Investigating Snow Sports Injury Mechanisms Using a Web Based Survey

An Interdisciplinary Qualifying Project

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Abstract

This project sought to determine if a web based survey could be used to investigate injury mechanisms of skiing and snowboarding related injuries. A web based survey was designed to determine the conditions of the responder, the mountain, and their equipment at the time of the injury. 22 responses were gathered from the survey and 11 injury mechanisms were able to be determined.

Contents

Introduction

Objective

The larger objective of this research is to reduce injuries related to skiing and snowboarding.

To further this larger objective, several specific, supporting objectives were pursued:

- A web based survey will be used to gather data regarding snow sports injuries
- Determine if the web based survey can aid in determining mechanisms of injury
- Determine if some injuries go unreported to Ski Patrol because skiers and/or snowboarders were injuried in places other than were ski patrol is available

If the web based survey can help determine injury mechanisms, several other sub objectives will be pursued:

- Determine if inadvertent binding releases are a cause of injury
- Determine if snowboarders report lower extremity injuries when only one foot is strapped into the binding
- Determine if there is a difference in the concussions reported by skiers and snowboarders who indicated whether they wore a helmet or not

Rationale

A person can incur an injury while skiing or snowboarding. There are many causes of injury including but not limited to equipment failure, catching an edge, and colliding with an object on the ski slope. Understanding why a snow sports injury occurred can help prevent a similar injury occurrence in the future. For example, a common snowboard injury is a wrist fracture (Langran D. M., Snowboarding Injuries, 2009) caused by the snowboarder using his or her hand to brace the fall (Orthopedics, 2006). After sustaining a wrist injury, the snowboarder could begin to wear wrist guards because they reduce the risk of wrist injury while snowboarding (Russel, Hagel, & Fancescuttti, 2007).

The survey created for this research will serve as a tool to determine the existence of injury types within the respondents; as well, the survey data will be analyzed to determine the mechanisms of the injuries reported. The survey respondents are asked to provide a detailed summary of their injury as well as the moments right before the injury occurred. Using this information, the cause of the injury reported can be explored.

Hosting the survey online has the potential to reach a population of people who may not have responded to a live study (Wright, 2005). The web survey may yield responses from skiers and snowboarders who were injured skiing or boarding in an area where there is no first aid such as ski patrol. The web survey may also yield responses from those skiers and boarders who did not sustain an injury bad enough to report to ski patrol.

While the responses of the survey can be used to identify injuries and causes of injury, the responses cannot provide any epidemiological information regarding specific risks of injury. There exists no control group of uninjured skiers and snowboarders to take the survey. Additionally, the responses of the survey cannot be used to assess the frequency of any of the injuries reported. The people taking the online survey are not from the same population of skiers and snowboarders. Epidemiological information can only be determined by surveying an entire population of a specific area.

State of the Art

Skiing and Snowboarding Injury Studies

The sport of skiing became a popular activity around the world during the early 20th century (Lund, 1996). Injuries from skiing accidents have been reported throughout the history of the sport. As the sport evolved, the injuries reported evolved too. By the 1970's, the sport had evolved from downhill races and ski jumping to freestyle and mogul skiing. Likewise, the injuries reported from accidents evolved too. Early 20th century injuries were most often torsional leg fractures whereas mid-1970's injuries were often knee injuries. (Masia, 2003)

The first studies of skiing injuries came from Sun Valley Idaho in the early 1960's. Scott Earle and his team investigated 1,470 accidents to skiers. Based on their data, they determined that 43% of the injuries they saw were ligament injuries mostly of the lower legs. They were able to determine that the injury rate was approximately 7.6 injuries per 1000 skier-days (Earle & Moritz, 1962). This early study established the precedence for injury reporting and review (Hunter, 1999).

The leading epidemiological ski injury study is the study conducted at Sugarbush North Ski Area. Since 1972, Robert Johnson, Carl Ettlinger, and Jasper Shealy have been monitoring injuries at the ski area through a ski injury clinic that operates in conjunction with the local ski patrol. The study includes all skiers who request any form of medical assistance from the ski patrol clinic except injuries that do not require medical treatment (Johnson, Ettlinger, & Shealy, 1997).

The Sugarbush team asks each injured skier to answer a series of questions regarding their skiing ability, the circumstances of the accident, their skiing habits, and general information about their age and ski equipment. (Johnson, Ettlinger, & Shealy, 1997). The ski equipment that was used when the accident occurred is tested in the ski shop at Sugarbush. A control group comprised of skiers from the general skiing population at the ski area is asked to take a survey similar to that of the injured survey.

The results of this study are updated and published regularly as the study is still ongoing today. Their research has affected ski equipment design and general alpine sports safety. For example, Ettlinger, Johnson and Shealy concluded that a large number of leg fractures that occurred during a twisting fall were directly related to how the binding on the ski functioned. They developed a binding that released the ski boot in the event of a twisting motion. Implementation of their binding ultimately led to a decrease in leg fractures related to twisting falls (Langran M. , 2010).

The Swedish Ski Lift and Area Organization has been studying ski and snowboard injuries that occurred from 1989 to 1999. Every skier or snowboarder who needed medical attention from the ski patrol was asked to answer and injury survey that documented skill level of the injured person, risk behavior, if any protective equipment was used, skiing days per season, and circumstances around the accident. The study determined that the majority of snowboard injuries affected the wrist or lower arm of the snowboarder and that half of all injuries stemmed from falling. (Made, 2003)

Ski injury surveys on the internet

Dr. Michael Langran, based out of Scotland, has been conducting several ski and snowboard injury studies as well. Langran's study is conducted through his website (www.ski-injury.com). In his survey, he asks questions regarding mountain conditions, cause of accident, injury location, type of injury, and general information about the respondent, such as age and height. As of October 25, 2010 Langran has received 176 completed reports but has yet to publish any data of his findings from this survey. (Langran M. , 2010)

Langran highlights that the highest reported injury rates come from self-reported cases as collected in web-based studies or written questionnaires. (Langran M. , 2010). However, he also notes that there are difficulties associated with studies of this type. Data accuracy cannot be verified in studies where people can self-report their injuries. There is no way to discern whether or not a reported injury in fact occurred or if someone made the story up.

Langran's web survey is unable to obtain data for a whole population of skiers and snowboarders from a specific area. Therefore, the survey results cannot be used to draw epidemiological conclusions about injuries and trends in the population. The survey results can however be used to determine injury mechanisms as well as negate claims of non-occurrence.

Injury Mechanisms

Skiers and snowboarders can have similar injuries. Both sports experience knee injuries, leg fractures, wrist fractures, concussions and many other injuries. However, the mechanisms that cause these injuries can differ greatly between the sports.

Both Langran and the Sugarbush team have identified many of the mechanisms surrounding the common injuries reported in skiing and snowboarding. Langran's website breaks down injuries both by sport and by body part (Langran D. M., Snowboarding Injuries, 2009). For the more common injuries, he gives a description of the various mechanisms that may cause the injury. For example, the portion of his web site dedicated to alpine ski injuries discusses three specific mechanisms of injury related to ACL injuries (Langran D. M., 2010). He discusses flexion-internal rotation, forward twisting fall, and boot induced anterior drawer mechanisms.

Knowing information about how the injury occurred can aid in preventing the injury in the future. Advances made in ski bindings, helmets, and various other pieces of safety equipment have reduced the risk of sustaining certain types of injuries. The Sugarbush team designed a type of ski binding that reduced the risk of leg fractures because it released the boot from the ski when the skier fell (Langran M. , 2010). Wrist guards have been proven to reduce the risk of wrist fracture while snowboarding. Wearing the wrist guards helps reduce stress to the joint when falling. (Russel, Hagel, & Fancescuttti, 2007)

Approach

Website Design

The website that hosts the survey was primarily coded by Greg Barrett as described in *Collecting Skiing and Snowboarding Injury Data with A Web Based Survey* (Barret, 2010). Together, Greg and I designed the website to be simple to use, easy to navigate, and aesthetically pleasing. Navigation through the website is controlled using the links located in the tool bar of the web site.

The survey feature of the website was designed so that you could not go back to a previous page while you were completing the survey. This was done to ensure that only one set of data was being stored per survey response.

Data collected from the survey is displayed on the results page. The graphs update immediately as new survey information comes in, thus the website is always displaying the most current results. A forum was designed and implemented to create a community where users could interact with one another regarding ski injuries.

Survey Structure

The survey was designed to be 4 pages long and was broken down into four categories: background, conditions, injury, and final questions. The survey pages each contain 15 questions or less. The first three pages of the survey contain static questions that provide information regarding the injury, the conditions of the mountain and general information about the injured person. The fourth page is a set of dynamic questions that varies depending on user-input from the previous pages. The point of the dynamic questions is to ask specific questions that only apply to certain types of injuries. The results of the survey are saved to a database associated with the website.

Methods

In order to fulfill the larger objective of reducing injuries related to skiing and snowboarding, a web-based injury survey was created and hosted on the website www.hurtskiing.com.

The web survey I designed was modeled off of the survey handed out at Sugarbush in the studies conducted by Ettlinger, Johnson, and Shealy; the web survey was comprised of questions that help frame the injury of the skier or snowboarder.

Web Survey Design

The survey length and aesthetics were based on several key features outlined by Thomas Archer in (Archer, 2003). Archer states that the survey needs to be short enough to keep people interested in responding. He recommends that the surveys are no longer than 8 pages. Titus Schleyer and Jane Forrest also suggest using a meter to measure the progress of the user (Schleyer & Forrest, 2000). At the top of each page of the survey for this research, there is a progress bar that indicated what stage of completion you are on.

Certain questions require the skier or snowboarder to manually enter in data or values. In instances where anything more than selecting an item from a list is required, subtext underneath the question gives directions to the skier or snowboarder to assist in answering the question. The purpose of the subtext is to reduce the discrepancies in the answers of the survey. Showing someone that height is measured in inches on the survey reduces the likelihood that the responder will report his or her height in feet.

The survey does not ask every responding skier or snowboarder the same questions. There are some questions within the survey that are unique to either a specific injury type or just to skiing, or just to snowboarding. For example, a skier does not need to answer questions about standing in the lift line with one foot strapped into the binding. Likewise, a snowboarder does not need to respond to questions regarding ski poles. The responses given from the first two pages affect the questions that could be displayed on the third and fourth pages. This shortens the length of questions that the responder has to interact with.

Web Survey Questions

The first page of the survey asks the responder to give details about themselves such as but not limited to age at the time of injury, ability level at the time of the injury, and whether they have any sort of recognition from a competitive association or instruction association. The purpose of these questions is to establish a baseline of information that can be used to identify patterns of injury within a gender, at specific points of the season, or across ability groups. I decided to require that the responder report their height and weight. These physical factors may be useful in analyzing injury mechanisms.

The second page of the survey asks questions about the physical condition of both the trail and the skier or snowboarder at the time of injury. The survey asks about the trail conditions, trail difficulty, the time of day, and the fatigue level of the skier or snowboarder. Understanding the physical conditions of both the trail and the skier or snowboarder at the time of injury helps establish which risks of injury the skier or snowboarder faced. For example, knowing that the trail was icy or that the lighting was poor can help determine if the injury occurred because of poor conditions on the slopes. Knowing if the skier or snowboarder was tired or hadn't stretched can help determine if any muscle injury could have been prevented.

The third page of the survey asks questions about the injury itself. It prompts the skier or snowboarder to check boxes correlating to the area of their body that was injured such as head, thumb, leg, or knee. The skier or snowboarder also must report the type of injury incurred such as a sprain or dislocation or laceration. The last question on the page is an open ended question. The skier or snowboarder has an opportunity to explain in words the circumstances leading up to the moment of injury.

The description of the accident given by the skier or snowboarder can provide insight into the injury that wasn't captured in the questions that were asked. For example, if a female skier reports having caught an edge skiing down a black diamond and injured her leg, the survey data would show a leg injury with either muscle or bone damage. Her description of the injury however states that as she was initiating a carved turn, the inside edge of her right ski got caught in a rut causing her leg to twist as she fell. From this description, the injury seems to have been caused by the torsional forces applied to her leg as she fell. This mechanism wouldn't have been determined without her description.

The fourth and final page contains a set of dynamic questions that appear only if certain injury boxes were checked off on the previous page. These questions that appear ask follow up questions to further understand the injury sustained. For example, if a skier reports a thumb injury on page three, the questions on page four would ask if he or she was wearing pole straps and if he or she knew how to correctly wear them. These questions are important to ask because they help clarify how the injury was sustained.

Injury Mechanisms from the Responses

With every complete survey response, I should be able to identify the injury mechanism from the data collected.

Injury mechanisms differ between skiing and snowboarding, so identifying whether the responses are from a skier or snowboarder should be the first step taken.

Upon determining if the response is from a skier or snowboarder, the next steps are to determine the location on the mountain where the injury occurred and what the condition of the trail was like at the time of injury. By understanding what the trail conditions were like, I can understand how the rider was moving on the trail right before the fall. This information can provide insight into whether or not the rider was in control of their speed at the time of the fall. It can also provide insight into how the condition of the mountain affected the fall. Icy trails would make quick maneuvering very difficult because the skis and snowboards do not grip ice as well as snow. Slushy, spring snow could weigh the tips of a rider's skis down and make turning and maneuvering difficult as well.

The response the snowboarder or skier wrote regarding how the injury occurred and help determine what caused the fall. Determining the cause of the fall can provide insight into the angle the rider fell. By examining this, the angle at which the rider impacted the ground, and the body part injured, we should be able to picture exactly how the rider fell.

The easiest way to determine what the mechanism of the injury is by knowing exactly how the rider fell.

For example, a skier is standing at a merging point of two trails. An out of control skier collides with the skier who was standing. The standing skier suffers a knee injury as a result. The standing skier reports in the survey than the conditions were icy and foggy that day. The skier also reports that it was toward the end of the afternoon on a black diamond trail on the east side of the mountain. The skier indicates in his written description of the injury that his left leg was twisted around from the boot during the collision.

From this information you can determine that the standing skier was hit with a reasonable amount of force. The angle of the fall is in a downward direction. The knee injury likely came from the force applied to the joint as the skier's leg was twisted around.

After determining this information, the injuries will be compared to resources that define specific types of injury mechanisms. Langran's website is a specific example of this.

Results and Discussion

Using the Website to Collect Injury Data

The website was successful in gathering injury data. The survey was answered by 22 participants, 6 of which did not completely fill out the survey.

The people who responded to the survey covered both genders, nearly every age bracket, and all every ability levels. Those who responded ranged in ability from beginner to expert and included 13 snow sports instructors. 5 of the responders also indicated that they were ranked with FIS or USSA points. Nearly all the responders claim to ski or snowboard more than 21 times a year. Table 1 below is a sample of the data collected from the survey. It highlights all 22 users who responded and demonstrates that responses came from all types of skiers and snowboarders.

age	gender	weight	height	vehicle	frequency	ability	Skier type	years skiing
15	female	120	65	ski	1-10	intermediate	recreational	5
16	female	98	62	ski	21+	expert	recreational	13
54	male	190	73	ski	11-20	expert	instructor	15
19	male	155	69	board	21+	expert	instructor	10
12	male	100	63	ski	21+	expert	racer	9
59	male	198	70	ski	21+	expert	recreational	10
47	male	215	74	ski	21+	expert	recreational	36
63	male	185	731	ski	21+	expert	instructor	55
42	male	170	66	board	21+	expert	instructor	38
43	male	128	5	ski	21+	expert	instructor	26
41	female	120	63.6	ski	21+	intermediate	recreational	35+
31	male	250	72	ski	21+	expert	instructor	28
0	male	132	70	board	21+	expert	instructor	6 years
14	male	121	69	board	11-20	intermediate	recreational	4
22	male	160	70	ski	21+	expert	instructor	18
29	female	185	5	ski	21+	expert	instructor	14
47	male	150	5	ski	21+	expert	racer	44
43	male	175	72	ski	21+	expert	instructor	38
17	male	130	70	board	21+	expert	instructor	5+
13	male	105	62	ski	21+	intermediate	recreational	9
47	male	160	67	ski	21+	expert	instructor	40
42	male	215	75	ski	1-10	beginner	recreational	2

Table 1: Population that answered the survey

The people who responded to the survey were asked to indicate where they heard about the survey. 18 of the 22 respondents of the survey indicated where they heard about it. Of those 18 respondents, all but 3 respondents reported that they heard about the survey from the author of this research, either through messages on social networking sites or from me asking them to fill out this survey. 2 of other responses reported hearing about the survey from Christopher Brown who is the advisor of this research. One response reports hearing about the survey from a flyer that was distributed during a ski race at a ski area in New York.

Based on this information, it is clear that the website and survey need to be publicized more. The survey should be marketed to groups such as but not limited to National Ski Patrol, National Standard Racing (NASTAR), International Ski Federation (FIS), and Professional Ski Instructors of America (PSIA). Ski patrol and PSIA could provide the website to person who sought medical attention at a clinic or who was injured during a lesson. Groups like NASTAR and FIS could provide the website information to the racers at a given race and ask them to provide responses to the survey. Marketing to large groups such as these could result in more success in using the survey to gather data.

Determining Injury Mechanisms from the Responses

Some of the data collected from the survey can be analyzed for injury mechanisms. Of the 22 total responses, only 11 injury mechanisms could be determined. This is because the respondents either did not completely fill the survey out or they did not provide enough information to determine injury mechanisms. Table 2 highlights the data that could not be used to determine injury mechanisms. The data is either missing an answer to a question, or the answer that was provided in the open ended question does not contain enough information.

age	gender	vehicle	warm up or stretch	snow conditions	trail type	trail difficulty	injury list	injury type list	injurydescription
15	female	ski	no	racecourse	alpine	blue	NULL	NULL	NULL
19	male	board	no	racecourse	other	green	NULL	NULL	NULL
47	male	ski	noanswer	noanswer	noanswer	noanswer	NULL	NULL	NULL
42	male	board	no	packed	alpine	green	shoulder	dislocation	trying new flatland trick
43	male	ski	noanswer	noanswer	noanswer	noanswer	NULL	NULL	NULL
41	female	ski	no	mixed	alpine	blue	NULL	NULL	NULL
0	male	board	noanswer	noanswer	noanswer	noanswer	NULL	NULL	NULL
29	female	ski	yes	mixed	alpine	blue	knee	tear	This injury was from earlier 1998-1999. I was not as strong of a skier. The blue squares at the point where like a double black. I believe i may have caught a edge.
17	male	board	no	mixed	jump	blue	head neck shoulder	laceration	NULL
13	male	ski	no	packed	jump	blue	head	concussion	I caught and edge while spinning off the lip of the jump.

Table 2: Responses that could not be used to determine injury mechanisms

To prevent incomplete survey responses, a function could be implemented into the code of the website that does not allow a user to exit the survey after he or she has begun to answer questions. This ensures that all responses stored in the database are complete.

11 responses from the survey were used to determine injury mechanisms. Tables 3 and 4 highlight the survey responses that contained enough information to determine injury mechanisms. The list below is a summary of the injury mechanisms that could be determined from the survey responses. These injury mechanisms are not supported by any medical documentation from the responses nor have they been reviewed by doctor; therefore they should not be considered medically accurate. They are simply a demonstration that it is possible to collect enough data on the web that can help determine injury mechanisms.

- Response Number 1: The knee injury was determined to be caused by an ACL mechanism known as forward twist falling.
- Response Number 2: The leg injury was determined to be caused by a twisting force called Skiboard Blocking applied to the leg during the fall.
- Response Number 3: The head injury was determined to be caused by a collision with the skier's own ski during the fall.
- Response Number 4: The knee injury was determined to be caused by an ACL mechanism known as forward twist falling.
- Response Number 5: The wrist injury was determined to be caused by falling out onto a stretched hand (also known as FOOSH).
- Response Number 6: The head, neck, and spine injuries were determined to be caused by a collision with the ground.
- Response Number 7: The knee injury was determined to be caused by hyperextension of the knee joint.
- Response Number 8: The knee injury was determined to be caused by an ACL mechanism known as Flexion-internal rotation
- Response Number 9: The calf injury was determined to be caused by over-stretching the calf muscle during the fall.

- Response Number 10: The knee injury was determined to be caused by an ACL mechanism known as Boot Induced Anterior Drawer.
- Response Number 11: The leg injury was determined to be caused by equipment failure when the binding didn’t release.

Response Number	age	gender	vehicle	warm up or stretch	snow conditions	trail type	trail difficulty	injury list	injury type list	injurydescription
1	16	female	ski	yes	packed	moguls	black	knee	dislocation	Coming down the moguls, I missed a pole plant and subsequent turn. I got launched over the top of one of the moguls and fell to my left, hitting my left leg on the top of another mogul. I slid for about 30 ft, all the time being bumped into moguls. Equipment stayed on, but somewhere in there I hit my knee hard enough to dislocate it.
2	54	male	ski	yes	mixed	alpine	blue	lowerleg	fracture	Skiing on Saloman snow blades with non release bindings. No crowd on trail. Snow was mixed with some piles in trail. Making a right hand turn when tip of snow blade stuck in a pile and twisted and broke the right tibia and fibia at the boot top. Was still standing on the left leg and had to throw myself down the hill to prevent putting any more stress on the right leg.
3	63	male	ski	no	powder	backbowl	triple	head	laceration	Hit a rock hidden under powder snow, ski caught, pitched forward and fell, ski windmilled on safety strap and hit me on the head causing laceration.
4	31	male	ski	no	packed	alpine	green	knee	tear	beginner hill, a lesson slid into me hooked my ski and slowly twisted my knee around before i could get away from them
5	14	male	board	yes	packed	alpine	black	wrist	fracture	Caught an edge, fell backward, put my arms out stiff and jammed wrist
6	22	male	ski	no	powder	alpine	black	head nose neck spine	concussion	caught and edge after going off a jump and trying to avoid a skier who had fallen in front of me, caught edge and took a high speed face plant

Table 3: Data from the Survey that Could be used to determine injury mechanisms Part 1

Response Number	age	gender	vehicle	warm up or stretch	snow conditions	trail type	trail difficulty	injury list	injury type list	injurydescription
7	47	male	ski	yes	racecourse	GS	black	knee	sprain tear	Was in control and suddenly went off race line for no apparent reason, tried to recover and immedaitly fell. Spun backwards and landed on my back. While sliding down the hill the back of my ski dug into the snow and hyperextended my knee. Still not sure whether my knee failed in the race turn, causing the crash, or wether the damage occured after the fall as my ski dug into the snow.
8	43	male	ski	yes	packed	alpine	blue	knee	tear	Was messing around at moderate speed (20mph), looked uphill to spot my companion, hit a patch of ice and went down. Tried to come right back up onto my skies, but caught an edge which redirected me towards the woods. Went off trail into the woods feet first and in an attempt to stop muself set a very agressive edge and my right knee blew.
9	47	male	ski	yes	mixed	alpine	green	lowerleg	tear	Ski went straight down into soft spring ski on other side of small jump. Leg pulled straight out of binding without any twisting motion. Tore gastroc muscle 4 cm.... My theory was the lack of twisting meant the binding did not release with expected DIN?
10	59	Male	Ski	Yes	Packed	Alpine	Blue	Knee	Sprain	was hit from behind by out of control skier, I tore the ACL in my knee a few years ago and still wear a brace on that leg (Don Joy Brace). It acted like a "seatbelt", if I hadnt had it on, I believe the injury would have been much worse.
11	42	male	ski	no	packed	alpine	blue	lowerleg	fracture	on trail, all alone, caught an edge, crash caused boot fracture of the fibula, binding did not release(bindings set to tight for my ability)

Table 4: Data from the Survey that could be used to determine injury mechanisms Part 2

In order for injury mechanisms to be truly investigated, the data needs to be supported medically. This survey does not currently have a way of collecting medical data such as x-rays or MRI's that could supplement the responses to the questions asked. The questions asked in the survey were designed by someone without any medical knowledge. There is the possibility that the survey does not ask all the necessary questions to gather enough data about an injury to determine its exact mechanism. Therefore, the conclusions about the injuries reported are based strictly on prior research done regarding ski and snowboard injuries.

Future work should investigate the possibility of consulting with a medical professional. The medical professional could help in determining what questions would be most appropriate to ask in regard to injuries; also, the medical professional could help in validating the determined injury mechanisms from the various responses.

Sub-Objectives Related to Injury Mechanisms

None of the sub-objectives related to injury mechanisms could be determined. There were no cases of inadvertent binding releases reported from skiers. There were no cases of leg injuries when only one foot was strapped into the binding reported from snowboarders. Only one concussion was reported by a skier who did not wear a helmet. No other cases of a concussion were reported from either skiers or snowboarders. With no other data to compare this injury to, no conclusion can be drawn regarding whether there exists a difference in the concussions reported by skiers and snowboarders who indicated whether they wore a helmet or not.

More data is necessary for investigating any kind of specific injury mechanism. Therefore, the survey must gather more responses before specific injury mechanisms are studied. Future work should focus on gathering more responses to facilitate investigating these sub-objectives.

Determining if Some Injuries Go Unreported

It cannot be determined if injuries go unreported to ski patrol. The survey responses all indicated that the skier or snowboarder was injured at a ski area. None of the responses contained any information indicating that the skier or snowboarder who responded was hurt skiing or boarding outside of the ski area at any other time. However, this survey was designed to investigate only one injury per respondent. The survey does not ask directly whether the respondent has ever been injured skiing or snowboarding outside of a ski area. In fact, the survey does not ask how many times the respondent has been injured skiing or snowboarding. Therefore, the only conclusion that can be made about is that none of the respondents reported being injured outside of a ski area.

In future work, the survey should incorporate questions that ask about multiple injuries. This includes asking questions that would indicate whether the skier or snowboarder rides outside of designated ski areas, such as local parks, playgrounds, schools, or at home. Injuries sustained from accidents outside of the ski area may present information that supports different injury mechanisms due to differences in skiing or snowboarding outside of the ski area.

Conclusion

- A web based survey can be used to investigate skiing and snowboarding related injuries.
- The data collected from the survey can be used to help determine injury mechanisms
  - In order to determine injury mechanisms of specific types of injuries, more data is needed
  - In order to more accurately determine injury mechanisms, the survey and data should be reviewed by a medical professional
- The survey must be modified in order to determine if injuries from areas outside of ski areas go unreported.
- The survey must be modified to prevent people from not answering questions

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