total number of thumb injuries and how many skiers compared to snowboarders have injured their thumbs.

The next question asked “How did you injure your thumb?” This question allowed for responders to give the responders the opportunity to briefly describe how their injury occurred.

If the injured responder was a skier the question was asked “Were you using ski poles at the time of the injury?” This question was a yes or no question to record data on the amount of people using ski poles at the time of their injury.

Skiers were then asked “How do you hold your ski poles?” This question gave three choices. Two based on whether the skier held the pole with the strap on top of, or below, the skier’s hand. The third option “I don’t use ski poles” was provided for skiers that do not use ski poles. This question could then be used to determine the amount of people who knew the correct way to hold a ski pole with a strap.

Any person who answered that they held a ski pole the incorrect way could then review the proper technique on the injury mechanisms part of the website.

3.3 Education and evaluation of snowboarding related wrist injuries.

The wrist injury survey was used to determine the experience level, location of wrist injuries as well as to compare the rates of wrist injuries between wrist guard wearers and non-wearers.
The following information was to be obtained from responders:

- Number of injuries
- Where was the injury obtained?
- What was the injury mechanism?
- Use and effectiveness of wrist guards

3.4 Education and evaluation on head injuries and helmet safety.

Define the desired information to be obtained from responders:

- Number of injuries
- What type of head injury was obtained?
- How was the injury obtained?
- Is the responder aware of helmet safety
- Does the rider wear a helmet?

Determine if snowboarders and skiers were aware of how helmets could reduce their head injuries. If they were not aware, inform them. At the end of the quiz, determine if their newly gained knowledge would encourage them to wear a helmet as a means to prevent head injuries.

In the head injuries and helmet safety survey, a quiz was created to determine if riders were aware of the importance of helmet safety. An explanation was written for each question in case the respondent was not aware of the correct answer (These explanations may be viewed in Fig. 5 below). The survey was created to only show the explanation if the wrong answer was selected. When analyzed, the survey results may lead to a trend in head injuries and helmet use. One objective was to keep the survey as short as possible while still obtaining all the necessary information.

Are skiers and snowboarders at risk of head injury?	Are you aware of what kind of head injuries can occur?	Does wearing a helmet effectively protect a skier or snowboarder?	Is helmet fit important?	Do you know when a ski or snowboard helmet should be replaced?	Are you aware of the four critical elements affecting a helmets protective property?
Head injuries are the most common cause of death among skiers and snowboarders. TBIs account for 50-88% of the fatalities at ski resorts and 67% of skier deaths in children. Head injuries make up 3 -15% of all injuries suffered by skiers and snowboarders. (FAQ Ski/Snowboard Helmet, 2011)	In snow sports, head and spinal cord injuries are increasing. The majority of head injuries (83%) are concussions. Concu ssions represent 9.6% of injuries in skiers, 14.7% of injuries in snowboarders. (FAQ Ski/Snowboard Helmet, 2011)	Studies have shown that ski and snow board helmets are effective at reducing head injuries. It is estimated that for every 10 people who wear a helmet, 5 may avoid head injuries. Studies have also demonstrated that helmets may minimize brain damage at a speed of 19km/h. (FAQ Ski/Snowboard Helmet, 2011)	Yes. How to find the proper helmet fit: 1. Ski and snowboard helmets should rest two fingers width above the eyebrow 2. The helmet should be snug and comfortable (only one finger width under the chinstrap) 3. The helmet pads should touch the cheeks and the forehead 4.The helmet back should not touch the nape of the neck (FAQ Ski/Snowboard Helmet, 2011)	Even if the helmet appears undamaged, it should be replaced if: 1. The helmet has been dropped 2. The wearer has been in a fall or collision (FAQ Ski/Snowboard Helmet, 2011)	"Impact management - how well the helmet protects against collisions with large objects. Helmet positional stability - whether the helmet will be in place, on the head, when it's needed. Retention system strength - whether the chin straps are sufficiently strong to hold the helmet throughout an incident involving head impact. Extent of Protection - the area of the head protected by the helmet. " (FAQ Ski/Snowboard Helmet, 2011)

Figure 5: Head Injury Survey

The survey was organized into two different sections. These are:

1) Background knowledge:
This section contains general knowledge about common types of head injuries in snow-sports as well as ways to reduce them.

2) Injury mechanism:
These questions are designed to provide insight on how the injury occurred. After the responder has completed the informational phase, then the injury mechanism questions

appear. In case the survey did not cover key aspects of their injury, the users are asked to include any additional information they think is necessary,

This survey was designed to find a correlation between a rider's knowledge on helmet safety, and the injuries they have (or have not) obtained.

4. Results

(See Appendix A for bar graphs of data).

4.1 Knee Injury:

Knee Injury Study #1: (non-instructed)

34 Responses **33** Completed Responses

62% have suffered a knee injury
38% of the injured were ACL injuries
30% have heard of the Phantom Foot mechanism
50% knew correct falling technique
72% would not buy a DVD to reduce likelihood of injury
60% have not heard of the product Knee-Binding™

Knee Injury Study #2: (instructed)

11 Responses **8** Completed Responses

64% have experienced a previous knee injury
50% were an ACL tear
The other 3 – meniscal tear, sprain, soft tissue damage
33% were not aware of the conditions of phantom foot
55% did not know good techniques for falling
75% did not want the DVD
100% knew why conventional bindings cause ACL injuries
38% did not know what should be exercised during a fall

4.2 Thumb Injury Survey Results:

12 Responses **12** Completed Responses

83% skiing thumb injuries
100% were using ski polls
20% grab the pole through the top of the strap
70% grab the pole through the bottom of the strap
10% don't know
17% snowboarding thumb injuries

4.3 Wrist Injury Survey Results:

16 responses **15** Completed Responses

50% injured wrist while snowboarding
38% were beginners
40% were in the terrain park
14% were wearing wrist guards
86% were on the heel side edge
43% did not know how to fall correctly

4.4 Head Injury Survey Results:

30 Responses **28** Completed Responses

79% have been informed on helmet safety
4% did not know skiers and snowboarders are at risk of head injuries
21% did not know the different kinds of head injuries
32% thought a helmet would not protect a skier or snowboarder
4% did not know the importance of helmet fit
46% did not know when a helmet should be replaced
70% did not know the elements affecting a helmets protective property
85% wore a helmet while skiing/snowboarding
22% injured their head while wearing a helmet

5. Discussion

5.1 Identification of Injury Trends:

One of the supporting objectives was to identify injury patterns in skiing and snowboarding through the use of the internet. By addressing injuries individually the group could draw conclusions on what their cause may be. Obtaining responses proved to be difficult for the injury studies. Several different methods were attempted to gain response but none produced adequate population sizes. With this in mind, the injury surveys all provided data on potential trends.

5.1.1 Knee Injuries

The knee injury studies provided some potentially interesting injury trends. Both the instructed and non-instructed versions of the study had similar rates of knee injury per the sample group, 64% and 62% respectively. This number is high compared to the expected rate of knee injuries per year, which is likely the result of the question not being current season specific. Had the question specified injuries in the past season the expected result would be lower.

Of these injuries there were cases of ACL tears in both knee studies, but a discrepancy in the numbers. The non-instructed study saw 38% of the knee injuries were ACL tears while the instructed

version saw a 50% rate of ACL tears. The difference in the injury rates between the two studies is most likely the result of small sample size and with a larger population the number may become more similar.

The non-ACL tear knee injuries provided interesting insight into other common injury types, the most common of which was Meniscal tears or damage. The non-instructed version saw an injury rate of 41% of the non-ACL knee injuries, while the instructed version provided 33% meniscal injuries of the non-ACL injuries. This value once again could be high due to the low response rate, but may also indicate a trend in Meniscal Tears.

The non-instruction component of the survey provided that 40% of responders have heard of Knee Bindings™. The instructed version of the knee survey provided that 25% of the responders were willing to purchase this product. Both pieces of data point to the current lack of market acceptance of this product. The remaining portion of the knee study focuses on education and intervention.

5.1.2 Thumb Injuries

Based on the thumb injury data, skiers, more often than snowboarders, injured their thumbs. Of those injuries all were using ski poles. Surprisingly the majority (80%) of the injuries occurred when the skier was holding the ski pole with their hand coming through the bottom of the ski pole strap. This is surprising because holding the ski pole strap with the hand coming through the bottom of that strap is thought to be the safer way to hold the ski pole.

The results of this survey indicate that it may not be how people are holding their ski poles but whether or not they are releasing their ski poles when they fall. When a skier falls and they are still holding their ski poles, this allows for the ski pole to act as a fulcrum creating additional and potentially harmful force to the thumb joint. Releasing the ski pole allows it to fall away from the skier's hand, minimizing the risk of injury, but only if the skier is holding the ski pole with their hand through the bottom of the strap. The ski pole will otherwise get caught in the skier's hand increasing the risk for injury.

The data collected may also reflect a specific group of skiers rather than a general population. Most of the advertisement for the survey was directed at collegiate ski teams, which may have skewed the data towards more advance skiers, who have a different risk of injury compared to beginner or intermediate skiers. Because of this, it is difficult to tell whether a skier was more likely to injure their thumb based on skill level or the way they held their ski poles.

5.1.3 Wrist Injuries

Based on the data collected for wrist injuries, most occur to a beginner or someone in the terrain park. The majority of the time the rider fell while on their heel-side edge most likely indicating they fell forward down the hill with an outstretched arm. The result of 86% of wrist injuries occurred without the use of a wrist guards. This data agrees with that collected by Hagel and colleagues (see section 1.3.3). Their results showed 85% of the injuries across 19 ski areas happened without the use of a wrist guard.

Surprisingly, 57% of the participants that injured their wrists claimed that they had previously been informed on how to fall without injuring their wrist. If more than half of snowboarders have the knowledge that falling onto an outstretched hand increases the risk of a wrist injury, this may indicate that the instinctual reaction of throwing out a hand to prevent possible harm to the head or body is strong enough to make an educated snowboarder neglect wrist injury prevention.

The data collected may also reflect mostly collegiate aged riders in the north east due the way the website was advertised. In retrospect, more information could be gained by the survey by asking more questions such as "which wrist was injured" and the questions may not have been completely clear as to whether the rider was a beginner at the time of injury or not.

5.1.4 Head and Helmet

The head injury survey was designed to find a correlation between a rider's knowledge on helmet safety and the injuries obtained. If the respondent was not aware of skiing and snowboarding head injuries and helmet safety, the quiz informed them. 30 responses were obtained from the survey; however, 2 surveys were incomplete so the following discussion is based on the 28 completed surveys.

Of the 28 responses received, 23 people said they were previously informed of helmet safety. Only 2 of those 23 people do not wear helmets while skiing or snowboarding. One of those 2 people, 1 has injured their head while skiing.

Out of the 5 people who have not previously been informed on helmet safety, 2 riders do not wear helmets. Of those 2 riders, 1 has sustained a head injury.

Of the 28 respondents, only 4 do not wear helmets. Of those 4, only 2 have sustained a head injury. Of the 24 people who do wear helmets, 6 of them have received a head injury. Of those 6 people, 5 experienced a mild concussion. The 6th respondent may be considered an outlier because his or her response appears to be a joke.

"I was night skiing in Maine when a rabid deer attacked me. I fought off the deer but it did hit me in the face several times with it hooves. The helmet did nothing."

From the results, we noticed that concussions were the only type of head injuries obtained. Most of the concussions occurred while the rider was wearing a helmet. Our response rate was low, and that is probably why we only received responses about concussions.

5.2 Education and Intervention:

Another supporting objective was to use the internet to educate people on proper technique for avoiding injuries. The knee injury study in particular tested this potential means for education. The non-instructed survey acted as a control for knowledge based questions to test current awareness of the injury type. According to the survey 70% of the responders had not heard of the Phantom Foot mechanism in Alpine Skiing. The Knee Injury studies in conjunction with the end of season response provided information on whether the education by the internet could reduce injuries. The comprehension of information provided in the instructed survey seems good, as the correct response was picked with a higher percentage. The results however, were inconclusive. None of the participants involved with the study responded at the end of the season. It was hypothesized that intervention on bad falling technique would reduce injuries, but no data was collected to support the claim. The lack of response has been a common problem in this project and a better means of advertisement or marketing should be explored.

6. Conclusion

The main objective of the project, to reduce snow-sports injuries, through identification and intervention was completed by the group. Having implemented the several different injury trend surveys, as well as the knee injury specific education and intervention component, the group received 103 total responses. The sample population's injury patterns appear high compared to larger epidemiological studies, which could come as a result of a bias in the population, toward previously injured responders. There is, however, no data available to prove that the education component had an impact on injury rates due to lack of response to the "end of season" survey.

1. The knee injury study provided data on the current rate of knee injuries ~63% of the sample population which is high compared to other epidemiological studies.
2. The knee injury study provided data on the number of ACL injuries, ~44% of the knee injuries in the sample population, also high compared to other available data.
3. The thumb injury survey showed of those who injured their thumb, 83% were skiers while 17% were snowboarders.
4. Of the 83% of skier thumb injuries 80% were injured holding the ski pole with their hand coming through the bottom of the ski pole strap.
5. The wrist injury survey showed that 50% of the sample population had injured their wrist snowboarding.
6. Of the 50% with wrist injuries 86% were not wearing wrist guards which agrees with current epidemiological data.
7. In the head injury study 85% of the sample population wear a helmet and of these 22% have experienced a head injury.
8. Of the 15% that do not wear a helmet 50% received a head injury.

6.1 Afterword:

This was a continuation of the Snow Sports Injuries IQP at Worcester Polytechnic Institute. There are already enough students showing interest in continuing the project in the 2012-2013 school year. The following suggestions are recommended to future groups.

- Make surveys more specific to get a better understanding of injury mechanisms and ideas for prevention.
- Find ways to encourage larger numbers of participants to respond to the end-of-season survey to determine whether the website effectively reduced snow sport injuries.
- Find more effective ways to advertise the website to get a larger number of participants.
- Further explore more injury mechanisms such as snowboard related knee injuries.

The project was developed and will be left in a position for future IQP groups to continue to work on.

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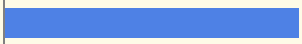
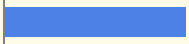
Appendix A:

Knee Injury Study #1:

Have you experienced a previous knee injury?

#	Answer		Response	%
1	Yes		21	62%
2	No		13	38%
	Total		34	100%

Was it an ACL tear?

#	Answer		Response	%
1	Yes		8	38%
2	No		13	62%
	Total		21	100%

What type of injury did you experience?

1. 2 bucket handle meniscal tears
2. bruised lateral meniscus
3. deep bruising of the knee
4. Medial ligament I think its called. the inside of the knee
5. Meniscus tear
6. not sure, lots of pain for 3 months
7. Soft tissue damage.
8. Sprain
9. Sprain/ not certain
10. Swollen knee joints from excessive strain
11. Tore my meniscus
12. Torn Meniscus

Have you heard of the Phantom Foot Mechanism related to ACL injuries?

#	Answer		Response	%
1	Yes		10	30%
2	No		23	70%
	Total		33	100%

Which component is not included in the conditions for the Phantom Foot?

#	Answer		Response	%
1	skier's uphill arm back		1	10%
2	hips below knees		0	0%
3	weight on the inside edge of the downhill ski		4	40%
4	upper body facing up the slope		5	50%
	Total		10	100%

When falling, which of the following is not good technique?

#	Answer		Response	%
1	Use hands to prevent impact with the trail		7	70%
2	Feet together		0	0%
3	Position downhill thigh in line with downhill ski, eliminates twisting in knee		3	30%
	Total		10	100%

Would you be willing to purchase and informative DVD if it could help you prevent ACL injuries while skiing?

#	Answer		Response	%
1	Yes		9	28%
2	No		23	72%
	Total		32	100%

Have you ever heard of Knee Bindings?

#	Answer		Response	%
1	Yes		4	40%
2	No		6	60%
	Total		10	100%

Knee Injury Study #2:

Have you experienced a previous knee injury?

#	Answer		Response	%
2	No		4	36%
1	Yes		7	64%
	Total		11	100%

Was it an ACL tear?

#	Answer		Response	%
1	Yes		3	50%
2	No		3	50%
	Total		6	100%

What type of injury did you experience?

Text Response
2 bucket handle meniscal tears
Sprain
Soft tissue damage.

Which component is not included in the conditions for the Phantom Foot?

#	Answer		Response	%
1	skier's uphill arm back		3	33%
2	hips below knees		0	0%
3	weight on the inside edge of the downhill ski		0	0%
4	upper body facing up the slope		6	67%
	Total		9	100%

When falling, which of the following is not good technique?

#	Answer		Response	%
1	Use hands to prevent impact with the trail		4	44%
2	Feet together		2	22%
3	Position downhill thigh in line with downhill ski, eliminates twisting in knee		3	33%
	Total		9	100%

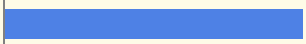
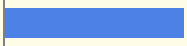
Would you be willing to purchase the Knee Bindings if they were proven to reduce ACL injuries?

#	Answer		Response	%
1	Yes		2	25%
2	No		6	75%
	Total		8	100%

Why do conventional bindings cause ACL injuries?

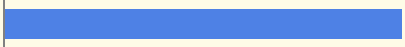
#	Answer		Response	%
1	a. The lack of a lateral heel release causes a strong twisting force in the knee.		9	100%
2	b. The lack of an upward heel release causes twisting in the knee.		0	0%
3	c. The conventional binding has no influence on ACL injuries.		0	0%
	Total		9	100%

Which of the following should be exercised during a fall?

#	Answer		Response	%
1	a. Avoid fully straightening legs during a fall.		5	63%
2	b. Arms back to remain balanced.		0	0%
3	c. Keep feet spread apart to provide a more balanced distribution of weight.		3	38%
4	d. Try to regain balance and continue skiing.		0	0%
	Total		8	100%

Thumb Injury Survey Results:

Have you injured your thumb while skiing or snowboarding?

#	Answer		Response	%
1	Skiing		10	83%
2	Snowboarding		2	17%
	Total		12	100%

How did you injure your thumb?

Text Response
I fell face first and when I went to catch myself my hand got caught under my body and my thumbs jammed back and broke
slapping the ground after a cliff drop

Were you using ski poles at the time of injury?

#	Answer		Response	%
1	Yes		10	100%
2	No		0	0%
	Total		10	100%

How do you hold your ski poles?

#	Answer		Response	%
1	Grabbing the pole through the top of the strap		2	20%
2	Grabbing the pole through the bottom of the strap		7	70%
3	I don't use ski poles		1	10%
	Total		10	100%

Wrist Injury Survey Results:

Have you injured your wrist while snowboarding?

#	Answer		Response	%
1	Yes		8	50%
2	No		8	50%
	Total		16	100%

Are you a beginner?

#	Answer		Response	%
1	Yes		3	38%
2	No		5	63%
	Total		8	100%

Was it in the terrain park?

#	Answer		Response	%
1	Yes		2	40%
2	No		3	60%
	Total		5	100%

Were you wearing wrist guards?

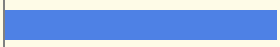
#	Answer		Response	%
1	Yes		1	14%
2	No		6	86%
	Total		7	100%

Wearing a wrist guard can reduce your chance of wrist injuries by 85%

Were you on your toe-side or heel-side edge?

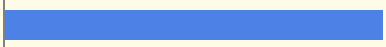
#	Answer		Response	%
1	toe side		1	14%
2	heel-side		6	86%
3	I don't know		0	0%
	Total		7	100%

Did you know how to fall correctly in order to prevent wrist injuries prior to your accident?

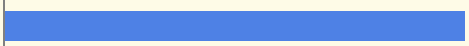
#	Answer		Response	%
1	Yes		4	57%
2	No		3	43%
	Total		7	100%

Head Injury Survey Results:

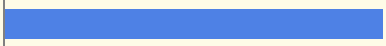
Have you previously been informed of helmet safety?

#	Answer		Response	%
1	Yes		23	79%
2	No		6	21%
	Total		29	100%

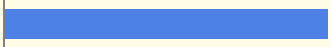
Are skiers and snowboarders at risk of head injury?

#	Answer		Response	%
1	Yes		27	96%
2	No		1	4%
	Total		28	100%

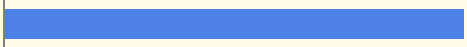
Are you aware of what kind of head injuries can occur?

#	Answer		Response	%
1	Yes		23	79%
2	No		6	21%
	Total		29	100%

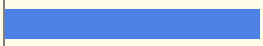
Does wearing a helmet effectively protect a skier or snowboarder?

#	Answer		Response	%
1	Yes		19	68%
2	No		9	32%
	Total		28	100%

Is helmet fit important?

#	Answer		Response	%
1	Yes		26	96%
2	No		1	4%
	Total		27	100%

Do you know when a ski or snowboard helmet should be replaced?

#	Answer		Response	%
1	Yes		15	54%
2	No		13	46%
	Total		28	100%

Are you aware of the four critical elements affecting a helmets protective property?

#	Answer		Response	%
1	Yes		8	30%
2	No		19	70%

Do you wear a helmet while skiing or snowboarding?

#	Answer		Response	%
1	Yes		23	85%
2	No		4	15%
	Total		27	100%

Have you injured your head while wearing a helmet?

#	Answer		Response	%
1	Yes		5	22%
2	No		18	78%
	Total		23	100%

Have you injured your head?

#	Answer		Response	%
1	Yes		2	50%
2	No		2	50%
	Total		4	100%

Explain the incident and injury

Text Response
No injuries while wearing a helmet. although have seen severe concussions resulting in convulsions from people (mostly racers) wearing helmets
Hit a tree, mild concussion, helmet cracked.
Never had one
I was night skiing in Maine when a rabid deer attacked me. I fought off the deer but it did hit me in the face e several times with it hooves. The helmet did nothing.
minor concussion while racing GS.
A snowboarder crashed into me and my head hit the ground hard.
Race course fell on head broke helmet knocked out
Airborne off large jump, upon landing head hit knees, severe concussion w/ memory loss resulted
no incident or injury
No Injury
Tree branch to the knoggin.
none.
I experienced a concussion and subsequent blackout while wearing a helmet. I went off a jump and fell, hitting the back of my head on ice.

Appendix B:

Group Management

Over the course of the project the group encountered many instances of poor group management. Below we have listed the problems we had come across.

- Gantt Chart configuration (how to use it and keep it updated)
- Missed Meetings(unexcused absences)
- Insufficient communication
- Flexibility

Working in a large group caused unexpected problems with keeping on task. Having five people on different schedules was the first obstacle to overcome. The meeting times became harder to schedule to suit the needs of all the group members. At first it was difficult to find a means for scheduling meeting times and project goals. To help aid in keeping the project moving forward the group created a Gantt chart.

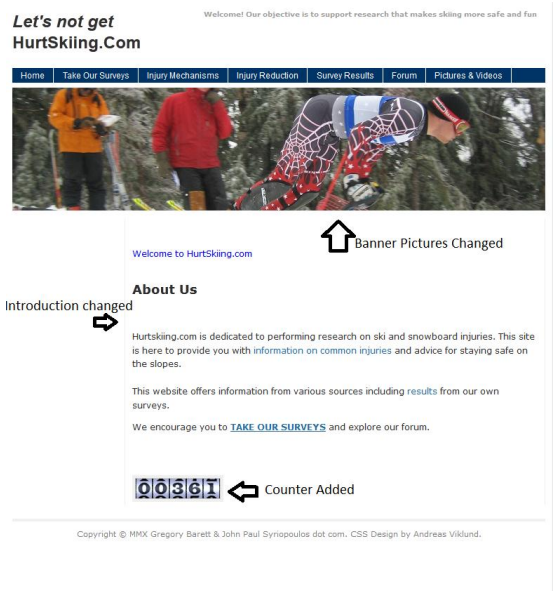
One of the more difficult challenges to overcome was the group's flexibility. The ability to arrange meeting times to suit everyone's schedules proved to be difficult. There were several instances of unexcused absences for meetings, which made it hard to meet weekly goals. The group considered implementing a penalty program for unexcused absences, but it proved to be unnecessary.

The group was able to work out a method for keeping on task on the project within the first few months. For future work on this topic it is recommended that the group size not exceed five or more people due to coordination issues. Although it is possible to coordinate large groups, the time wasted doing so can interfere with meeting deadlines.

Appendix C:

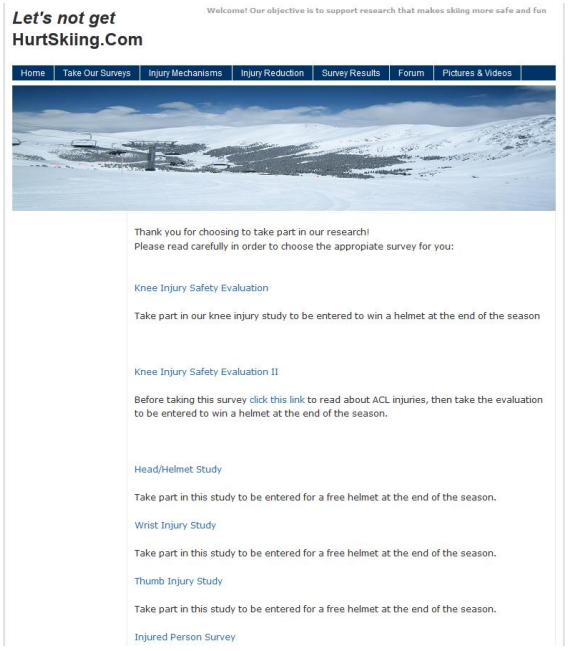
Website Updates

Homepage



The homepage received a few updates which included the greeting, banner pictures, and a counter which tracks how many visits to the site. The goal was to create a user friendly homepage to allow the user easy navigation.

Survey Page:

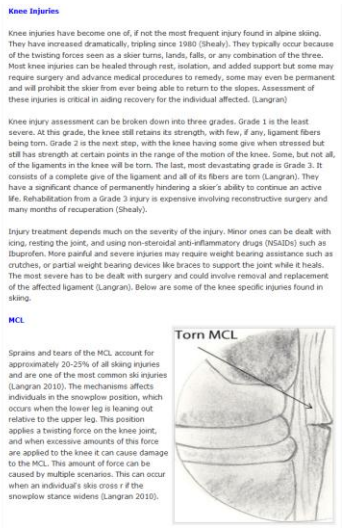


The group added 5 new surveys to the existing survey page.

1. Knee Injury Safety Evaluation 1
2. Knee Injury Safety Evaluation 2
3. Wrist Injury Survey
4. Thumb Injury Survey
5. Head/Helmet Survey

This page allows the user to take any of the desired surveys. After the survey link is clicked another page opens for the user to take the survey. Upon completion of the survey it returns the user to hurtskiing.com. The page also allows the user to navigate between other pages.

Injury Mechanism Page



Knee Injuries

Knee injuries have become one of, if not the most frequent injury found in alpine skiing. They have increased dramatically, tripling since 1980 (Shealy). They typically occur because of the twisting forces seen as a skier turns, lands, falls, or any combination of the three. Most knee injuries can be healed through rest, isolation, and added support but some may require surgery and advance medical procedures to remedy, some may even be permanent and will prohibit the skier from ever being able to return to the slopes. Assessment of these injuries is critical in aiding recovery for the individual affected. (Langran)

Knee injury assessment can be broken down into three grades. Grade 1 is the least severe. At this grade, the knee still retains its strength, with few, if any, ligament fibers being torn. Grade 2 is the next step, with the knee having some give when stressed but still has strength at certain points in the range of the motion of the knee. Some, but not all, of the ligaments in the knee will be torn. The last, most devastating grade is Grade 3. It consists of a complete give of the ligament and all of its fibers are torn (Langran). They have a significant chance of permanently hindering a skier's ability to continue an active life. Rehabilitation from a Grade 3 injury is expensive involving reconstructive surgery and many months of recuperation (Shealy).

Injury treatment depends much on the severity of the injury. Minor ones can be dealt with icing, resting the joint, and using non-steroidal anti-inflammatory drugs (NSAIDs) such as Ibuprofen. More painful and severe injuries may require weight bearing assistance such as crutches, or partial weight bearing devices like braces to support the joint while it heals. The most severe has to be dealt with surgery and could involve removal and replacement of the affected ligament (Langran). Below are some of the knee specific injuries found in skiing.

MCL

Sprains and tears of the MCL account for approximately 20-25% of all skiing injuries and are one of the most common ski injuries (Langran 2010). The mechanisms affects individuals in the snowplow position, which occurs when the lower leg is leaning out relative to the upper leg. This position applies a twisting force on the knee joint, and when excessive amounts of this force are applied to the knee it can cause damage to the MCL. This amount of force can be caused by multiple scenarios. This can occur when an individual's skis cross r if the snowplow stance widens (Langran 2010).

Several changes were made to this section of the website. The page consists of a description of all the injury mechanisms addressed. These injuries include Knee, Head, Thumb, and Wrist. These injuries were then broken down into specific mechanisms. For example, Knee injuries include ACL, MCL and Meniscal. This page contains educational material on specific areas where ski/snowboard injuries occur.

Website Updates Discussion

The first added feature to the website was a visit counter. Previously there was no way of tracking website visits. With this feature it is possible see how many people are actually visiting the site.

Another previously overlooked issue was the way surveys were constructed and accessed. The previous database hosting service made it difficult to create and distribute surveys. The previous software also did not offer an easy way to access the data received. By adding Qualtrics™ survey software it was possible to easily construct and review surveys and results.

Overall the website updates added were successful in creating a more user friendly experience. The future groups will be able to update create and distribute surveys more easily than in previous attempts. Now that the website is easier to use, higher visitor rates are expected as well as more people taking the surveys.

Appendix D:

Advertising:

The group used the following materials to advertise the website:

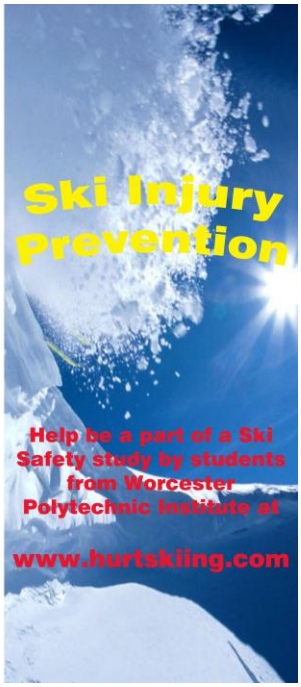
Mission Statement

The goal of this project is to determine the correlation between the knowledge one has of ski safety and their risk of becoming injured and to help lower the rate of snow sports injuries nationwide.

NSAA Skier Responsibility Code

1. Always stay in control.
2. People ahead of you have the right of way.
3. Stop in a safe place for you and others.
4. Whenever starting downhill or merging, look uphill and yield.
5. Use devices to help prevent runaway equipment.
6. Observe signs and warnings, and keep off closed trails.
7. Know how to use the lifts safely.

www.hurtskiing.com



Ski Safety Facts

- Borrowing skis without resetting the bindings can increase the risk of injury by up to 800%
- ACL injuries account for 30-40% of ski injuries
- Proper training can reduce the risk of an ACL injury by up to 62%
- Thumb injuries account for 5% of ski injuries
- Thumb injuries can be prevented by simply knowing the correct way to hold a ski pole

Your Cooperation is Greatly Appreciated!

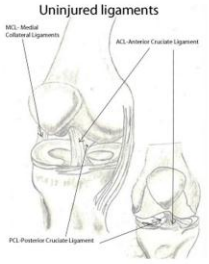
Please take the time to visit our website at www.hurtskiing.com and take our survey or safety quiz. Five minutes of your time may help to lower the rates of ski injuries across the nation.

While you're there, you can find out more information about common ski and snowboard injuries and ways to prevent them.

Ever heard of "Phantom Foot"?

Sprains and tears of the ACL account for approximately 10-15% of all skiing injuries. A variety of mechanisms are related to damage of the ACL, however; the mechanisms related to most ACL injuries is known as the "Phantom Foot." This specific mechanisms occurs when there's is a combination of twisting and bending loads to the knee.

Uninjured ligaments




LETS NOT GET
HURTSKIING.COM
We encourage you to go on our website, and take our survey.
A web based safety analysis on ski and snowboard injuries.
THE MAIN OBJECTIVE
TO
REDUCE INJURIES
THE RESEARCH WILL TEST
THE HYPOTHESIS
THAT EDUCATING SKIERS,
AND SEEING IF THE BASIC
KNOWLEDGE OF SKI SAFETY,
THROUGH A WEBSITE
DELIVERED
CAN REDUCE
SKI AND SNOWBOARD INJURIES
REGARDLESS
OF THE SKI AREA
REGION
OR COUNTRY
contact us
skiingiqp@wpi.edu