A Web Based Survey on the Environmental Risk Factors Associated with ACL Injuries in Soccer Players

An Interactive Qualifying Project

Submitted to the faculty of

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Abstract

The goal was to create a web survey to study the relationship and risk factors associated with anterior cruciate ligament injuries in soccer players. Interactions between footwear and surfaces were focused on, looking into any potential relationships. We successfully designed a series of surveys, a website and marketed the project to high school and college teams. Low response rates were obtained, preventing us from making conclusions about shoe-surface combinations and prevention methods. However we were able to conclude that the methods used did not generate adequate responses.

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1. Introduction

1.1 Objective

The objective of this project was to determine the nature and relationship of risk factors associated with anterior cruciate ligament (ACL) injuries in soccer players. The survey focused on the environmental factors: the players' footwear and the field surface. The information from this project was used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

1.2 Rationale

Since 1972 when the United States government passed Title IX, there has been roughly a 900 percent increase in the number of females participating in sports (Women in Sports Foundation). Title nine states that: "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any educational program or activity receiving Federal financial assistance" (Women in Sports Foundation). "Coinciding with participation increase is the number of ACL injuries occurring each year. In 16 NCAA sports, between the 1988-1989 school year and 2003-2004 there was a 1.3 percent increase in ACL injuries each year" (Agel et al., 2005).

1.2.1 Social

An ACL injury can be an extremely devastating, with approximately 150,000 occurring each year in the United Sates alone (Boden, 2008). Rehabilitation is a gruesome four to six month process, where athletes are sidelined and on top of that it takes roughly another six months for players to "feel" back to normal (Sokolove, 2008). The effect can be almost twice as devastating for younger players, says Hannafin as depicted by Sokolove (2008) in his book "Warrior Girls: Protecting Our Daughters against the Injury Epidemic in Women's Sports." "Each of them will likely experience what Hannafin [calls] 'a grief reaction.' 'They've lost their sport,' she says 'and they've lost the kinship of their friends, which is almost as bad as not being able to play'" (pg.8). A college athlete can also be at risk of losing his or her scholarship funding, dependent on the institution, due to inability to compete. Some even suffer from psychological side effects which can be seen by lower academic performance (Myer et al., 2004). The injury does not only affect the athlete on the field or court, it also affects his or hers social life, and psychological and long term health.

1.2.2 Economical

Injuries are not only detrimental to a person physically, but economically as well. "To, date the majority of the sport injury literature in the USA has not addressed the costs associated with sports injuries in a comprehensive manner" (Knowels et al., 2007). Based on the study by Knowles and colleagues (2007) of North Carolina High School athletic injuries, the cost for a knee injury such as an ACL tear is upwards of $248,000. A recent 2011 study broke down the cost of two different types of surgery; total ACL reconstruction surgery and knee arthroscopy

surgery, the two run anywhere from $6,310 to $12,740 (Lobowitz, 2011). In addition to medical costs, Knowles and colleagues' (2007) proposed cost takes into consideration loss of future earnings of the student-athlete and his or her parents, for taking care of the athlete and reduced quality of life. Their study based quality of life on seven different factors (mobility, cognition, bending/grasping, pain, sensory, cosmetic, and ability to work) that physicians rated each patient on. This price reflects patients who chose to be operated on, patients who do not choose to be operated on will have a much lower cost (Wojtys & Brower, 2010).

1.2.3 Technological

Studies have used a variety of technologies to gather and analyze injury data. There are various databases in affect that allow coaches and athletic trainers to file injury reports. Some of these databases include the NCAA Injury Surveillance System, National Athletic Injury/Illness Reporting System, and the National High School Injury Registry. Some states also have injury reporting systems (Radelet et al., 2002). Renstrom and colleagues (2008), described the types of studies that can be done including interviews with injured athletes, analysis of video recordings of actual injuries, clinical studies, in vivo studies, cadaver studies, mathematical modeling of injury situations and measurements/estimation from "close to injury" situations. Of these modes the most predominate are video analysis and interviews/questionnaires.

1.3 State of the Art

As ACL injury numbers continue to rise, the facets of the injury are being scrutinized even more. In reviewing the research it was determined to break the project into three components. First, the environmental factors will be explored in detail, then the data retrieval methods, and finally forms of prevention.

1.3.1 Environmental

Environmental factors are considered to be extrinsic factors including; knee bracing, footwear, playing surface and weather. The main focus here was on player's footwear, and playing surface.

1.3.1.1 Shoe Design

Athletic shoes are a necessary part of training and competition, providing a variety of advantages. The midsole, which is made of a compliant, elastic material and sits between the upper part of the shoe and the outsole acts as a protective layer between the foot and the ground and disperses the forces of planting over a larger surface area. Although the midsole helps cushion the forces acting on the body while in motion, it does not reduce the magnitude of the force. Another important component is the traction that a shoe provides. "The frictional interface between the ground and the outsole of the shoe determines the amount of traction offered by the athletic shoe" (McPoil, 2000). Due to the various playing surfaces, outsoles must be constructed from different materials to provide an appropriate amount of traction. Shoes also provide control of rearfoot and mid-foot motion. The degree of motion control is dependent on the last, which determines the fit of the shoe, and the density of the midsole.

Despite all the advantages of footwear, there are also some noteworthy disadvantages. Over time shoes can deform which can affect how well the shoe performs. For instance, with side to side movement, the upper material of the shoe can become over-stretched leading to excessive shear and compressive forces. In addition, some athletes experience a decreased sensory perception as a result of wearing shoes by "underestimate[ing] the actual load applied through their foot and lower extremity" (McPoil, 2000).

Some of the first to research the interactions between shoes and playing surfaces were Torg and Quedenfeld (2006). They observed a correlation between the occurrence of knee and ankle injuries and the number and size of cleats on a shoe (Livesay et al, 2006). Torg went on to quantify the injury potential of shoe-surface combinations by defining a release coefficient based on peak torque. It was found that this torque was dependent on the distribution of material at the toe and heel among other factors.

Cleat design has been a target of various studies over the past 30 year, especially in football. From 1989 to 1991, Lambson, Barnhill and Higgins(2006) tracked ACL tears in over 3000 high school football players. They found that of the four cleat designs they were examining, the one most likely to be associated with knee injuries had "irregular cleats placed at the peripheral margin of the sole, with a number of smaller, pointed cleats positioned interiorly" (Livesay et al., 2006). In 2010 another study looked into the torque created by different shoes on a grass field, under different game relevant loading conditions. It was discovered that conventional shoes with round cleats created the highest peak torque in two of the loading patterns. In addition, the shoe with both round and bladed cleats had the highest peak and effective torques for the other two loading patterns (Grund & Senner, 2010). Although different studies found correlations, Villwock and coworkers (2009) found no relationships between the cleat pattern and rotational stiffness in the 10 types of football cleats that they tested. The only outlier was turf cleats, which produced significantly lower torque. The model of the shoe however did significantly affect the rotational stiffness. The shoe with large rubber cleats and rigid upper and sole produced a higher rotational stiffness (Villwock et al., 2009).

1.3.1.2 Surface Risk Factor

The two main characteristics of surfaces related to injury are ground hardness and traction. Ground hardness is "the effect that the surface has on absorbing impact energy" and traction is "the type of footing or grip a playing surface provides" (Petrass & Twomey, 2012).

There are a variety of playing surfaces that are used by field athletes. Some of the most popular are natural grass and synthetic surfaces. The first synthetic surface was Astroturf, which is composed of rough monofilament knitted nylon fibers. Since the release of Astroturf other synthetic turfs have been developed to more closely mimic grass. These surfaces include Astroplay and FieldTurf, which "are based on an in-fill system consisting of a mat of polyethylene fibers within a bed of sand and/or rubber particles" (Livesey et al., 2006).

Studies have also considered the ground condition and how it relates to injury rates. One of the first studies on ground conditions in football was conducted in 1972 by Bramwell and colleagues (2102). The researchers found no statistically significant differences "between injury rates on wet and dry grass, or between dry synthetic turf and wet or dry grass" (Petrass & Twomey,

2012). There was however a higher rate of injury on dry synthetic turf versus all other surfaces. In 1974 Adkison and colleagues (2012) studied natural and artificial turf and found that there were no significant differences between injury rates on soaked, wet, or dry fields. That same year Mueller and Blyth noticed a noteworthy decrease in knee and ankle injury rates on well-maintained natural turf fields as opposed to regular fields (Petrass & Twomey, 2012).

In the 1980s, Andresen and colleagues (2012) assessed natural turf condition on four descriptors (good, wet/slippery, hard, and muddy). They found that injury rates differed significantly with different ground conditions and found the highest rates of injury during "good field" conditions and the lowest during wet/slippery conditions (Petrass & Twomey, 2012). In three studies on rugby over the past 10 years there has been an agreement that playing on very firm/hard natural turf is associated with higher injury rates. In football two studies done by Meyers and colleagues (2012), affirm this theory that more injuries will occur on a dry field. In addition, Meyers observed a lower incidence of injury on FieldTurf than grass. However in 2006 Ramirez and colleagues, documented that injuries were 1.2 times more common on wet or muddy grass than on natural/artificial turf (Petrass & Twomey, 2012).

Grimmer and colleagues (2012), who studied Australian Rules football at a community level, found that injuries were most often associated with surfaces that had low/normal hardness. However, "studies with elite AFL players identified an increased risk when ground conditions were classified as harder" (Petrass & Twomey, 2012).

With different types of turf, questions arise about which one is the safest. Villcock and colleagues (2009), tested cleated football shoes on 16 different surfaces to measure the torque produced at the shoe/surface interface. They found that in turf, the infill particle size and fiber spacing were factors in generating excess torque. In addition, over a 5-year period, 318 ACL injuries in college football were reported to the NCAA ISS. Of these, 147 occurred on artificial turf and 161 occurred on natural grass. However, "there was a greater rate of ACL injuries on artificial turf versus natural grass" (Dragoo et al., 2012). Almost 90 percent of the injuries that occurred on artificial turf were on an artificial surface with fill. The only time that this was not the case was during game settings in which more injuries occurred on grass (Dragoo et al., 2012).

1.3.1.3 Shoe-Surface Interaction

Studies have looked at shoe-surface interactions from either the shoe perspective, by trying to calculate the torques, or the surface perspective, by observing its effect on injuries. However, Livesay and colleagues (2006), took a slightly different approach. Their research is based on the knowledge that "the friction between shoe sole and surface is necessary. In sports, high friction avoids slipping and permits one to grip a surface better, and this normally permits faster movements; but if friction is excessive, overload is produced in joints and injuries may occur" (Dura et al., 1999). Livesay and colleagues tested two types of shoes ("grass" and "turf") on a variety of field surfaces to measure the peak torque. The researchers found that the highest mean peak torque was 38.8 N*m for a grass shoe-FieldTurf combination. In the turf shoe the Astrourf resulted in the highest peak torque at 33.2 N*m (Livesay et al., 2006).

1.3.2 Testing Methods

The majority of studies done on environmental risk factors have been mechanical or biomechanical in nature. Villwock and coworkers' (2012), study created a testing apparatus, to measure the torque produced at the shoe-surface interface. Other testing methods include those used for surface hardness. A Clegg impact tester is often used. The device is a hollow tube in which a weight is dropped onto the surface measuring how quickly the weight stops upon impact. The faster the weight comes to a stop, the harder the surface. In addition to the Clegg hammer, a penetrometer has also been used in studies to measure soil strength by depth of penetration (Petrass & Twomey, 2012).

Ronkainen and colleagues (2012) aimed "to identify relationships that players' perceive between the characteristics of a soccer pitch and the way in which the game of soccer is played." In doing so, individual interviews and focus groups were conducted with 103 elite players. A ground theory approach was then used to group together the qualitative data. Surface condition, ball interaction and the player emerged as three key areas (Ronkainen et al., 2012).

Lots of studies have also utilized the NCAA's Injury Surveillance System (ISS) to get data. Dragoo and colleagues (2012) utilized the ISS to collect information over a five year period. Data was collected on "basic mechanism of injury, time and place of injury, body part injured, type of injury, severity of injury, and sport-specific questions such as player position and equipment involved" (Dragoo et al., 2012).

A few studies have used questionnaires to collect data, often utilizing medical staff to document the injuries. In the research done by Andresen, Hoffman, and Barton (2012), on field conditions and other factors, all data was obtained by direct observation and recorded on a standardized form. In 2000, Chomiak examined football players of different skill levels and ages to determine extrinsic and intrinsic factors associated with severe injuries. In this study orthopedic surgeons completed a standard examination and analyzed the medical history of their patients. In addition, all of the players completed a questionnaire about their injury, including the ground condition (Petrass & Twomey, 2012).

1.3.3 Current Methods of Prevention

Two current methods of prevention commonly used are: strength and conditioning/rehabilitation and external knee supports. External knee supports are commonly known as braces, and are sold in a variety of styles and materials. They are readily available and can be bought at any pharmacy or general store, with more customized ones being sold through sports medicine doctors. According to Clement and coworkers (2009), it has been concluded that knee braces provide 20-30 percent greater knee ligament protection. Once the ACL is injured most people are fitted with a custom knee brace, with the goal of preventing a second injury. The brace is typically bulky and made out of hard plastic as shown below in Figure 1.

Figure 1: Brace for ACL injuries (http://www.kneepaininfo.com/bracesACL.html)

As seen the brace hinges at the knee allowing for the knee to straighten, providing rotational support as well as medial and outer support helping to keep the knee in an anatomically correct position (Anterior Cruciate Ligament Braces, 09/17/2012). After the injury, this knee position is crucial because the ACL is one of the main stabilizing ligaments of the knee, when injured it will often feel unstable and can give out.

The goal of rehabilitation is to regain strength and stability of the knee, and get the player back in action. Depending on the treatment, rehabilitation is going to be different and is customized for each individual. Talking with various individuals it is a gruesome process involving roughly four to five hours of in office physical therapy a week, plus treatment at home. Rehabilitation typically lasts six months until the player can slowly start getting back into a routine.

1.4 Background

The two major bones of the knee are the femur and tibia which meet up to create a hinge joint. The knee is protected in the front by the patella, more commonly known as the kneecap, and is cushioned by the articular cartilage (Anatomy of the Knee). The bones are then connected to the muscle by tendons and to one another by ligaments. Within the knee there are four ligaments: (1) anterior cruciate, (2) posterior cruciate, (3) medial collateral and (4) lateral. The anterior cruciate ligament and its counterpart the posterior cruciate ligament are located deep within the knee and form a cross; they connect the femur and tibia to one another, preventing the tibia from sliding forward or backward on the femur. The other two ligaments run along the side of the knee and prevent the femur from sliding side to side. There are also countless bursae (fluid-filled sacs) that keep the knee moving smoothly (Knee Pain Health Center, 09/17/2012). This can all be seen in Figure 2.

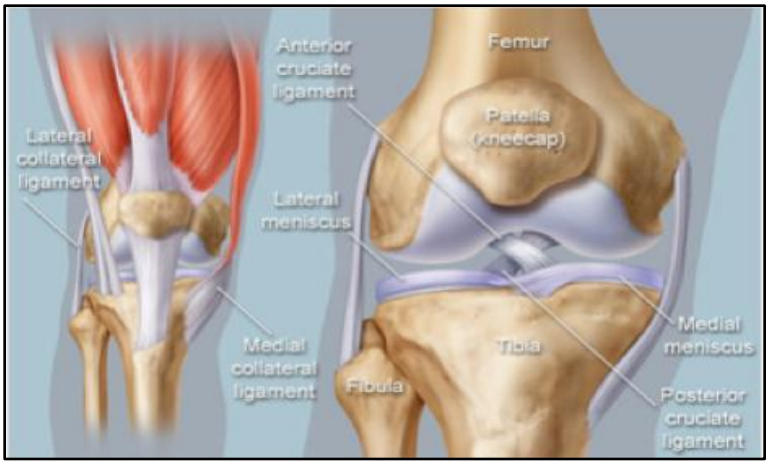

Figure 2: Anatomy of the Human Knee (http://www.kneepaininfo.com/bracesACL.html)

1.4.1 How the ACL is Injured

Seventy percent of reported ACL injuries are non-contact, and the remaining 30 percent involve contact from an outside force (Silvers & Mandelbaum, 2011). Non-contact injuries often occur through cutting tasks, sudden changes in direction, landing jumps and deceleration. Deceleration of the athlete is often followed by a quick change in direction, and it is hypothesized that the injury occurs after the deceleration, but before the player changes direction (Dowling et al., 2010).

One major risk factor of ACL injuries is: biomechanics of the human body. This may explain why women are up to eight times more likely to tear their ACL then men in the same number of athletic exposures (Sokolove, 2008). The most common kinematic position for an injury to occur in is, when the tibia is externally rotated, the knee is close to full extension, the foot is planted on the ground, there is valgus collapse of the knee and the center of mass if behind and away from the base support of the foot (Alentorn et al., 2009). These injuries occur generally through hyperextension and hyperflexion of the knee often after starting or landing jumps (Alentorn et al., 2009). Often causing knee valgus, when the knee turns outward, or varus, when the knee turns inward, an example of varus is shown in Figure 3.

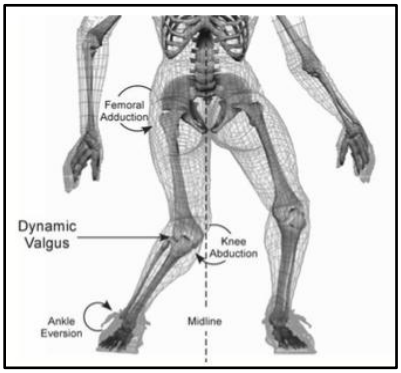

Figure 3: Picture of a varus deformity of the knee (Hewitt et al., 2005)

The ACL itself varies slightly between men and women, which could be part of the reason why women have more injuries. The cross sectional area, length, volume and mass of the ACL have been found to be smaller in females than in males. This can be seen below in Table 1.

Table 1: Sex-Based Comparison of Various ACL Anthropometricl Parameters (Chandrashekar, Slauterbeck, Hashemi, 2005)

Parameter	Male ACL	Female ACL	*P*
ACL length, mm	29.82 ± 2.51	26.85 ± 2.82	.01
Minimum area, mm^2	78.36 ± 23.62	56.79 ± 14.90	.012
Midsubstance area, mm^2	83.54 ± 24.89	58.29 ± 15.32	.007
ACL mass, g	2.04 ± 0.26	1.58 ± 0.42	.0095
ACL volume, mm^3	2967 ± 886	1954 ± 516	.003
ACL mass density, g/cm^3	0.75 ± 0.28	0.82 ± 0.16	.77

[a]Values are presented as means ± SDs.

1.5 Approach

This project compared the environmental risk factors involved in ACL injuries through an observational epidemiology study of soccer players. Most environmental risk factor studies focus on a level of play (recreational or elite) or an age group (college, high school, or adult). However, for this project, high school through college aged athletes, at all levels of play were considered. This project also focused solely on ACL injuries.

Studies have also utilized testing apparatus when investigating shoe-surface interactions, however all the information in this project was collected by surveying the target population. Dragoo and colleagues' (2012), research on the effect of playing surface on incidences of ACL injuries closely resembles this project. In their study, they used an online database to collect data from colleges and universities and all of their data was submitted using an online submission form, which asked questions related to the injury. In addition, a separate exposure form was submitted by schools. This form summarized the number of practices and games, how many people attended each activity, the location of each game and type of playing surface (Dragoo et al., 2012). In this project two surveys were done, however the injury based survey focused more on extrinsic factors rather than the mechanism of injury.

2. Methods Development

In order to determine the appropriate methods for this project, a variety of factors needed to be considered. These factors included determining the population at risk, creating an easily accessible survey, and marketing the project.

2.1 Determining the Population at Risk

To understand the final population it is first necessary to explain the process that occurred and changes that had to take place. Initially the population was kept to just Worcester, so that if necessary the team could go and visit the schools and explain the survey to the coaches and

players, the total number of teams can be seen in Table 2 found. Upon analyzing this number for female high school athletes only, it was shown that roughly 5 female players would injure themselves during the course of the season. This conclusion was based on Hootman's 2007 research were he concluded that .31 injuries occur in every 1000 exposures. We also assumed that each team would participate in 5 total practices and games a week.

Table 2: The initial population of Worcester high schools and colleges.

	Number of schools	Number of teams	Approximate number of players
High School	10	31	620
College	8	16	320

Due to this low number and the lack of responses it was decided that the college population should be opened up to more colleges. It was decided that 40 colleges should be asked to participate in our study. This conclusion was formed using the player and game information from WPI's soccer teams, and the same injury to exposure rate as before. Ideally if all college replied to the survey there would be 10 injuries during the season.

Originally the survey was only going to be distributed to DII and DIII schools, since they have smaller Athletic Departments which appeared to be easier to work with. However after meeting with WPI's athletic director Dana Harmon opening up to DI schools seemed to have its advantages. Dana explained that DI schools provide their athletes with footwear and that the trainers do a much better job of keeping track of injuries and even keep track of what surfaces each game was played on. With this new information it was decided to open the population up to DI schools by contacting the school's Athletic Trainer.

The population chosen in the survey was, challenging, and much more complicated than originally thought to be. Due to the low response rate the population was changed multiple times and in the end turned out to be more a trial and error method then one based on statistics.

2.2 Creating the Survey

Once the size of the population was determined it was decided that an epidemiology study was the best way to find relationships between ACL injuries and environmental factors. Three questionnaires were created: one for high school athletes, one for high school coaches or athletic trainers and one for college athletic trainers. These forms can be seen in Appendix 8.1.

Since the population was not within driving distance, it was determined that an online survey was the most efficient way to collect data. A Google website was created for trainers, coaches, and athletes to access the surveys and provide additional information on the investigators and the study. Screenshots of the website can be seen in Appendix 8.7.

In order to comply with the HIPPA Privacy Rule, which "addresses the use and disclosure of individuals' health information" each participant needed to agree to an Institutional Review Board approved Informed Consent Agreement to be able to use any protected health information for the purpose of this study (HIPAA Privacy Rule, 2003). This agreement was placed at the

beginning of each questionnaire and anyone who did not agree with it was then directed to a separate page.

2.3 Marketing the Project

WPI's Institutional Review Board (IRB) was contacted because the project worked with human subjects. An application was filed to obtain approval to move forward. The IRB, said that the appropriate line of communication at a high school level should start with the Superintendent of the School District then proceed to the individual high school principals, and then finally to the athletic departments.

The IRB was also asked about the appropriate lines of communication when contacting colleges. They advised contacting the coaches and trainers directly. However, the IRB believed that the trainers may ask us to go through the school's own IRB, depending on their procedure. For DI schools it was decided that the best way to make contact was by emailing the trainers. For DII and DIII schools a slightly different approach was taken because they tend to have smaller athletic departments (Harmon 2012). For those instances the athletic directors were contacted not the trainer, an email template can be seen in Appendix 8.2. Contacting the Athletic Director, allowed us to know if we needed to go through that school's IRB and see if the school was interested in participating. Upon approval by the Athletic Director, a second contact was made with the individual men and women's coaches at that school explaining the purpose of the study and asking for their team's participation.

3. Methods

Web surveys were conducted to look into the relationship between environmental factors shoes and ACL injuries. The survey was distributed to various high school and college soccer teams.

3.1 Determination of the Population at Risk

As shown in the methods development section determining the population at risk went through multiple different stages. The determination method in the end was more of a trial and error method then a statistical analysis. This was largely due to the low response rate for survey participation, and to make up for this we had to increase the population 2 different times to have a greater chance of getting response. A complete list of schools contacted can be seen in Appendix 8.3 this includes High School and DI, DII and DIII schools.

3.2 Contacting Schools

The next step was to contact the schools. There were separate procedures for contacting high schools and colleges.

3.2.1 High Schools

Superintendents of School District's near Worcester, MA were contacted asking for permission to contact their individual principals. Once approval was received, the principals were emailed. When approval was obtained from the principals and headmasters the survey was then sent to the athletic directors at the school. The exception to this was with Worcester's School District, which had an application process for anyone wishing to do a study with their students. The application can be found in Appendix 8.6. In addition, sample emails can be found in Appendix 8.2.

3.2.2 Colleges

Contacting college teams was a lot less complicated than it was for high schools, as we did not have to go through multiple levels of contact as dictated by the IRB. For DI schools the athletic trainers themselves were contacted directly, since they kept a record of all the information needed for the study. Of those contacted, none responded, so no additional contact with the individual men and women's coaches were made. It is believed that this is due to our late start with the research, however we are making efforts to get participation from coaches for the 2013 season. In both cases for colleges and high schools the total number of teams contacted and their responses can be seen in Appendix 8.8.

3.3 Collecting the Data

In order to gain information from the athletic trainers, coaches and athletes, questionnaires were created to collect data on the athlete's footwear, playing surfaces, exposure, severity of injury, and mechanism of injury. The surveys were made accessible to the population via a website, which can be seen in Appendix 8.7. The following sections detail the questions asked to obtain information.

3.3.1 Shoes and surfaces

In order to collect data on shoes and surfaces, players, trainers, and coaches were asked a variety of questions. Players were asked what type of shoes they wear; cleats, tennis shoes (trainers), flats (indoors) or turf shoes, a representation of each one was provided as shown in Figure 4, to avoid confusion.

Figure 4: Classification of shoes (soccer.com 10/08/2012)

Players were also asked to identify the shoe type that they wore for each of the four surfaces being considered, indoor turf, gym floor, natural grass and outdoor turf. An example can be seen in Table 3.

Table 3: Playing surfaces and shoe classifications.

Playing Surface	Shoe Type
Grass	Cleats
Outdoor Turf	Turf Shoes
Indoor Turf	Indoors and Tennis Shoes
Gym Floor	N/A

For colleges, the survey was geared towards the athletic trainers and coaches. They were asked if the school provided footwear for their athletes, and if so the type of shoe. In addition they were asked to provide the most commonly used footwear for each playing surface. High school soccer coaches and athletic trainers also had a similar questionnaire, asking to specify the most common shoes worn for each playing surface.

3.3.2 Exposure

Each full length game was considered to be one exposure. In-season and playoff games were considered for review as well as full length tournament games and scheduled preseason scrimmages. The rules governing the duration of a game are described below:

- For college soccer, as stated by the NCAA "The duration of the game shall be two periods of 45 minutes. (Andres, 2012)" The game will be declared "no-contest" if less than 70 minutes have been played (Dennison, 2012) and will not be considered for our review.

- For high school soccer, as stated by the National Federation of State High School Associations (NFHS), a regulation game is considered to be two 40 minute halves or four 20 minute quarters. The game will only be declared official if one complete half (or 40 minutes) has been played (Dennison, 2012). If declared unofficial the game will not be considered for our review.
- For indoor soccer the duration is consider by the house rules depending on the age of the players and generally consists of 2-4 periods, halves or quarters (United States Soccer Federation).

An official team practice was also considered as one exposure for the purpose of this study, as long as the practices was at least 90 minutes long for college soccer teams, and 80 minutes long for high school soccer teams. In order to limit the number of variables in the study, any unofficial practices were considered for review. Pickup games were also not considered. Coaches and athletic trainers surveyed were asked to report both the number of games and number of practices athletes participated in during the season for statistical analysis.

3.3.3 Injury

In this study an injury was defined as a doctor diagnosed ACL injury that was sustained during an exposure, as defined above. The degrees of injury considered can be found in Table 4.

Table 4: Degrees of ACL injuries (Scott et al., 1996)

Degree	Injury Type	Further Description/Symptoms
1st	Sprain or strain	Possible small microfiber tears, swelling, increased pain if continued activity, moderate pain, stiffness of the knee
2nd	Partial tear	Mild tear, moderately instability, discolored knee, popping noise in the knee
3rd	Complete tear or rupture	Severely immobilized and unstable, loud pop, knee is stuck in one position, intense pain and swelling

Athletic trainers and coaches were asked to report the gender, playing surface and footwear for each injury sustained during the season as well as the total number of ACL injuries. In addition, all athletes were asked if they were injured during the season. If the athlete responded that he or she had been injured, he or she was directed to additional questions about the injury including playing surface and footwear worn during the injury.

3.3.4 Mechanism of Injury

College athletic trainers and high school coaches were asked to provide the injury mechanism for each ACL injury that occurred during the season. In comparison athletes were asked to explain how their ACL was injured.

An ACL injury can be classified as either contact or noncontact. With contact the player usually collides with another causing the injury. With noncontact the player usually decelerates, cuts, has a sudden change in direction, lands from a jump or hyperextends the knee. It was believed

that video analysis could offer valuable information on the mechanism of injury. In an attempt to gain video to analyze, athletes were also asked on the questionnaire if they had any video of the injury, and if so to email us.

4. Results

Due to different reasons there was a low response rate from all parties involved. After contacting and following up with all of the high schools and colleges, we were only able to obtain results from one student and one athletic trainer, both of these results can be seen below in Tables 5 through 10.

Table 5: Athletic Trainer responses for the exposure of female athletes.

How many players are on the women's team?	How many times were your female athletes exposed to a gym floor?	How many times were your female athletes exposed to indoor turf?	How many times were your female athletes exposed to grass?	How many times were your female athletes exposed to outdoor turf?
20	0	None	73	21

Table 6: Athletic Trainer responses for the exposure of male athletes.

How many players are on the men's team?	How many times were your male athletes exposed to indoor turf?	How many times were your male athletes exposed to grass?	How many times were your male athletes exposed to outdoor turf?	How many times were your male athletes exposed to a gym floor?
24	0	76	16	0

Table 7: Athletic Trainer responses for ACL injuries.

How many ACL injuries occurred during the season?	Please specify the playing surface and footwear for each injury sustained.	Please specify the injury mechanism, for each ACL injury, if known.
1	Female, Cleats on outdoor Turf	Landing from heading in a cross

Table 8: Total number of exposures to each surface, based on team size and exposure data.

	Grass	**Outdoor Turf**	**Indoor Turf**	**Gym Floor**
Female	1824	144	0	0
Male	1460	420	0	0

Table 9: Athlete responses to exposure questions.

Gender	Please specify which type of shoes you wear most when playing on each field surface. [Grass]	Please specify which type of shoes you wear most when playing on each field surface. [Outdoor Turf]	Please specify which type of shoes you wear most when playing on each field surface. [Indoor Turf]	Please specify which type of shoes you wear most when playing on each field surface. [Gym Floor]
Female	Cleats	Cleats	N/A	N/A

Table 10: Athlete responses to injury questions

Please specify the severity of the injury.	Please specify the playing surface that you sustained the injury on.	Please specify the footwear you were wearing when the injury was sustained.	How was your ACL injured?
3-Full Tear	Outdoor Turf	Cleats	Jumped up to head a cross and landed on one leg, knee caved in.

Since such a low number of results were obtained we were not able to come to any conclusions based on the most injury prone shoe-surface combinations in the population.

We were able to obtain information on the effectiveness of the research method we used. The number of schools that were contacted and the number of responses that we got can be seen in the graph below.

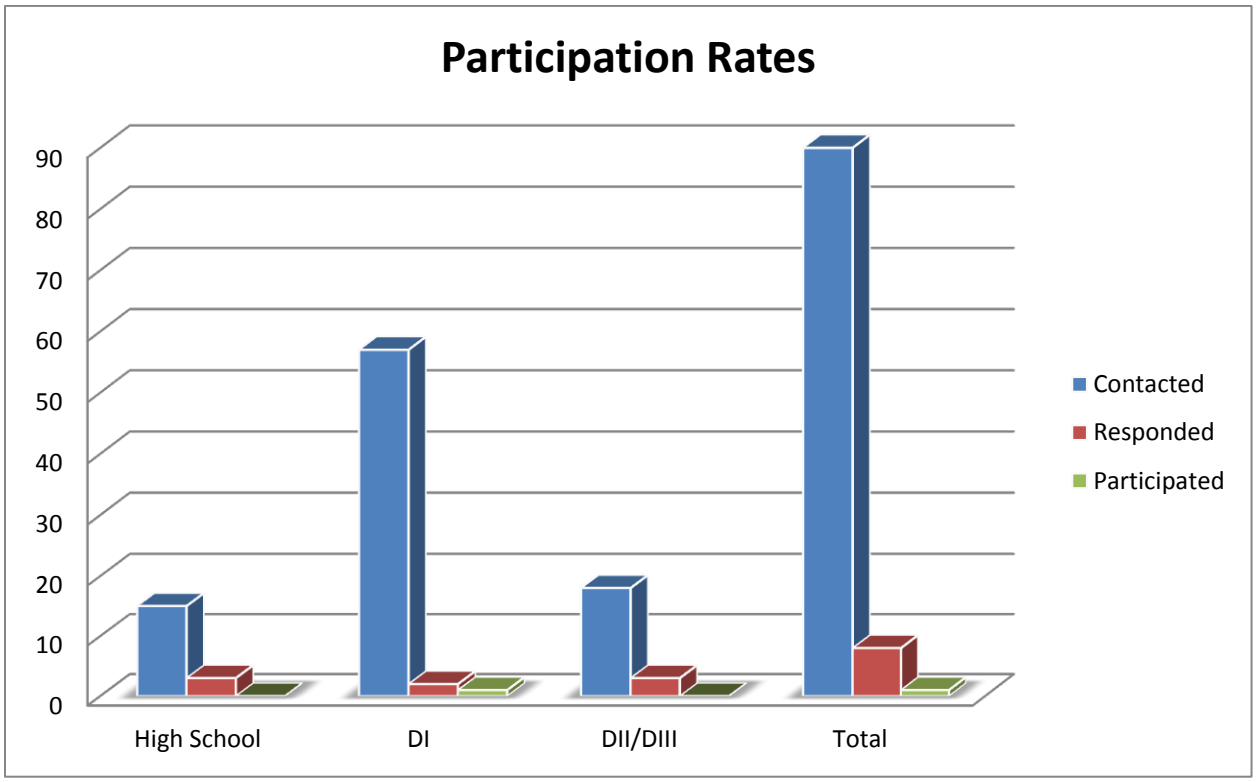

Figure 5: The total number of schools contacted versus response and participation rates.

5. Discussion

5.1 Low Response Rate

When collecting the data there was an 8.8 percent response rate from all parties involved. The different factors that may have attributed to this low rate are late start, lots of channels of communication to go through, and the website survey method used.

5.1.1 Late Start

Contacting schools did not start until late in the season. Part of the reason for this was the unknown IRB application process which put us back roughly one month. When filing the IRB application it was required to submit the methods section, the surveys, and an abstract as well. The complete IRB application can be found in Appendix 8.4. The timeline of our interactions with the IRB are illustrated in Appendix 8.5, as well as a complete list of the pros and cons of working with the IRB.

Another source of the low response rate could be that by the time we heard from the IRB soccer season was nearly over, and coaches were about to lose a significant amount of contact with their players per NCAA regulations. In addition, athletic trainers were transitioning to winter sports.

When contacting the teams we did not give them an estimate of how long the survey would take to complete. This may have been an attributing factor as to why people did not want to fill it out. In addition, a respond by date was not given so many coaches may have brushed the email aside.

5.1.2 Emailing Process

The emailing process was another reason that the team got off to a late start in contacting coaches, because it took longer than expected. Finding the email addresses required more time than expected. In addition, the population size grew during the project. Resulting in additional schools being contacted a month after the first group. The first group was contacted the week of November 13th and the additional teams were not contacted until December 3rd or 4th.

When contacting Worcester Public schools, the emailing procedure that the IRB advised did not apply. After contacting the Superintendent, we learned that the school district required anyone wishing to conduct a survey with their students to file an application. After receiving the application from the superintendent of the school, the IQP team did not communicate well and did not file the application until mid-way through C-term.

5.2 Information Obtained from the Survey

5.2.1 Mechanism of Injury

Understanding the mechanism of injury is useful in designing ways to reduce injuries. On the survey athletes and athletic trainers were asked to specify the mechanism of injury through an open-ended question. As a result the data collected was challenging to analyze because the answers provided were vague as seen in Table 11 below.

Table 11: Comparison of open-ended answer responses.

Athletic Trainer	Athlete
Landing from heading in a cross	Jumped up to head a cross and landed on one leg, knee caved in.

The athlete provided more information than the athletic trainer, which allowed for a better understanding of the mechanism. However this information still leaves some uncertainty about the mechanism and the most appropriate way to gather data on the mechanism.

5.2.2 Prevention Methods

The survey provided information on injuries and exposures; however it did not adequately collect information on prevention methods. In order to evaluate prevention methods it is necessary to know what the athletes do during their practices and games. By including components of neuromuscular or proprioceptive training, athletes are working "to diminish the effect of fatigue on neuromuscular control, which can lead to poor knee and hip positioning" (Cimino et al., 2010). It is unknown if the participating team did any such training.

5.2.3 Shoe-Surface Interactions

Another potential opportunity to improve the research method can be seen in the survey's ability to assess shoe-surface interactions. The survey asked athletic trainers if the school provided shoes for its athletes and if so to provide the shoe type. The school that responded did not give shoes to its athletes, so no data was able to be collected about the shoes, other than the footwear of the person injured. In this instance, we were unable to assess the shoe-surface combinations for all athletes.

The player survey provided much more information about the athlete's footwear. The survey asked about the player's general footwear for games and practices. In addition, it asked the player to specify which footwear he or she wore the most when playing on each surface. This allowed for the most information to be collected about the shoes. However, this information is vague because there are a lot of varieties of cleats, sneakers, flats, and turf shoes. It is believed that shoes such as flat cleats, cleats with screw-ins and cleats with pivot disks have lower ACL injury risk (Webb, 2011). This level of detail was unable to be obtained and therefore could not be analyzed.

Lastly the survey did not account for field conditions. Athletic trainers and athletes were asked to specify the types of fields in which games and practices were played on. The surfaces considered were a gym floor, indoor turf, outdoor turf and grass. These generalizations were used because of Livesay and colleagues' (2006), research. However, there are different types of artificial turf. In addition, the conditions of the field were unknown. Uneven playing surfaces can result in unexpected foot positions or throw off a player's balance. These risk factors were not taken into account because of the lack of data received.

6. Conclusion

From this project the following can be concluded:

1. Conclusions about shoe-surface interactions were not able to be made with the low response rate from the survey.
2. More detail needs to be given by survey participants, in order to compare mechanisms of injury.

3. Prevention methods were unable to be studied due to an unclear mechanism of injury and unknown information about the team's training regimen.

In addition, we have the following recommendations for anyone looking to do further research on this topic:

1. Complete the IRB application process before school begins in order to give enough time for the IRB to process the application and obtain approval to begin the project by the beginning of soccer season.
2. Have email addresses prepared as well as template emails for all of the possible contacts, in order to streamline the emailing process.
3. Contact teams by the beginning of the soccer season in order to build relationships with coaches and trainers so they are more willing to participate in the project.
4. See if someone at WPI in athletics will endorse the project in order to add value to the project.
5. When emailing the athletic trainers and high school coaches, give a rough time estimate 10-15 minutes so people are not deterred from finishing the survey.
6. Include a response by date in the emails, so contacts are aware of the timeline of the project.
7. Consider offering an incentive for participants, in order to increase response rate. An incentive could include the projects findings.
8. If open ended questions are used on the survey, make sure to ask for as much detail as possible. Or create a multiple choice question that includes all possible mechanisms of injury as well as options for those who do not know or remember.
9. Add a survey question to the coach and athletic trainer surveys about player participation in neuromuscular training programs.
10. Add a survey question for athletic trainers about shoe type that most players wear on each surface. Or have every athlete fill out the athlete survey.

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8. Appendices

8.1 Survey Forms

8.1.1 Athletic Trainer Form

Athletic Trainer Form

Thank you for contributing to the WPI Study of ACL Injuries.

Does your institution have mens and womens soccer teams?

- ○ No,Only Female
- ○ No, Only Male
- ○ Yes

If shoes are provided, please specify the type of shoe for each team.

Please list the men's shoe first and on another line the women's shoe.

How many players are on the womens team?

What is the average length of a womens soccer practice?

How many players are on the mens team?

What is the average length of a mens soccer practice?

Exposure

The following questions are based on the exposure of the players to each field surface during the Fall 2012 Season. One exposure is considered a practice or game. If your athletes do not play on a particular surface, please type N/A. The first four questions focus on the womens team and the second four questions are for the mens team.

How many times were your female athletes exposed to indoor turf?

How many times were your female athletes exposed to grass?

How many times were your female athletes exposed to outdoor turf?

How many times were your female athletes exposed to a gym floor?

How many times were your male athletes exposed to indoor turf?

How many times were your male athletes exposed to grass?

How many times were your male athletes exposed to outdoor turf?

How many times were your male athletes exposed to a gym floor?

ACL Injuries

The following questions are about ACL injuries of players. An injury is defined as a sprain, partial tear, or full tear of the ACL as diagnosed by a doctor.

How many ACL injuries occured during the season?

Please specify the playing surface and footwear for each injury sustained.

Example: 1.Male, Turf shoe on Grass 2.Female,Cleats on Grass

Please specify the injury mechanism, for each ACL injury, if known.

Thank you for contributing to the WPI ACL Study. Please click submit below if you are satisfied with your responses.

8.1.2 Athlete Form

Athlete Survey

Informed Consent Agreement for Participation in a Research Study

Primary Investigator: Christopher Brown
Email: brown@wpi.edu
Tel: 508-831-5627

Student Investigators: Veronica Goldsmith and Jessica Prashaw
Email: aclinjuries@wpi.edu
Tel.: 503-476-7109 or 518-588-0371

Title of Research Study:
Anterior cruciate ligament (ACL) injuries in high school through college-age soccer players.

Introduction:
You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study:
The objective of this study is to determine the probability of risk factors associated with anterior cruciate ligament (ACL) injuries in soccer players through web based surveying. This questionnaire will provide us with information on your footwear and the field surface(s) that you play on. The information will be used to understand the exposure of the population being surveyed.

Procedures to be followed:
Upon agreement, you will be asked to answer seven questions. These general questions will include your school code, which your coach should have provided you, your jersey number, your age and your gender. You will also be asked to provide information on the surfaces you play soccer on and the shoes that you use when playing on each surface. In addition, if you injured your ACL during the season, this questionnaire will provide us with information on the footwear and field surface that you were playing on when it occured. The information will be used to determine if certain shoe-surface combinations contribute to ACL injuries.

Risks to study participants:
There is no risk to you.

Benefits to research participants and others:
The findings will be provided to participating players in order to broaden their knowledge on adequate footwear for different playing surfaces.

Record keeping and confidentiality:
You will be identified by your jersey number and school code throughout this study. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or it's designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Compensation or treatment in the event of injury:
You do not give up any of your legal rights by agreeing to participate in this study.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: Veronica Goldsmith or Jessica Prashaw at aclinjuries@wpi.edu or WPI's IRB Chair, Professor Kent Rissmiller, Tel. 508-831-5019, Email: kjr@wpi.edu or WPI's University Compliance Officer, Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu.

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By selecting agree below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before agreeing. You are entitled to retain a copy of this consent agreement. If you desire a copy please email aclinjuries@wpi.edu.
* Required

*

- ◯ Agree
- ◯ Disagree

What is your school code? *

What is your jersey number? *

Age *

Gender *

- ◯ Male
- ◯ Female

What types of shoe(s) do you wear during games and practices? *
Please see Figure 1 for a pictoral description of each shoe type.

- ☐ Cleats
- ☐ Turf
- ☐ Indoors(flats)
- ☐ Tennis/Training

Please specify which type of shoes you wear most when playing on each field surface. *
If there is a field surface you do not play on please select N/A.

	Cleats	Turf	Indoors (flats)	Tennis/Training	N/A
Grass	○	○	○	○	○
Outdoor Turf	○	○	○	○	○
Indoor Turf	○	○	○	○	○
Gym Floor	○	○	○	○	○

Did you injure your ACL during the season?

- ○ Yes
- ○ No

Please specify the severity of the injury.

2-Partial Tear ▼

Please specify the playing surface that you sustained the injury on.

- ○ Grass
- ○ Outdoor Turf
- ○ Indoor Turf
- ○ Gym Floor

Please specify the footwear you were wearing when the injury was sustained.

- ○ Cleats
- ○ Turf Shoes
- ○ Indoor Shoes (flats)
- ○ Tennis/Training Shoes

How was your ACL injured?

8.1.3 High School Coach/Athletic Trainer Form

High School Athletic Trainer/ Coach Form

Thank you for contributing to the WPI Study of ACL Injuries.

Please provide your team code if known.

Does your high school have boys and girls soccer teams?

- ○ No,Only Girls
- ○ No, Only Boys
- ○ Yes

How many soccer players are on the team?

What is the average length of a soccer practice?

Exposure

The following questions are based on the exposure of the players to each field surface during the Fall 2012 Season. One exposure is considered a practice or game. If your athletes do not play on a particular surface, please type N/A.

How many times were your athletes exposed to indoor turf?

How many times were your athletes exposed to grass?

How many times were your athletes exposed to outdoor turf?

How many times were your athletes exposed to a gym floor?

Please specify which type of shoe the majority of your athletes wear on each surface

	Cleats	Turf Shoes	Trainers (Sneakers)	Flats	N/A
Grass	○	○	○	○	○
Outdoor Turf	○	○	○	○	○
Indoor Turf	○	○	○	○	○
Gym Floor	○	○	○	○	○

ACL Injuries

The following questions are about ACL injuries of players. An injury is defined as a sprain, partial tear, or full tear of the ACL as diagnosed by a doctor.

How many ACL injuries occured during the season?

Please specify the playing surface and footwear for each injury sustained.

Example: 1.Turf shoe on Grass 2.Cleats on Grass

Please specify the injury mechanism, for each ACL injury, if known.

Thank you for contributing to the WPI ACL Study. Please click submit below if you are satisfied with your responses.

8.2 Email Templates

8.2.1 High School Templates

8.2.1.1 Superintendent Email Template

Dear <Superintendent's Name>:

We are writing to request the participation of you school district's soccer teams in our epidemiology study. Our study is looking into the interactions between players' footwear and playing surfaces. The information from the study will be used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

An ACL injury can be extremely devastating, with approximately 150,000 occurring each year in the United Sates (Boden, 2008). Rehabilitation is a gruesome four to six month process and on top of that it takes roughly another six months for players to "feel" back to normal (Sokolove, 2008). These injuries are not only detrimental to a person physically, but economically as well costing upwards of $250,000 for serious ACL tears (Knowels et al., 2007). As ACL injuries continue to rise 1.3 percent each year, it is important to look into the various risk factors associated with them (Agel et al., 2005). This study focuses specifically on footwear and play surface, two important but often overlooked environmental factors.

The study will consist of two brief web surveys. The first questionnaire will act as a means to acquire data on players' exposures to different shoe-surface combinations. The second questionnaire will only be given to athletes that injured their ACL during the season.

Player participation in this survey is completely voluntary and the responses by students will be kept confidential. Each school, in your district, will be given a code and players will be identified by their jersey number. This will eliminate personally identifiable information from the responses. If you have any questions or comments, please feel free to contact us at aclinjuries@wpi.edu or call 503-476-7109.

Upon your approval, we will be contacting the individual high school principals and soccer coaches to attain their approval to move forward with the study. Thank you very much for your time and cooperation.

Sincerely,

Veronica Goldsmith & Jessica Prashaw
WPI Class of 2014

8.2.1.2 High School Principal Email Template

Dear <Principal's Name>:

We are writing to request the participation of <High School Name>'s soccer teams in our epidemiology study. <Superintendent's Name> believed that you were interested in helping and we want to follow up with you. Our study is looking into the interactions between players'

footwear and playing surfaces. The information from the study will be used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

An ACL injury can be extremely devastating, with approximately 150,000 occurring each year in the United Sates (Boden, 2008). Rehabilitation is a gruesome four to six month process and on top of that it takes roughly another six months for players to "feel" back to normal (Sokolove, 2008). These injuries are not only detrimental to a person physically, but economically as well costing upwards of $250,000 for serious ACL tears (Knowels et al., 2007). As ACL injuries continue to rise 1.3 percent each year, it is important to look into the various risk factors associated with them (Agel et al., 2005). This study focuses specifically on footwear and play surface, two important but often overlooked environmental factors.

The study will consist of two brief web surveys. The first questionnaire will act as a means to acquire data on players' exposures to different shoe-surface combinations. The second questionnaire will only be given to athletes that injured their ACL during the season.

Player participation in this survey is completely voluntary and the responses by students will be kept confidential. Each school, in your district, will be given a code and players will be identified by their jersey number. This will eliminate personally identifiable information from the responses. If you have any questions or comments, please feel free to contact us at aclinjuries@wpi.edu or call 503-476-7109.

Upon your approval, we will be contacting <Athletic Director/Coach's Name> to proceed with the study. Thank you very much for your time and cooperation.

Sincerely,
Veronica Goldsmith & Jessica Prashaw
WPI Class of 2014

8.2.1.3 High School Coach/Athletic Director Email Template

Dear <Coach/Athletic Director>

We are writing to you to request the participation of your soccer team(s) in our epidemiology study. We are looking to determine the nature and relationship of risk factors associated with anterior cruciate ligament (ACL) injuries in high school and college-aged soccer players. The information from the study will be used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

An ACL injury can be extremely devastating, with approximately 150,000 occurring each year in the United Sates (Boden, 2008). Rehabilitation is a gruesome four to six month process and on top of that it takes roughly another six months for players to "feel" back to normal (Sokolove, 2008). These injuries are not only detrimental to a person physically, but economically as well costing upwards of $250,000 for serious ACL tears (Knowels et al., 2007). As ACL injuries continue to rise 1.3 percent each year, it is important to look into the various risk factors associated with them (Agel et al., 2005). This study focuses specifically on footwear and play surface, two important but often overlooked environmental factors.

The study will consist of three parts. The first web-based questionnaire will act as a means to gain data on players' exposures to different shoes and playing surfaces. The second questionnaire we would like to only give to athletes that injured their ACL during the season. Lastly, we would like information from you on the type of surface your team played on for each game this season.

Player participation in this survey is completely voluntary and the responses by students will be kept confidential. Upon your acceptance to participate, we will give you a school code and the links to our WPI IRB approved surveys. In order to eliminate personally identifiable information from the responses, we will be asking players to use their jersey number as identification to keep track of responses.

If you have any questions or comments, please feel free to contact us at aclinjuries@wpi.edu or call 1-503-476-7109. Thank you very much for your time and cooperation.

Sincerely,

Veronica Goldsmith &Jessica Prashaw
WPI Class of 2014

8.2.2 College Templates

8.2.2.1 College Athletic Director Email Template

Dear <Athletic Director>,

We are writing to request the participation of your <college or university> soccer teams in our epidemiology study. Our study is looking into the interactions between a player's footwear and the playing surface. The information from the study will be used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

An ACL injury can be extremely devastating, with approximately 150,000 occurring each year in the United Sates (Boden, 2008). Rehabilitation is a gruesome four to six month process and on top of that it takes roughly another six months for players to "feel" back to normal (Sokolove, 2008). These injuries are not only detrimental to a person physically, but economically as well costing upwards of $250,000 for serious ACL tears (Knowels et al., 2007). As ACL injuries continue to rise 1.3 percent each year, it is important to look into the various risk factors associated with them (Agel et al., 2005). This study focuses specifically on footwear and play surface, two important but often overlooked environmental factors.

The study will consist of three parts. The first questionnaire will act as a means to acquire data on players' exposures to different shoes and playing surfaces. The second questionnaire, we will only ask athletes that injured their ACL during the 2012 season to fill out. We would also like to have you coaches submit information on the surfaces the team played on for each game.

Player participation in these surveys is completely voluntary and the responses by students will

be kept confidential. Upon your acceptance to participate, we will give you a school code and the link to our website which has our WPI IRB surveys.

If you have any questions or comments, please feel free to contact us at aclinjuries@wpi.edu or call 1-503-476-7109. If you need us to first go through your school's Institutional Review Board, please let us know so that we can move forward by contacting them.

Thank you very much for your time and cooperation.

Sincerely,

Veronica Goldsmith & Jessica Prashaw
WPI Class of 2014

8.2.2.2 College Athletic Trainer Email Template

Dear <Athletic Trainer>

We are writing to request your participation in our epidemiology study. Our study is looking into the interactions between a players footwear and the playing surface. The information from the study will be used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

An ACL injury can be extremely devastating, with approximately 150,000 occurring each year in the United Sates (Boden, 2008). Rehabilitation is a gruesome four to six month process and on top of that it takes roughly another six months for players to "feel" back to normal (Sokolove, 2008). These injuries are not only detrimental to a person physically, but economically as well costing upwards of $250,000 for serious ACL tears (Knowels et al., 2007). As ACL injuries continue to rise 1.3 percent each year, it is important to look into the various risk factors associated with them (Agel et al., 2005). This study focuses specifically on footwear and play surface, two important but often overlooked environmental factors.

The study will consist of two parts. Part one, background information; how many games and practices your teams had this season, what time of shoes they received form the school, and what surfaces they were playing on (i.e turf or grass). Part two, the number of ACL injuries sustained during the season and what surface each injury was on as well as the severity of the injury.

Participation in the survey is completely voluntary and the responses will be kept confidential. If you have any questions or comments, please feel free to contact us at aclinjuries@wpi.edu or call 1-503-476-7109. You may also contact our advisor Professor Christopher Brown at brown@wpi.edu or 1-508-83105627.

Thank you very much for you time and cooperation.

Sincerely,

Veronica Goldsmith and Jessica Prashaw
WPI Class of 2014

8.3 List of Schools Contacted

8.3.1 High Schools

School	Superintendent	Athletic Director
Doherty Memorial High School	Dr. Melinda Boone Boone@worc.k12.ma.us	David Shea SheaDavid@worc.k12.ma.us
University Park High School	Dr. Melinda Boone Boone@worc.k12.ma.us	David Shea SheaDavid@worc.k12.ma.us
Claremont High School	Dr. Melinda Boone Boone@worc.k12.ma.us	David Shea SheaDavid@worc.k12.ma.us
North High School	Dr. Melinda Boone Boone@worc.k12.ma.us	David Shea SheaDavid@worc.k12.ma.us
Burncoat High School	Dr. Melinda Boone Boone@worc.k12.ma.us	David Shea SheaDavid@worc.k12.ma.us
South HIgh School	Dr. Melinda Boone Boone@worc.k12.ma.us	David Shea SheaDavid@worc.k12.ma.us
Worcester Technical High School	Dr. Melinda Boone Boone@worc.k12.ma.us	David Shea SheaDavid@worc.k12.ma.us
Bancroft High School	Scott R. Reisinger Headmaster@bancroftschool.org	Stephen Kelley skelley@bancroftschool.org
Holy Name High School	Edward Reynolds (Headmaster)	James Manzello
Shrewsbury High School	Joesph Sawyer info@shrewsbury.k12.ma.us	Jason Costa jcosta@shrewsbury.k12.ma.us
Saint John's High School	Michael Welch (Headmaster) mwelch@stjohnshigh.org	Patrick White (Department Chair) Pwhite@stjohnshigh.org
Saint Mary's JR/SR High	Sr. Ann Morrison, SND, Principal amorrison@nda-worc.org	---
Worcester Academy	Ronald Cino ron.cino@worcesteracademy.org	Edward Reilly edward.reilly@worcesteracademy.org

8.3.2 DII/DIII Colleges

School	Athletic Director
American International College	Richard.bedard@aic.edu
Amherst College	Suzanne Coffey scoffey@amherst.edu
Anna Maria College	Stanley Vieira svieir@annamaria.edu
Assumption College	Nick Smith na.smith@assumption.edu
Babson University	Josh MacArthur wmacarthur@babason.edu
Becker College	Frank Milerick frank.millerick@becker.edu
Bentley University	Bob DeFelice rdefelice@bentley.edu
Brandeis University	Sheryl Sousa sousa@brandeis.edu

Clark University	Sean Sullivan ssullivan@clark.edu
Framingham State University	Thomas Kelley tkelley@framingham.edu
Massachusetts Institute of Technology	Julie Soriero jooriero@mit.edu
Salem State University	Tim Shea tshea@salemstate.edu
Smith College	Lynn Oberbilig loberbil@smith.edu
Tufts	Bill Gehling bill.gehling@tufts.edu
Wellesley College	Bridget Belgiovine bbelgiov@wellesley.edu
Wentworth Institute of Technology	Bobby Desilets desiletsr@wit.edu
Williams College	Lisa Melendy Lmelndy@williams.edu
Worcester Polytechnic Institute	Dana Harmon dharmon@wpi.edu
Worcester State University	Julie Kazarian jkazarian@worcester.edu

8.3.3 DI Colleges

Division 1 Schools	**Athletic Trainer**	
American University	Sean Dash	sdash@american.edu
Boston College	Michael Vigneau	vigneau@bc.edu
Boston University	Larry Venis	lvenisat@bu.edu
Brown University	Russ Fiore	Russell_Fiore@brown.edu
Bryant University	Patrick O'Sullivan	posulliv@bryant.edu
Bucknell University	Mark Keppler	keppler@bucknell.edu
Canisius College	Andy Smith	smitha@canisus.edu
Central Connecticut State University	Kathy Pirog	pirog@ccsu.edu
Colgate University	Steve Chouinard	schouinard@colgate.edu
Columbia University	Darlene Camacho	dc2164@columbia.edu
Cornell University	Bernie DePalma	bfd5@cornell.edu
Dartmouth College	Jeff Frechette	jeff.frechette@dartmouth.edu
Delaware State	Lori Leary	lleary@desu.edu
Drexel University	Katie Castellanos	ksc37@drexel.edu
Duquesne University	Vic bauer	
Fairfield University	Mark Ayotte	mayotte@fairfield.edu
Fordham University	Vincent Porricelli	vporricelli@fordham.edu
George Washington University	Chris Hennelly	henz@gwu.edu
Georgetown University	W. Blanton Jones	wbj@georgetown.edu
Harvard College	Brant Berkstresser	bberkstr@fas.havard.edu
Hofstra University	Evan Malings	evan.malings@hofstra.edu
Howard University	Senta Cleveland	senta.cleveland@howard.edu
Iona College	Sam De Rosa	sderosa@iona.edu
La Salle University	Bill Gerzabek	Gerzabel@lasalle.edu
Lafayette College	Matt Bayly	baylym@lafayette.edu
Lehigh University	Tim Donane	tsd3@lehigh.edu
Long Island University Brooklyn Campus	Danny O'Connor	doconnor@liu.edu

Manhattan College	Douglas Straley	stephan.dombroski@manhattan.edu
Marist College	Glenn Marinelli	Glenn.Marinelli@marist.edu
Niagara University	Derick Thorton	dthornton@niagara.edu
Northeastern University	Ben Miller	b.miller@neu.edu
Penn State University Park	Wayn J. Sebastianellie	wsebastianelli@psu.edu
Providence College	Bryn VanPatten	bvanpatt@providence.edu
Quinnipiac University	Ernie Hallbach	ernest.hallbach@quinnipiac.edu
Robert Morris University	Mike Virrorino	vittorino@rmu.edu
Sacred Heart University	Leo Katsetos	katsetosl@sacredheart.edu
Saint Bonaventure University	Christopher Hobler	chobler@sbu.edu
Saint Joseph's University	Bill Lukasiewicz	blukasie@sju.edu
Siena College	Greg Dashnaw	dashnaw@siena.edu
St. Francis University		
Women's	Hannah Jaussen	hjaussen@francis.edu
Men's	Alison Stubbs	astubbs@francis.edu
St. John's University	Ron Linfonte ATC	linfontr@stjohns.edu
SUNY Binghamton	Dan King	deking@binghamton.edu
SUNY Stony Brook	Elizabeth Zanolli	elizabeth.zanolli@stonybrook.edu
SUNY University at Buffalo	Sue Rocque	rocque@buffalo.edu
Syracuse University	Brad Pike	brpike@syr.edu
Temple University		
Women's	Travis McCormack	tmccorma@temple.edu
Men's	Todd Price	todd.price@temple.edu
United State Military Academy (West Point)	Tim Kelly	tim.kelly@usma.edu
University Of Connecticut	Bob Howard	robert.howard@uconn.edu
University of Delaware	John Smith	jsmith@udel.edu
University of Hartford	Shawn McCarthy	mccarthy@hartford.edu
University of Maine	Ryan Taylor	ryan.taylor@umit.maine.edu
University of Massachusetts Amherst	Jeff Smith	jbsmith@admin.umass.edu
University of New Hampshire	Dan Sedory	dan.sedory@unh.edu
Yale University	Gregory Basmajian	gregory.basmajian@yale.edu
College of the Holy Cross	Anthony Cerundolo	acerundo@holycross.edu

8.4 IRB Application

WORCESTER POLYTECHNIC INSTITUTE
Institutional Review Board
Application for Exemption from IRB Review for
Survey or Interview Research Involving Minimal or No Risk

WPI IRB use only
IRB # 12-157
Date: 10/15/12

This application is specifically intended for projects in which students are expected to conduct interviews, surveys or focus groups. *Use of this application is recommended for most student project research involving minimal risk. Proposed research meets the definition of "minimal risk" when the risks to research subjects are not greater than those ordinarily encountered in daily life.*

Project Faculty Advisor(s):

Name:	Christopher Brown	Tel No:	5627	E-Mail Address:	brown@wpi.edu
Department:	ME				
Name:		Tel No:		E-Mail Address:	
Department:					

Project Faculty Instructor:

Name:		Tel No:		E-Mail Address:	
Department:					

Student Investigator(s): *ALL student investigators must be listed.*

Name:	Veronica Goldsmith	Tel No:	5034767109	E-Mail Address:	v.goldsmith@wpi.edu
Name:	Jessica Prashaw	Tel No:	5185880379	E-Mail Address:	jeprashaw@wpi.edu
Name:		Tel No:		E-Mail Address:	
Name:		Tel No:		E-Mail Address:	
Name:		Tel No:		E-Mail Address:	

Project Title: ACL tears in indoor and outdoor soccer

Project Location and Time Frame:

Data will be collected November 1st through February 1st, dependent on approval by the IRB. This project will be based at WPI, however the teams participating will be within New England.

WPI IRB Application for Exemption from IRB Review for Survey or Interview Research Involving Minimal or No Risk

Expected Research Subjects: (e.g. museum visitors under the age of 12)

Male and female soccer players that play for a middle school through college aged team in New England.

Project Mission Statement and Objectives

The objective of this project is to determine the nature and relationship of risk factors associated with anterior cruciate ligament (ACL) injuries in soccer players. The survey will focus on the environmental factors: the player's footwear and the playing surface. The information from this project will be used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

Brief Methods Listing: (e.g. "Survey of public to ascertain knowledge and opinions about climate change" or "Interviews of professionals working on climate change regarding effective city climate change program")

Every player that participates will fill out a preliminary survey to obtain information on the exposure of the population. Every player that injures their ACL during the season will fill out the follow-up survey to gain data on the mechanism of the injury and footwear and player surface at the time of the injury.

Appendix 1: Attach the draft methodology chapter or statement of research methods.

Appendix 2: Attach a draft of surveys and/or a list of questions to be used for interviews or focus groups. If sample questions are included in Appendix 1, Methodology Chapter, indicate page numbers here.

1. Is the proposed research sponsored or supported by a US federal agency or by US government funding? If so, identify sources. No ☑ Yes ☐
2. Is the proposed research funded by a corporation or foundation? If so, identify sources. No ☑ Yes ☐
3. Does the proposed research involve vulnerable research subjects? (e.g. children, prisoners, students, persons with mental or physical disabilities, pregnant women) No ☐ Yes ☑
4. Does the research involve human subjects in ways other than as participants in interviews, focus groups, or surveys? (e.g. observation of public behavior, use of archived data or experimental procedures) If yes, explain. No ☐ Yes ☑

   Players and coaches will have the opportunity to send the investigators video of the injuries if they have any for further review of the mechanics of the injury.
5. Will the researchers collect information that can be used to identify the subjects? No ☐ Yes ☑
6. Could the disclosure of a human subject's identity and responses place the subject at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability or reputation? No ☑ Yes ☐
7. Will the researchers disclose the identity or the individual responses of any human subjects? (e.g. by quoting an individual, whether or not identified by name or title) No ☑ Yes ☐

IF you answered yes to question 6 or 7, answer these questions:

A. What is the potential risk to human subjects?

B. How will you eliminate or reduce said risk to an acceptable level?

Please Print Form Before Signing Below

By signing below, all participants in this research project are agreeing to abide by the following instructions:

1. You agree to inform subjects orally or in writing that:
   - Participation in the research is voluntary.
   - Participants may end their participation at any time.
   - Participants need not answer every question in an interview or survey.

2. If your research is **anonymous**, you also inform subjects that you are not collecting names or any identifying information from them.

3. If your research is **confidential**, you inform subjects that no identifying information will be disclosed with individual responses.

4. If your research is **NOT** completely anonymous and confidential, you must obtain each subject's permission to publicly disclose his or her identity and/or responses. All requests for anonymity and confidentiality must be honored. The subject must be offered the opportunity to pre-approve the publication of any quoted material

Signature of Faculty Advisor Chris Brown Date 10/12/12

Print Full Name and Title CHRISTOPHER A. BROWN PROF. OF ME

Please return a signed hard or electronic copy of this application to the WPI IRB c/o Ruth McKeogh, 2nd floor Project Center or irb@wpi.edu.
If you have any questions, please call (508) 831-6699.

2. Methods

An epidemiology web survey will be conducted to look into the relationship between environmental factors and ACL injuries. The survey will be sent out to several soccer teams in New England, both male and female with ages ranging from high school to college. The survey will be split into two different parts; a preliminary survey of the entire team and an injury report survey.

2.1 Population

This study will survey New England high school and college male and female, indoor and outdoor, soccer teams. Each team will receive a team code, to help with classification and the review of data. In addition, each player on the team will be identified by his or her jersey number. Team codes will be assigned as follows; the state initials, followed by a number assigned at random.

2.2 Exposure

Each full length game is considered to be an exposure. In-season and playoff games will be considered for review as well as full length tournament games. For indoor soccer a full length game will be defined as "consist[ing] of two halves, with duration according to 'house rules'" (The Official Rules of Indoor Soccer, 2009). In outdoor soccer, a full length game will consist of at least two 30 to 45 minutes halves. Coaches will be asked to report the number of games played at the end of the season in order to determine the exposure of the population.

2.3 The Preliminary Survey

The preliminary study will be used to gain a better understanding of the current equipment, and playing surfaces being used. It will be the basis for the epidemiology study, depicting the entire picture. Each player will be asked seven questions, including his or her age and gender. The player will also be asked what type of shoe(s) he or she wears; cleats, tennis shoes (trainers), flats (indoors) or turf shoes.

Along with the type of shoe each player wears, it is also important to know whether he or she is playing indoor or outdoor soccer. The playing surfaces the athletes use are also important. The four surfaces being considered are indoor turf, gym (basketball court), natural grass and outdoor turf. In a season, athletes may play both indoors and outdoors and have different shoes to accommodate. Therefore the last question on the survey is to match the playing surface and shoes worn on that surface, an example can be seen in Chart 1.

Playing Surface	Shoe Type
Grass	Cleats
Turf	Turf shoes
Indoor Turf	Indoors and Sneakers
Gym floor	Indoors

Chart 1. Playing surfaces and shoe classification

2.4 Definition of injury

In this study an injury is defined as being a doctor diagnosed ACL injury that was sustained during game play.

2.5 Follow-up Survey

The goal of this survey is to gain a better understanding of the environmental causes that can lead to an injury and more importantly how common they are. The follow up questionnaire will only be used for the athletes that injure their ACL, based on the definition of injury. The follow up questionnaire will be given to coaches at the same time as the preliminary questionnaire, but asked to be held until there is an injury. The player will record his or her player code and school code. He or she will indicate what field surface was being played on, as well as the location indoor or outdoor and the type of shoe being worn. The player will also be given a chance to explain how the injury was sustained and the severity of the injury.

2.6 Data

Once the data is received it will be classified and sorted into excel documents, and graphs will be made to show trends in footwear, and playing surfaces. All of the original data will give a solid background into the problem. Once follow up surveys are received, it will be crossed checked with the original data, to gather the basic information about the player. After, all of the classification and sorting is done the information will be scrutinized. The data and results from the study will then be used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

Initial Survey Informed Consent:

Informed Consent Agreement for Participation in a Research Study

Primary Investigator: Christopher Brown
Email: brown@wpi.edu
Tel: 508-831-5627

Student Investigators: Veronica Goldsmith and Jessica Prashaw
Email: aclinjuries@wpi.edu
Tel.: 503-476-7109 or 518-588-0371

Title of Research Study: Anterior cruciate ligament (ACL) injuries in high school through college-age soccer players.

Introduction (recommended)
You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study: The objective of this study is to determine the probability of risk factors associated with anterior cruciate ligament (ACL) injuries in soccer players through web based surveying. This questionnaire will provide us with information on your footwear and the field surface(s) that you play on. The information will be used to understand the exposure of the population being surveyed.

Procedures to be followed: Upon agreement, you will be asked to answer seven questions. These general questions will include your school code, which your coach should have provided you, your jersey number, your age and your gender. You will also be asked to provide information on the surfaces you play soccer on and the shoes that you use when playing on each surface.

Risks to study participants:
There is no risk to you.

Benefits to research participants and others:
There is no direct benefit to you.

Record keeping and confidentiality:
You will be identified by your jersey number and school code throughout this study. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or it's designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Compensation or treatment in the event of injury: You do not give up any of your legal rights by agreeing to participate in this study.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: Veronica Goldsmith or Jessica Prashaw at aclinjuries@wpi.edu or WPI's IRB Chair, Professor Kent Rissmiller, Tel. 508-831-5019, Email: kjr@wpi.edu or WPI's University Compliance Officer, Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu.

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By selecting agree below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before agreeing. You are entitled to retain a copy of this consent agreement. If you desire a copy please email aclinjuries@wpi.edu.

Injury Survey Informed Consent

Informed Consent Agreement for Participation in a Research Study

Primary Investigator: Christopher Brown
Email: brown@wpi.edu
Tel: 508-831-5627

Student Investigators: Veronica Goldsmith and Jessica Prashaw
Email: aclinjuries@wpi.edu
Tel.: 503-476-7109 or 518-588-0371

Title of Research Study: Anterior cruciate ligament (ACL) injuries in high school through college-age soccer players.

Introduction (recommended)
You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents

information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study:
The objective of this study is to determine further risk factors associated with anterior cruciate ligament (ACL) injuries in soccer players through web based surveying. This questionnaire will provide us with information on the footwear and field surface that you were playing on when you injured your ACL. The information will be used to determine if certain shoe-surface combinations contribute to ACL injuries.

Procedures to be followed:
Upon agreement, you will be asked to answer seven questions. These general questions will include your school code, which your soccer coach should have provided you, your jersey number, your age and your gender. You will also be asked to provide information on the how you injured your ACL, including the surface you were playing on and the shoe type you were wearing. If you have any video of the injury occurring, please send it to aclinjuries@wpi.edu for analysis.

Risks to study participants:
There is no risk to you.

Benefits to research participants and others:
The findings will be provided to participating players in order to broaden their knowledge on adequate footwear for different playing surfaces.

Record keeping and confidentiality:
You will be identified by your jersey number and school code throughout this study. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or it's designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Compensation or treatment in the event of injury: You do not give up any of your legal rights by participating in this study.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: Veronica Goldsmith or Jessica Prashaw at aclinjuries@wpi.edu or WPI's IRB Chair, Professor Kent Rissmiller, Tel. 508-831-5019, Email: kjr@wpi.edu or WPI's University Compliance Officer, Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu.

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The

project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By selecting agree below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before agreeing. You are entitled to retain a copy of this consent agreement. If you desire a copy please email aclinjuries@wpi.edu.

WORCESTER POLYTECHNIC INSTITUTE

Worcester Polytechnic Institute IRB# 1
HHS IRB # 00007374

2 November 2012
File: 12-157

Re: IRB Expedited Review Approval: #12-157 "ACL Tears in Indoor and Outdoor Soccer"

Dear Prof. Brown,

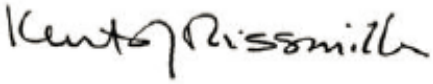
The WPI Institutional Review Committee (IRB) approves the above-referenced research activity, having conducted an expedited review according to the Code of Federal Regulations 45 (CFR46).

Consistent with 45 CFR 46.116 regarding the general requirements for informed consent, we remind you to **only use the consent form provided to the IRB with the on-line survey**.

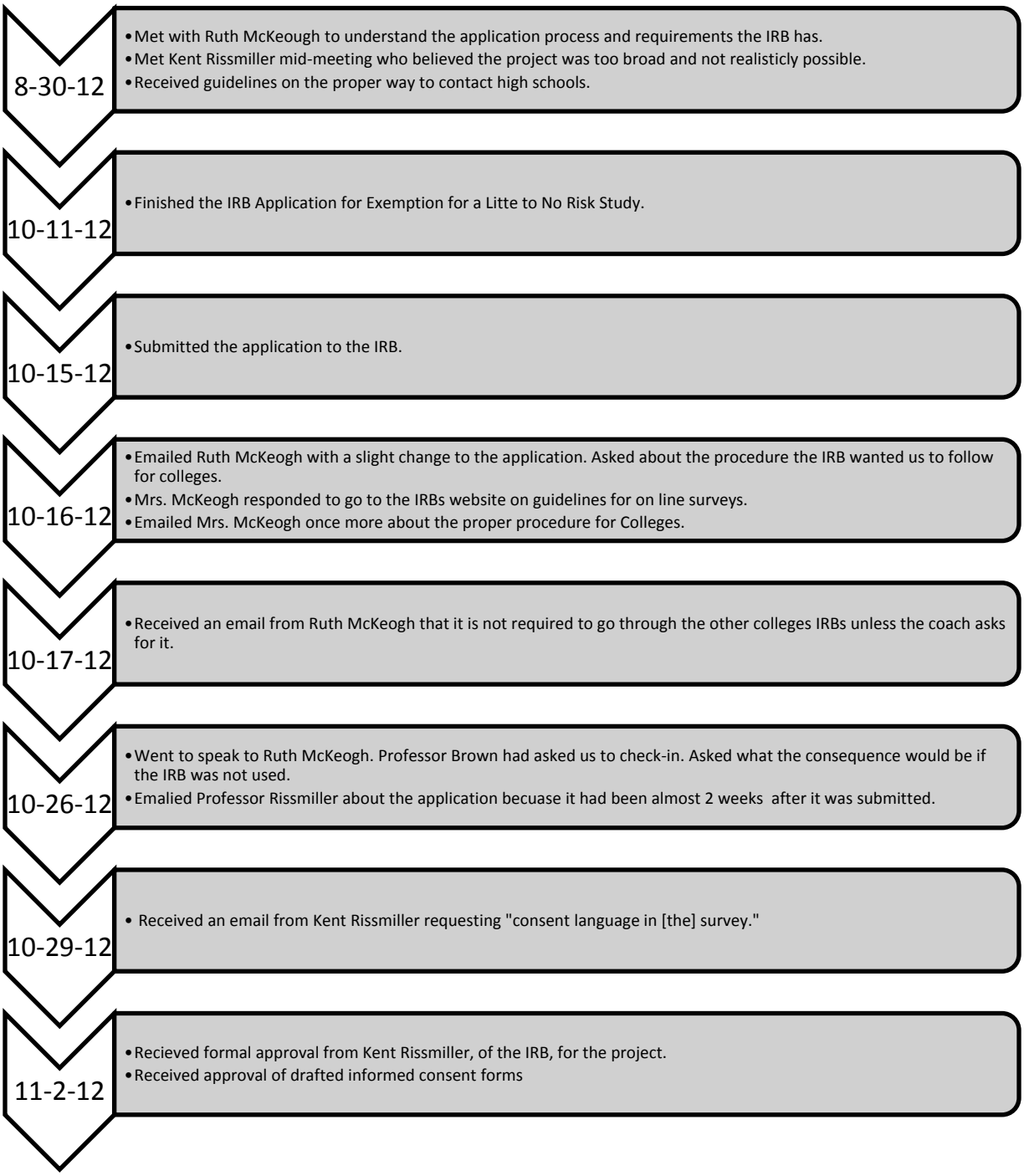
The period covered by this approval is 2 November 2012 until 1 November 2013, unless terminated sooner (in writing) by yourself or the WPI IRB. Amendments or changes to the research that might alter this specific approval must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue.

Please contact the undersigned if you have any questions about the terms of this approval.

Sincerely,



8.5 IRB Review



The following pros and cons of working with the IRB have been drafted.

Pros	Required by the University when working with human subjects.
Cons	A very time consuming process.
	IRB assumed that the advisor is directing the students in the application process.
	Mrs. McKeogh and Professor Rissmiller hadconflicting opinions.
	IRB website was not well designed and was challenging to get the necessary information from.
	The application did not clearly explain all parts that need to be turned in.

8.6 Worcester Public School Application

WORCESTER PUBLIC SCHOOLS

RESEARCH PROJECT APPLICATION

Date: January 16, 2013

Name: Veronica Goldsmith and Jessica Prashaw

Tel #: 503-476-7109

E-mail address: aclinjuries@wpi.edu

College/University Affiliation: Worcester Polytechnic Institute

If you are a college/graduate student, name/phone of faculty advisor: Christopher Brown/ 508-831-5627

Title of Research Project: ACL Tears in Indoor and Outdoor Soccer

Purpose of Project: *Please attach a one-page description of the proposed research project (see sample below)*

Methodology: See page 3.

The number and name of people conducting the research and data project is to begin: Veronica Goldsmith and Jessica Prashaw started the project November 2nd, 2012.

Estimated completion date: March 1st, 2013

Date project is to begin: As soon as possible.

Characteristics of students in the study**:**

a. Students' age(s): 14-18 b. Students' grade(s): 9-12

c. Number of students in the sample: Unknown

Will the research be conducted during school hours? YES: _____ NO: x

Estimated time for a student's participation in each session: 20 minutes

Estimated total participation time required of each student: 20 minutes

Will parent(s) be required to participate? YES: _____ NO: x
Please explain:

a. Number of parents in the sample:

b. Estimated time for a parent's participation in each session:

c. Total participation time required of each parent:

Will teacher(s) be requested to participate? YES: x NO: _____
Please explain: Coaches or Athletic Directors at the High Schools will be asked to fill out a survey about their teams.

a. Number of teachers in the sample: up to 15 (depending on who at the school fills out the survey)

b. Estimated time for a teacher's participation in each session: 20-30 minutes

c. Total participation time required of each teacher: 20-30 minutes

How will Worcester Public Schools' students and/or faculty benefit from this project: The data obtained will lead to further investigation of ACL injury prevention. The findings of the study will be made available to the coaches and athletic departments.

Have you already discussed this project with school personnel? YES: _____ NO: x

IF YES, whom have you contacted?

Will research participants be compensated? YES: _____ NO: x

Please Explain: Participation is voluntary.

ALL WORCESTER PUBLIC SCHOOLS' STUDENTS MUST HAVE THE PERMISSION OF THEIR PARENTS/GUARDIANS BEFORE PARTICIPATING IN A RESEARCH PROJECT. PLEASE INCLUDE A SAMPLE OF THE PARENT PERMISSION FORM YOU WILL USE.

FOR SCHOOL DEPARTMENT USE ONLY

SCHOOL: _____ PROGRAM: _____

APPROVED: _____ DATE: _____

DISAPPROVED: _____ DATE: _____

COMMENT: _____

_____

_____

Please e-mail and/or mail completed form to: David Perda
Chief Research and Accountability Officer
20 Irving Street, Room 209
Worcester, Massachusetts 01609

OR Fax to: 508.799.8277

e-mail: perdad@worc.k12.ma.us

Methodology

Our study is looking into the interactions between players' footwear and playing surfaces. The information from the study will be used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

The study consists of two brief web surveys that can be found on our website: https://sites.google.com/site/wpiaclinjuries/

The first survey acquires data on each player's exposure to different shoe-surface combinations during the 2012 season. In addition, if a player injures their ACL during the season, the survey asks what was going on when the injury occurred (i.e. practice or game), what surface it occurred on and what type of shoes they wearing.

The second survey is for the coaches or an athletic trainer to fill out. This survey gathers a second perspective on the season and asks for information on the number of games and practices the team had and any ACL injuries that occurred during it.

Player and coach/athletic trainer participation in this survey is completely voluntary and the responses will be kept confidential. Each team at a school is given a code and players will be identified by their jersey number. This eliminates personally identifiable information from the responses.

The codes for the Worcester Public High Schools are as follows:

School	Team	Team Code
Doherty Memorial High School	Girl's Varsity	MA-H1
	Girl's JV	MA-H2
	Boy's Varsity	MA-H3
	Boy's JV	MA-H4
North High	Girl's Varsity	MA-H5

School	Girl's JV	MA-H6
	Boy's Varsity	MA-H7
	Boy's JV	MA-H8
Burncoat High School	Girl's Varsity	MA-H9
	Girl's JV	MA-H10
	Boy's Varsity	MA-H11
	Boy's JV	MA-H12
South High School	Girl's Varsity	MA-H13
	Boy's Varsity	MA-H14
	Boy's JV	MA-H15

Paper Surveys

Player Survey

Informed Consent Agreement for Participation in a Research Study

Primary Investigator: Christopher Brown
Email: brown@wpi.edu
Tel: 508-831-5627

Student Investigators: Veronica Goldsmith and Jessica Prashaw
Email: aclinjuries@wpi.edu
Tel.: 503-476-7109 or 518-588-0371

Title of Research Study:
Anterior cruciate ligament (ACL) injuries in high school through college-age soccer players.

Introduction:
You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study:
The objective of this study is to determine the probability of risk factors associated with anterior cruciate ligament (ACL) injuries in soccer players through web based surveying. This questionnaire will provide us with information on your footwear and the field surface(s) that you play on. The information will be used to understand the exposure of the population being surveyed.

Procedures to be followed:
Upon agreement, you will be asked to answer seven questions. These general questions will include your school code, which your coach should have provided you, your jersey number, your age and your gender. You will also be asked to provide information on the surfaces you play soccer on and the shoes that you use when playing on each surface. In addition, if you injured

your ACL during the season, this questionnaire will provide us with information on the footwear and field surface that you were playing on when it occured. The information will be used to determine if certain shoe-surface combinations contribute to ACL injuries.

Risks to study participants:
There is no risk to you.

Benefits to research participants and others:
The findings will be provided to participating players in order to broaden their knowledge on adequate footwear for different playing surfaces.

Record keeping and confidentiality:
You will be identified by your jersey number and school code throughout this study. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or it's designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Compensation or treatment in the event of injury:
You do not give up any of your legal rights by agreeing to participate in this study.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: Veronica Goldsmith or Jessica Prashaw at aclinjuries@wpi.edu or WPI's IRB Chair, Professor Kent Rissmiller, Tel. 508-831-5019, Email: kjr@wpi.edu or WPI's University Compliance Officer, Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu.

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By selecting agree below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before agreeing. You are entitled to retain a copy of this consent agreement. If you desire a copy please email aclinjuries@wpi.edu.

( ) Agree (directed to rest of the survey)
( ) Disagree (directed to a page that says thank you for participating)

What is your school code? _____

What is your jersey number? _____
Age___

Gender
( ) Male
( ) Female

What type of shoe(s) do you wear during games and practices? (A photo is provided for further description of each type of shoe)
( ) Cleats
( ) Turf
( ) Indoors (flats)
( ) Tennis/Training

Please specify which type of shoe you wear most when playing on each field surface.

	Cleats	Turf	Indoors(flats)	Tennis/Training	N/A
Grass					
Outdoor Turf					
Indoor Turf					
Gym Floor					

Did you injure your ACL during the season?
( ) Yes (directed to more questions)
( ) No (directed to thank you for participating)

Please specify the severity of the injury.
( ) 1 – sprain or strain
( ) 2 – partial tear
( ) 3 – full tear

Please specify the playing surface that you sustained the injury on.
( ) grass
( ) outdoor turf
( ) indoor turf
( ) gym floor

Please specify the footwear you were wearing when the injury was sustained.
( ) Cleats
( ) Turf Shoes
( ) Indoor Shoes (flats)
( ) Tennis/Training shoes

How was your ACL Injured?

_____

_____

Thank you for participating.

Coach's Survey

How many soccer players are on the team? _____

Does your school provide shoes for the soccer players?
( ) Yes
( ) No

If shoes are provided, please specify the type of shoe. _____

What is the average length of a soccer practice? _____

Exposure

The following questions are based on the exposure of the players to each field surface during the Fall 2012 Season. One exposure is considered a practice or game. If your athletes do not play on a particular surface, please type N/A.

How many times were your athletes exposed to indoor turf? _____

How many times were your athletes exposed to grass? _____

How many times were your athletes exposed to outdoor turf? _____

How many times were your athletes exposed to gym floor? _____

ACL Injuries

The following questions are about ACL injuries of players. An injury is defined as a sprain, partial tear, or full tear of the ACL as diagnosed by a doctor.

How many ACL injuries occurred during the season?

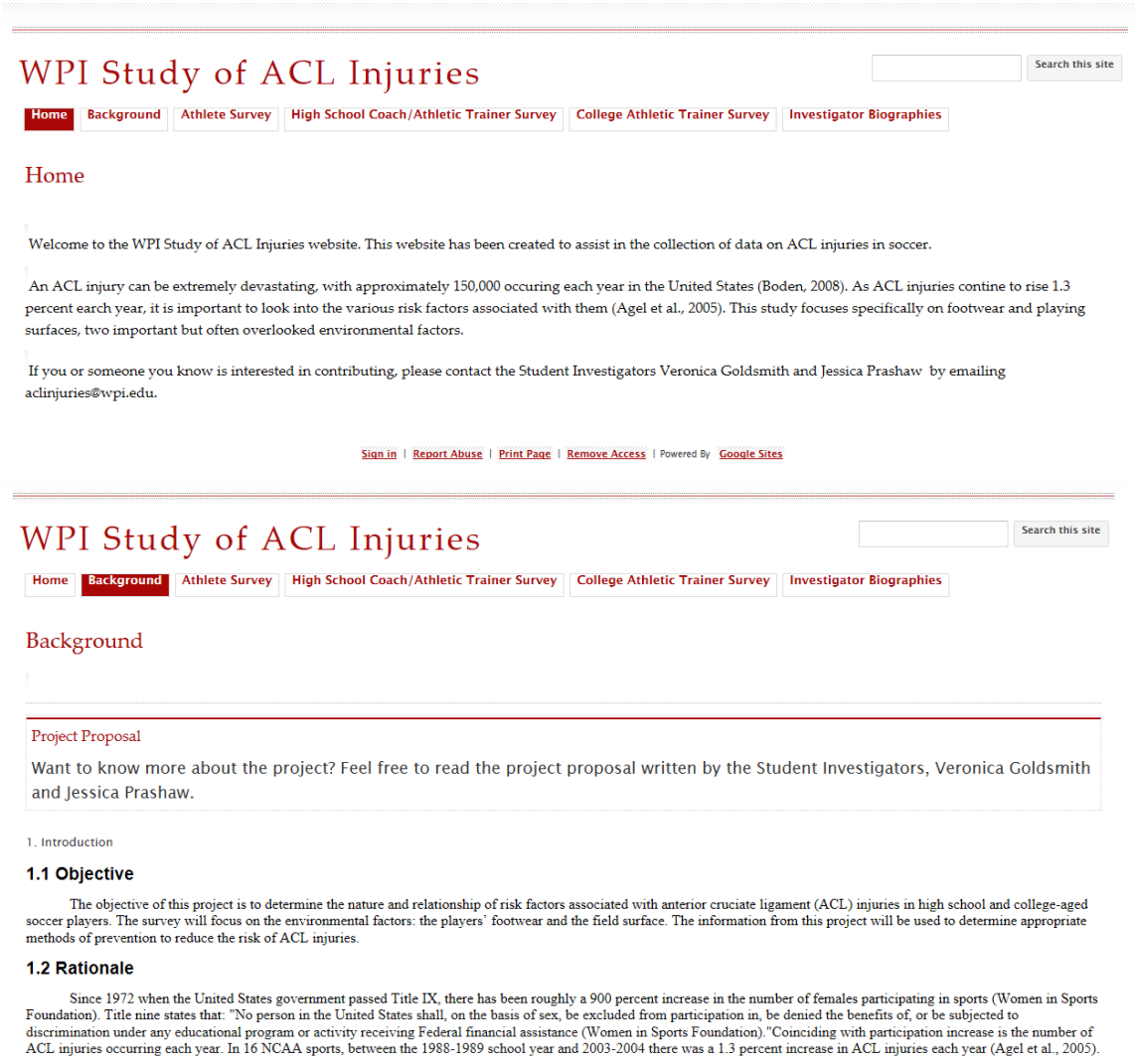
Please specify the playing surface ad footwear for each injury sustained. (Ex.: 1. Turf shoe on Grass, 2. Cleats on Grass, etc.)

Please specify the injury mechanism, for each ACL injury, if known.

Thank you for contributing to the WPI ACL Study. Please click submit if you are satisfied with your answers.

8.7 Website

https://sites.google.com/site/wpiaclinjuries/



WPI Study of ACL Injuries

Search this site

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Home

Welcome to the WPI Study of ACL Injuries website. This website has been created to assist in the collection of data on ACL injuries in soccer.

An ACL injury can be extremely devastating, with approximately 150,000 occuring each year in the United States (Boden, 2008). As ACL injuries contine to rise 1.3 percent earch year, it is important to look into the various risk factors associated with them (Agel et al., 2005). This study focuses specifically on footwear and playing surfaces, two important but often overlooked environmental factors.

If you or someone you know is interested in contributing, please contact the Student Investigators Veronica Goldsmith and Jessica Prashaw by emailing aclinjuries@wpi.edu.

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Background

Project Proposal

Want to know more about the project? Feel free to read the project proposal written by the Student Investigators, Veronica Goldsmith and Jessica Prashaw.

1. Introduction

1.1 Objective

The objective of this project is to determine the nature and relationship of risk factors associated with anterior cruciate ligament (ACL) injuries in high school and college-aged soccer players. The survey will focus on the environmental factors: the players' footwear and the field surface. The information from this project will be used to determine appropriate methods of prevention to reduce the risk of ACL injuries.

1.2 Rationale

Since 1972 when the United States government passed Title IX, there has been roughly a 900 percent increase in the number of females participating in sports (Women in Sports Foundation). Title nine states that: "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any educational program or activity receiving Federal financial assistance (Women in Sports Foundation)."Coinciding with participation increase is the number of ACL injuries occurring each year. In 16 NCAA sports, between the 1988-1989 school year and 2003-2004 there was a 1.3 percent increase in ACL injuries each year (Agel et al., 2005).

WPI Study of ACL Injuries

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Athlete Survey

Informed Consent Agreement for Participation in a Research Study

Primary Investigator: Christopher Brown
Email: brown@wpi.edu
Tel: 508-831-5627

Student Investigators: Veronica Goldsmith and Jessica Prashaw
Email: aclinjuries@wpi.edu
Tel.: 503-476-7109 or 518-588-0371

Title of Research Study:
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Risks to study participants:
There is no risk to you.

Figure 1.

Cleats

Indoor Shoes (flats)

Turf Shoes

Tennis/Training Shoes

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High School Coach/Athletic Trainer Survey

High School Athletic Trainer/ Coach Form

Thank you for contributing to the WPI Study of ACL Injuries.

Please provide your team code if known.

Does your high school have boys and girls soccer teams?

- ○ No,Only Girls
- ○ No, Only Boys
- ○ Yes

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College Athletic Trainer Survey

Thank you for contributing to the WPI Study of ACL Injuries.

Does your institution have mens and womens soccer teams?

- ○ No,Only Female
- ○ No, Only Male
- ○ Yes

Continue »

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Investigator Biographies

Principal Investigator

Prof. Christopher A. Brown, PhD, PE, FASME
Surface Metrology Laboratory
Mechanical Engineering Department
Worcester Polytechnic Institute

Chris Brown was born in Lausanne, Switzerland to American parents in 1952. He grew up mostly in Central NY, attending public schools in Syracuse. He finished elementary school at Constableville Central School in Lewis County, NY, where his parents ran a ski lodge near Snow Ridge. He attended Manlius-Pebble Hill School in Dewitt, NY, and Holderness School in NH before graduating from Harwood Union HS in Vermont.

He earned three degrees at the University of Vermont. As an undergraduate he captained the ski team was a first team All-American. His MS thesis was on fracture testing of tool steels and his PhD dissertation was on chip formation in machining. His advisor was Branimir von Turkovich. He also worked in the orthopaedics department in Vermont and collaborated with C.D.Mote, Jr at UC Berkley and Robert Johnson and Carl Ettlinger on ski injury research.

He spent four years in the Materials Department at the Swiss Federal Institute of Technology studying machined surfaces. For two years he was a senior research engineer working on product and process development at Atlas Copco's European research center.

Since the fall of 1989 Chris has been on the faculty at WPI. He has published over a hundred articles on design, surfaces, sports engineering, and surface metrology. He has patents a fractal method for characterizing surface roughness and on an apparatus for friction testing. He also develops software for surface texture analysis. He teaches grad courses on axiomatic design and on surface metrology and an undergraduate course on the technology of alpine skiing. He advises senior design projects in mechanical engineering that use axiomatic design. He also consults and teaches courses for industry on axiomatic design.

Student Investigator

Veronica Goldsmith

Major: Chemical Engineering
Year: 2014
Worcester Polytechnic Institute
Email: v.goldsmith@wpi.edu

Veronica Goldsmith was born in Portland, Oregon in 1992. She grew up in the suburbs of Portland attending public schools in the Beaverton School District. She attended a talented and gifted middle school, Summa North, where she first became interested in math and engineering. Her interest grew in high school while attending Westview High School. Veronica currently is pursuing her Bachelors of Science in Chemical Engineering with a minor in Materials. Upon graduation, she hopes to be manufacturing coatings and adhesives and eventually obtain her MBA.

While in high school Veronica was very involved in extracurriculars. Her freshmen year she joined Key Club, a community service organization, to get more involved in her community and went on to join National Honors Society her junior year. Veronica also became very involved in DECA, a marketing association for high school students. As part of DECA, Veronica created an entrepreneurship promotion project to gain support for Oregon DECA from local businesses and a social norms campaign on alcohol awareness for her school. Athletics were another big part of Veronica's high school years. She played soccer for Westview High School for two years and was on the swimming and lacrosse teams for all four years. Her senior year she unfortunately sustained a series of shoulder injuries that dwindled her senior lacrosse season.

At WPI Veronica has kept very busy. Veronica is heavily involved in Residential Life as a second year Residential Advisor and Chairperson of Residence Hall Council, an organization aspiring to build communities through programming, leadership development and advocacy. She is a sister of Alpha Gamma Delta International Women's Fraternity. She has also been inducted into the WPI Circle of Omicron Delta Kappa, a leadership honors society. Lastly, she is the goalie for the Women's Club Lacrosse team.

Student Investigator

Jessica Prashaw

Major: Mechanical Engineering - Biomechanics
Year: 2014
Worcester Polytechnic Institute
Email: jeprashaw@wpi.edu

Jess Prashaw was born in Troy, New York in 1991. She grew up in upstate NY, attending public schools in East Greenbush. In 2010 she graduate at the top of her class from Columbia High School. In 2011 she entered Worcester Polytechnic Institute as a Biomedical Engineering major, and has since changed her major to Mechanical Engineering with an concentration in biomechanics and couldn't be happier. After graduating Jess would like to work in the sports industry, improving athletic equipment to make it very biomechanically friendly.

In high school Jess was very involved in both sports and the community. Jess played soccer for Columbia High School for four years, as well as Greenbush Youth Soccer and Averill Park as a member of their travel teams. Jess was an all around player, playing mainly defense for school and forward for travel. In the winter time Jess not only played soccer but was a 6 year member of the Varsity bowling team, attending the State Championships her Sophomore year where her team took home the Second place medal. As if that wasn't enough her junior and senior year Jess joined an after school weight lifting program, Iron Devils, and competed yearly, taking home multiple medals in the squat. Starting her sophomore year Jess ran outdoor track, competing as a Sprinter. Along with all of this Jess was an honors student, a member of the symphonic band playing the tenor and alto Saxophone, an active Girl Scout, and a member and officer of both the Outdoors Club and the German Club.

In college Jess is just a busy. She is a two year member of the Women's Varsity Crew team as a coxswain. In the summer of 2011, Jess had the wonderful opportunity to travel to England and represent WPI at Women's Henley, as a member of "The Fabulous Freshman Four," and took home the first international win for WPI women ever. On campus Jess is also a member of Student Alumni Society, planning lots of traditions and activities for WPI students. Lastly, Jess is a sister of Alpha Gamma Delta where she is currently the Correspondence Coordinator.

8.8 Response Results

8.8.1 High Schools

High Schools contacted	Responses	Participated
Doherty Memorial High School	None	No
University Park High School	None	No
Claremont High School	None	No
North High School	None	No
Burncoat High School	None	No
South HIgh School	None	No
Worcester Technical High School	None	No
Bancroft High School	None	No
Holy Name High School	Headmaster responded, but when contacted the AD did not respond	No
Shrewsbury High School	Superintendent said that they would forward the survey to school's coaches	No
Saint John's High School	None	No
Saint Mary's JR/SR High	None	No
Worcester Academy	None	No
Worcester Public School	Superintendent said that they would participate, we just needed to fill out an application for the study	No

8.8.2DII/DIII

School	Responses	Participated
American International College	None	No
Amherst College	None	No
Anna Maria College	Did email back but said since the season was over the AD wanted to have his	No

	athletes catch up on missed work through out the season	
Assumption College	None	No
Babson University	Yes- AD said he would forward to his Coaches and he never responded	No
Becker College	None	No
Bentley University	None	No
Brandeis University	None	No
Clark University	None	No
Framingham State University	None	No
Massachusetts Institute of Technology	None	No
Salem State University	None	No
Smith College	None	No
Tufts	None	No
Wellesley College	Yes	Declined participation because they said no on had any injuries.
Wentworth Institute of Technology	None	No
Williams College	None	No
Worcester State University	None	No

8.8.3 DI

	Responses	Participated
Brown	None	No
College of the Holy Cross	None	No
American University	None	No
Boston University	Responded and said they were on vacation never followed up even after a second email	Note* we contacted the AD on this one not the AT
Boston University	None	No

Brown University	None	No
Bryant University	None	No
Bucknell University	None	No
Canisius College	None	No
Central Connecticut State University	None	No
Colgate University	None	No
Columbia University	None	No
Cornell University	None	No
Dartmouth College	None	No
Delaware State	None	No
Drexel University	None	No
Duquesne University	None	No
Fairfield University	None	No
Fordham University	None	No
George Washington University	None	No
Georgetown University	None	No
Harvard College	All of the emails were returned to sender; we used the emails from their athletic website	No
Hofstra University	None	No
Howard University	None	No
Iona College	None	No
LaSalle University	None	No
Lafayette College	None	No
Lehigh University	None	No
Long Island University Brooklyn Campus	None	No

Manhattan College	None	No
Marist College	None	No
Niagara University	None	No
Northeastern University	None	No
Penn State University Park	None	No
Providence College	None	No
Quinnipiac University	None	No
Robert Morris University	None	No
Sacred Heart University	None	No
Saint Bonaventure University	None	No
Saint Joseph's University	None	No
Siena College	None	No
St. Francis University	AT responded- would like the results of this study when it is complete	Both the AT and the injured athlete filled out surveys
St. John's University	None	No
SUNY Albany	None	No
SUNY Binghamton	None	No
SUNY Stony Brook	None	No
SUNY University at Buffalo	None	No
Syracuse University	None	No
Temple University	None	No
United State Military Academy (West Point)	None	No
University Of Connecticut	None	No

University of Delaware	None	No
University of Hartford	None	No
University of Maine	None	No
University of Massachusetts Amherst	None	No
University of New Hampshire	None	No
Yale University	None	No