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Injuries to the anterior cruciate ligament (ACL) of the knee are one of the most serious injuries sustained in sports. It has previously been shown that female athletes are at a risk 4-6 times greater than their male counterparts to sustain such an injury. Injury prevention programs (IPP) have been developed that have been shown to successfully reduce the risk of ACL injuries, but data on the implementation of these programs is limited. The purpose of this project was to obtain data on the implementation of ACL IPP among high school girls' soccer coaches in Pennsylvania and to identify barriers that limit the implementation of such programs. An online survey was completed by Pennsylvania high school girls' soccer coaches (N=32) to assess ACL IPP knowledge, attitudes, implementation rates, and barriers to implementation. Overall, coaches reported a higher rate (45%) of implementation than shown in previously studied populations. Only one commonly used ACL IPP was found to be familiar to greater than 50% of participating coaches. When reporting barriers to implementation, lack of knowledge of ACL IPP was reported by 37% of coaches with only 21% of coaches reporting having received formal training on ACL IPP. Time was also reported by 17% of respondents and was the most frequent response in open ended questions regarding barriers. The data suggest that coaches may benefit from training opportunities providing instruction on ACL IPP and instruction on the use of programs that can be utilized with minimal time requirements. More research is needed on implementation strategies and the potential use of policy changes by regulating organizations to encourage the use of IPP.

BARRIERS THAT INFLUENCE THE ADOPTION OF ACL INJURY PREVENTION
PROGRAMS IN HIGH SCHOOL GIRLS'
SOCCER COACHES

by

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APPROVAL PAGE

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I would like to acknowledge the patience and support of my wife and children over the past four years as I have worked towards the completion of this project.

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CHAPTER I

PROJECT OVERVIEW

The exact number of ACL injuries sustained each year is unknown, but it has been estimated that as many as 200,000 - 350,000 ACL injuries occur each year in the United States, with most cases resulting in surgical reconstruction (Mall et al, 2014; Pauda et al., 2018; Nessler, Denney, & Sampley,2017). Studies have shown that the risk of injuries to the anterior cruciate ligament (ACL) can be effectively reduced using specific training practices (Pauda et al., 2018). While both males and females are at risk for ACL injury, in high school and collegiate athlete populations, females have been found to be at a four to six times greater risk of suffering an ACL injury than their male counterparts (Hewitt et al, 2010.) Most ACL injuries are not the result of a direct hit to the knee but are the result of noncontact or indirect contact movements (Pauda et al., 2018). In many cases, these injuries can be attributed to faulty mechanics of movement or poor body control (Nessler, Denney, & Sampley,2017). ACL injury prevention programs (IPP) have been developed that appear to effectively reduce injury rates (Grimm, Jacobs, Kim, Denney, & Shea, 2015). Multicomponent training programs have been developed that require more than one type of exercise (Pauda et al., 2018). While there has been no universally accepted program, all successful programs include at least some of the following attributes: muscle strengthening, muscle recruitment patterns, landing and deceleration patterns, proprioception, and plyometrics (Voksanian, 2013). Despite the reliability, effectiveness, and availability of these programs,

participation rates in these programs is low (Norcross, Johnson, Bobvbjerg, Koester, & Hoffman, 2016).

Background and Review of Literature

The ACL is one of the four primary ligaments of the knee and provides stability to the joint and controls the movement of the femur against the tibia during movements such as cutting and jumping. As involvement in sports has increased, so have the number of injuries sustained while playing sports (Gatt, 2014). Though an injury such as an ACL tear will occur at a rate much lower than a less serious injury like a hamstring strain or ankle sprain, the impact of such an injury is much more severe and burdensome on the athlete (Bahr, Clarsen, & Ekstrand, 2017). In athletic populations, females have been shown to be at a risk of ACL injury at a rate 4-6 times greater than that of their male counterparts (Hewitt, 2010). Injuries to the ACL will undoubtedly end an athlete's season and result in at least six months of rehabilitation. In most cases, 9-12 months of rehabilitation will be required before being able to return to competition, depending on the factors such as physical readiness, specific procedure, and psychological readiness (Bizzini, Hancock, & Impellizzeri, 2012). This type of injury may lead to psychological difficulties that impair the athlete; physical complications may not arise until years later such as the early development of osteoarthritis within the knee joint (Padua et al, 2018). Due to the extended recovery and rehabilitation period required following ACL reconstruction surgery, prevention of ACL injuries has become a major focus sports medicine research over the past 30 years.

Increased understanding of the specific risk factors for ACL injuries have led to the development explicit protocols that can be implemented to mitigate the risk factors

for sustaining an injury. The protocols have been developed and are considered the basis for development of multicomponent training programs. These programs provide sport specific neuromuscular training through skills such as jumping and landing technique training, plyometrics, strengthening, and agility exercises.

One of the most commonly implemented programs is known as SportsMetrics. The SportsMetrics program consists of the following phases within in each training session: warm-up, plyometrics and jump training, high-intensity strength training, and flexibility training (SportsMetrics Technique & Training, 2017). The Prevent Injury Enhance Performance Program (PEP) was developed by the Santa Monica Sports Medicine Foundation and first cited in 2008 by Gilcrest et al. This program consists of a warm-up, stretching, strengthening, plyometrics, and sport specific agilities to correct potential deficiencies in the strength and coordination of the stabilizing muscles of the knee joint. The PEP protocol was studied with a sample of over 1400 division one athletes on 62 different teams. Subjects performed the prescribed program three times per week over the course of the sports season. Participants in the program were found to have an overall rate of ACL injury 1.7 times less and a rate of non-contact injury 3.3 times less than those who did not receive the intervention. A reduction in game related ACL injuries by almost 50% occurred during this period (Gilcrest et al., 2008). Noyes and Westin (2012) completed a review of 17 different studies utilizing five different established ACL injury prevention programs. During their review, they found that the two programs with the most supporting evidence for prevention of ACL injury were the SportsMetrics program and the PEP program. According to the authors, SportsMetrics participants exhibited significant increases in lower extremity strength and abdominal strength, vertical jump height, estimated maximal aerobic power, speed, and agility. PEP

participants were able to improve isokinetic knee flexion strength significantly but did not improve vertical jump height, speed, or agility. Both programs also were able to show significant reductions in ACL injury rates. The other three programs reviewed for the study (Myklebust, the "11," and Knee Ligament Injury Prevention) did not improve ACL injury rates or athletic performance tests (Noyes & Westin, 2012). Padua et al (2018) completed an analysis of several systematic reviews and report that injury rates following the use of a multicomponent ACL IPP could be reduced by 51%-62%.

To date, the literature has shown limited research concerning the implementation of ACL injury prevention programs. Joy et al. (2013) hypothesized several reasons for the poor implementation of ACL injury prevention programs by coaches at all levels of competition. These include the following: lack of knowledge that ACL injury is a preventable condition, demands on time, lack of expertise, and insufficient benefits or absence performance benefit. In their study of girls' soccer coaches in Utah, they found only 19.8% coaches have implemented a team-based ACL injury prevention program. Similarly, Norcross et al. (2016) discovered in a survey of Oregon high school sports coaches that only 21% of respondents reported that they were using a scientifically supported injury prevention program, despite over 50% of the coaches being aware that such programs exist. When limiting the data to high school girls' coaches, the rate was 35%, but only 18% admitted that they were using the program as designed.

Barriers to the implementation of ACL injury preventions programs have received little attention in the literature. Five barriers were identified in systematic review of 15 studies involving ACL IPP. These barriers are motivation, time requirements, skill requirements for facilitators, compliance, and cost (Bogardus, Martin, Richman, & Kulas, 2017). The studies for this review included data from coaches and players from multiple

sports and age levels. Similarly, lack of time was also reported to be the primary barrier reported among high school female basketball players (Thein-Nissenbaum & Brooks, 2016). Richmond et al. (2018) discussed the necessity to consider the use of IPP in a real-world setting. Those implementing programs may initially be excited about the prospect of the use of the programs but may become frustrated by the perceived complexity of exercises or commitment using the program as designed. This can lead to a decline in use or modifications to the program that may jeopardize the efficacy. A similar finding was reported among German youth coaches who implemented the FIFA 11+ program. Over time, coaches reported frustration with the monotony and rigidity of the program as barriers to continued use (Weber-Spickschen et al., 2018).

The body of previous work reviewed highlights the need for further investigation of barriers and coaches' knowledge to better implement ACL IPP. While the effectiveness of ACL IPP has been well established in the literature as well as the poor rate of implementation, few studies have addressed the barriers of implementation of these programs specific to coaches. It is the objective of this research to fill this critical gap in the literature.

Purpose and Aims

The long-term goal is to reduce the barriers to ACL IPP participation, increase the participation rate in ACL IPP among athletes, and reduce the incidence of ACL injury. The purpose of this research is to identify the barriers to the implementation of ACL IPP among high school girls' soccer coaches. Soccer is the fourth most popular sport among American high school girls and carries one of the highest risks for ACL injury among the participants (Gornitzky et al., 2016; National Federation of State High School Associations, 2018). Coaches are often the primary driver of training methods

among high school athletes, exhibiting complete control over utilization of practice time and training (Pryor et al., 2017). The coach is also the principal leader for injury prevention practices among their players (Bizzini, Junge, & Dvorak, 2013). For this reason, this study also evaluated coaches' knowledge and attitudes towards ACL IPP. Understanding coaches' beliefs may contribute to the planning of effective interventions, and the selection of successful strategies for implementation (McGlashan, Verrinder, & Verhagen, 2018). This research study addresses the following specific aims:

Specific Aim #1: Assess coaches' perceptions and use of ACL injury prevention programs. High school girls' coaches were surveyed to assess their current level of knowledge and attitudes regarding ACL IPP and how this may affect implementation as well as gather information on current practices among coaches regarding ACL IPP.

Specific Aim #2: Identify facilitators and barriers to implementation of ACL injury prevention program among high school girls' soccer coaches. High school girls' coaches were surveyed to assess facilitators and barriers for implementation of ACL IPP.

There is currently little information available on the barriers to implantation of ACL IPP. At the completion of this study, it is expected that additional understanding of the barriers that high school girls' soccer coaches perceive regarding ACL IPP will be obtained. These data, along with insights into current coaches' knowledge and attitudes towards the implementation of ACL IPP may lead to better methods of dissemination and preparation of coaches to work with athletes.

The number of ACL injuries sustained in the United States has been increasing despite available methods to reduce the rate of injury. Soccer represents one of the

sports with the highest rates of ACL injury, due to the required amounts of cutting, jumping, and twisting movements during play. 60% of female ACL injuries sustained while playing soccer are caused by a non-contact mechanism compared to 40% of those sustained by their males (Agel, Rockwood, & Klossner, 2016). The literature has shown that IPP can effectively reduce the rate of injury among participants, but there is a disconnect between what has been shown in the literature and what is being implemented on the field (Donaldson & Finch, 2013). Real-world implementation and compliance by coaches of proven ACL IPP is key to the long-term effectiveness of an ACL IPP (Frank, Register-Mihalik, & Padua, 2015). Due to the seriousness of such injuries, the study is significant, because the findings will support a reduction to the gap between academic knowledge and current coaching practices regarding ACL IPP. It is important to identify barriers that coaches experience relating to ACL IPP. With increased understanding of barriers that coaches experience, new methods for the implementation of ACL IPP may be developed. This will result in the reduction in the incidence of ACL injury among high school athletes and benefit the quality of life of thousands of young athletes.

Methods

To address the purpose and aims, an online survey was administered to high school girls' soccer coaches in Pennsylvania. Soccer coaches were selected due to the high participation rates of soccer and the high rates of ACL injuries in high school girls' soccer.

Participants.

Participants in this study were drawn from high school level girls' soccer coaches in the state of Pennsylvania. According to the Pennsylvania Interscholastic Athletic

Association (PIAA), there are 544 high schools in Pennsylvania participating in girls' soccer as of 2017 (PIAA,2017). Participants were selected from listings of coaches made publicly available through the PIAA or through information available from member schools or regional leagues. The Pennsylvania Soccer Coaches Association (PSCA), an association of high school soccer coaches in Pennsylvania was also used as a method of contact for participants. The Western Pennsylvania Interscholastic Athletic League (WPIAL) was also contacted and the executive director agreed to distribute the survey on behalf of the PI as well. Participants were volunteers who were contacted via email to participate in the study. The survey received 32 responses. The overall survey response rate is unknown due to the unidentified number of coaches reached through the forwarding of the recruitment email on behalf of the PI through the assistance of third parties. Of the coaches who responded, 16 were male and 14 were female with 2 non-responses. Coaches reported a mean age of 39 years (23 years min, 70 years max). 29 coaches reported that they were white, with three non-responses. All responses recorded, were from coaches that live in Pennsylvania and that are currently coaching in Pennsylvania.

Measures.

An online web-based survey hosted by Qualtrics was sent to the participants via email (Appendix A). The survey was designed to acquire information about coaches' knowledge, attitudes, and behaviors regarding IPPs and training/practice sessions. The survey was made up of 33 questions consisting of original questions and adaptations from surveys previously used by Joy et al. (2013) and Norcross et al. (2016) that have been used to examine attitudes towards IPP. Survey questions were designed to address both specified research aims on one survey instrument. The survey was

evaluated for validity and revised accordingly prior to use. Other attributes included for evaluation were; demographics, coaching level, previous personal injury, and level of playing experience of each participant. The survey also included prompts for coaches to provide open ended statements regarding ACL IPP and their own experience to be included in the study.

Design and Procedure.

Informed consent information was provided to each participant. Informed consent forms contained information about procedures, benefits and risks of participating, an explanation how to acquire the results of the research, voluntary participation, and contact information of the researcher. The purpose of the study was also included on the consent document. A random drawing for a \$50.00 prepaid gift card was offered to serve as an incentive for participation in the survey. Email invitations were sent directly from specified organizations on behalf to the researcher or directly from the researcher as determined by the assisting organization (Appendix B). Follow up emails were sent after two weeks and four weeks to encourage the completion of the survey and increase survey response rate.

Following the submission of completed surveys, descriptive statistical analysis were performed using SPSS statistical software to identify trends among coaches regarding their adoption and attitudes towards ACL IPPs.

Results and Findings

When reporting coaching experience, most coaches (21) responded that they had over five years of coaching experience. Only one coach responded that they had one year or less, while 10 coaches indicated that they had over 15 years of experience with nearly identical numbers corresponding to experience coaching girls' soccer.

Coaches reported various competition levels of experience primarily at the youth/club level and high school level, with 5 responses indicating some college level coaching experience and 1 coach with professional experience. 25 coaches are currently acting as the team's head coach and five reported they are currently serving as an assistant coach. One of these coaches reported serving as a head coach with a prior team. All 32 coaches responded that they had experience playing soccer competitively with levels of experience ranging from youth/club (21) to college (17) and professional (2).

When asked about their use of and ACL IPP, 45% (16) of coaches indicated that they were using such a program. These coaches indicated that they had learned of these programs from a variety of sources, most commonly an athletic trainer (45%). The next most common responses were "playing experience" (15%) and a "professional conference or clinic" (15%). Coaches that indicated that they were currently using an ACL IPP were asked to indicate what factors lead to their decision to implement an ACL IPP. The most common response designated "injury prevention/player safety" as the primary motivator for using such a program (72%). "Performance enhancement" was the only other response to be indicated with 28% of responses. Some of the coaches indicated that they were using injury prevention programs that may not be specific to ACL injury prevention. Some of the responses included: "pilates/yoga", "personal trainer", "strength and agility coach", and "program from our trainer".

When asked about ACL Injuries, 21% (n=6) of coaches responded that they had experienced their own ACL injury. When these coaches were asked if they were using a training program specifically designed to prevent ACL injuries, 50% of those who responded indicated that they had implemented such a program, while 50% indicated they had not. Coaches were also asked if a member of their family had sustained an

ACL injury, 5 coaches reported that they had. Of these coaches, 1 reported that they were using an ACL IPP. Coaches were also asked if a player on their team had an ACL injury within the last year. Of the coaches who responded, 23 reported that a player had suffered an ACL injury. Of these coaches, 11 responded that they were not using an ACL IPP. 100% of coaches who responded, indicated that their team had access to an athletic trainer. Access to other sports and training professionals was not as widespread. 53% indicated that they had access to a strength coach. Access to a medical professional was more limited, with 25% indicated access to a physical therapist and just 21% had access to a team physician.

When presented with a series of popular ACL injury prevention programs and asked how familiar they were with each program, all but the FIFA 11+ (41%) program resulted in greater than 50% of coaches reporting they were not familiar at all with the program. The FIFA 11+ program was recorded as the program that coaches indicated “moderately familiar”, “very familiar”, and “extremely familiar” at the highest rate, while ACL Play it Safe and SportsMetrics were indicated the least in these categories (Table 1).

Table 1

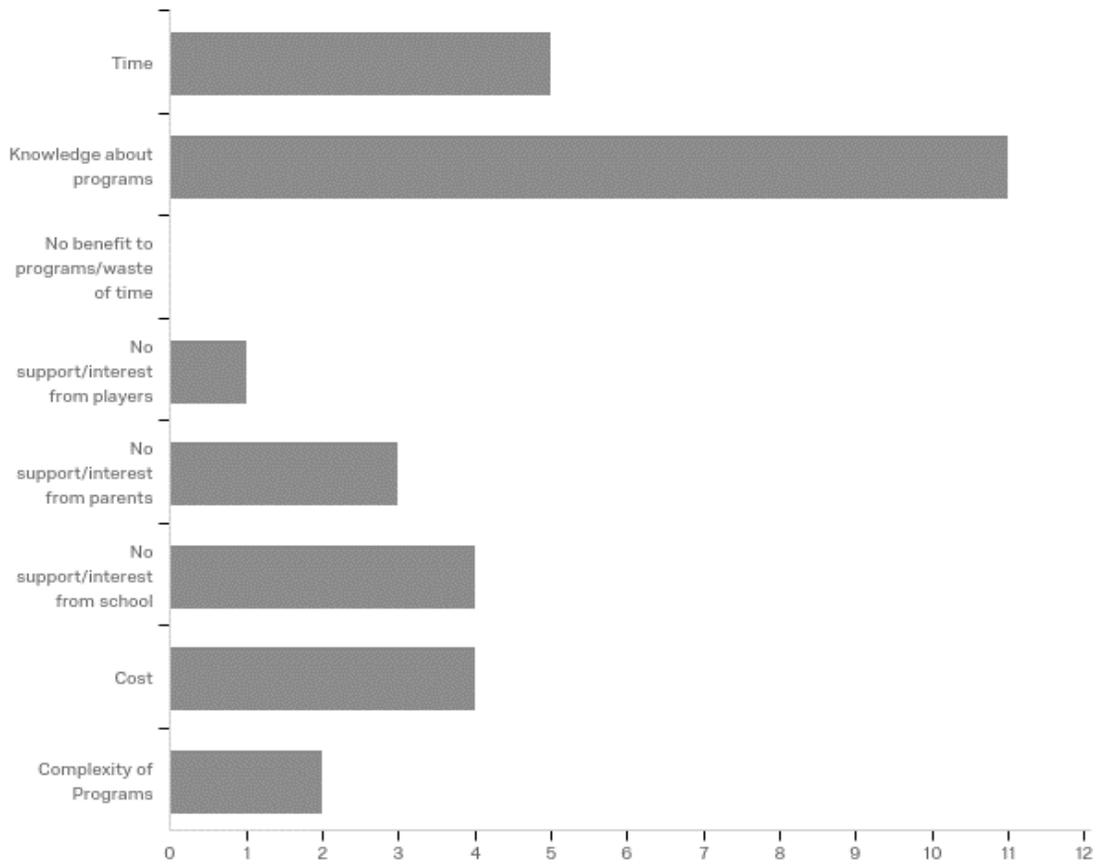
Coaches Familiarity with Specific ACL IPP

ACL IPP	Not familiar at all	Slightly familiar	Moderately familiar	Very familiar	Extremely familiar	Total
Sportsmetrics	65.5%(19)	20.7%(6)	10.3%(3)	0.00%(0)	3.5%(1)	29
ACL Play it Safe	50.0%(14)	35.7%(10)	10.7%(3)	3.6%(1)	0.0%(0)	28
FIFA 11+	42.9%(12)	25.0%(7)	14.3%(4)	3.6%(1)	14.3%(4)	28
Prevent Injury Enhance Performance (PEP)	53.6%(15)	14.3%(4)	14.3%(4)	7.1%(2)	10.7%(3)	28
Other	80.0%(4)	0.0%(0)	0.0%(0)	20.0%(1)	0.00%(0)	5

Most of the responding coaches (n=21, 79%) indicated that they had not received any formal training on ACL IPP and only single coach indicated that they were required to received ACL IPP training prior to coaching. All respondents agreed that injury prevention was a responsibility of the coach, but when asked to rate their level of knowledge on ACL injury prevention strategies, coaches reported varied levels of agreement, with 54% (n= 15) reporting agreement that they are at least moderately knowledgeable. Nearly all of the responding coaches (n=26, 96%) also agreed that ACL injuries are a major concern for female high school athletes.

Coaches were asked to indicate factors that influenced their decision not to implement an ACL IPP from a list of commonly stated barriers to the use of an injury prevention program. Figure 1 shows that a lack of knowledge of ACL IPP is listed as the most common barrier to ACL IPP implementation (37%).

Figure 1. Reported Barriers to ACL IPP Implementation



The second most frequent response to this question was time (n=5). Another question asked coaches why they had stopped using an ACL IPP if they had previously implemented one, but no longer were. In this instance, time was given as the top response (n=4) among the 14 coaches who responded to this question.

Open Ended Questions.

Coaches were presented with several open-ended questions to allow responses in their own words regarding ACL IPP and barriers that they perceive to implementing such a program. Compilation of these responses revealed results consistent with the other survey questions. Coaches were asked to describe challenges or barriers that

prevent them from using an ACL IPP. Of the 25 coaches who responded to this question, Time was indicated more frequently (n=15, 60%) than any other factor. While many coaches simply referred to “time” in their responses, some coaches made statements that give additional insight into the time restraints that coaches face. One coach mentioned the constraints of time over the course of the season, stating “after pre-season, the compactness of the season is ridiculous, we play 3-4 games per week”. Coaches also expressed in these questions concerns about knowledge of ACL IPP programs. One coach stated “Lack of knowledge is probably the biggest barrier. Getting information about the problems and solutions, if it is not a priority, is likely a barrier.” Another coach stated “I don't have a program to use with my players. We have a weight training program in place, but not a specific program for ACL injury prevention”. Other coaches used phrases such as “ignorance” and “knowledge” to describe their views on barriers.

Coaches were also asked to express their views on what could be done to address the challenges that they perceive regarding implementing an ACL IPP. The responses to this question show more variation, but several suggestions surpassed others. Eleven (46%) of those who responded indicated that some form of courses or mandatory training would be beneficial to them. In response to this question, one coach wrote “Inservice days or other training provided.”. Other responses included phrases such as “More coaches clinics for ACL prevention.” and “Educating coaches and having certified trainers to help start the program.”. Other suggestions that garnered multiple mentions included more days off between games and practices (2) and more direction from administrators, athletic trainers, and health professionals (3).

Data Analysis.

Chi-squared analysis were used to determine if relationships existed between specific survey responses and the implementation of ACL IPP. No significant association was found between any factors (previous injury, family member injury, gender, playing experience, or player injuries on their team) and the implementation of and ACL IPP.

Discussion

To my knowledge, this is the first study to assess the knowledge of ACL IPP and factors related to implementation specific to high school girls' soccer coaches in Pennsylvania. The results suggest that coaches in Pennsylvania are implementing ACL IPP at a higher rate than found in previous studies with similar populations in other states. Of the coaches sampled for this study, 45% (n=13) reported that they had implemented an ACL IPP in comparison to 35% of girls' coaches surveyed in Oregon and 19.8% of surveyed coaches in Utah (Norcross et al, 2016; Joy et al, 2013). This higher rate of implementation occurred, despite at least in Oregon, where a higher level of awareness was reported about ACL IPP. In the current study, more training or workshops were listed as one of the top suggestions from coaches for removing barriers to implementation responding coaches indicated a desire to learn more about ACL IPP. Previous studies have discussed the willingness of coaches to learn more about injury prevention strategies, especially in instances that can concurrently improve player performance at the same time (Twomey, Finch, Roediger, & Loyd, 2009). The National Athletic Trainer's Association suggested in their 2018 position statement, that proper training is critical to achieving higher rates of compliance (Pauda et al, 2018). Though this intervention would likely be beneficial, it is possible that it would not significantly

increase implementation alone. Frank et al (2015) discussed that coaches' intent, positive attitude, and awareness of ACL do not always translate into increased compliance. In their study, 53% of coaches implemented an ACL IPP twice per week, despite 100% participation in an ACL IPP workshop and increased reporting of confidence and intent to implement an ACL IPP. Bogardus et al. (2017) suggested the use of a socio-ecological model that addresses multiple levels of relationships among players, coaches, and other stakeholders in youth sports. The interpersonal level of this model suggests that not only coaches must be made aware of the seriousness of an ACL injury, but also the players and the parents. Increased awareness of all parties may aid in creating a more unified approach to ACL IPP. No coaches in the current study reported pressure from parents as a reason for implementation of an ACL IPP, but 10% reported a lack of support from parents as a reason they did not use a program. Only one surveyed coach suggested including parents in meetings with medical staff as a way to reduce barriers. For any program involving young athletes to be successful, it must involve the parents or guardians of the athletes. Often, parental concern and involvement are the drivers of change within youth sports and policy changes will be most successful with the support of parents (Emery, Hagel, & Morrongiello, 2006). In a study that investigated parental knowledge of ACL injuries and prevention strategies among parents of soccer players, only 50% of parents surveyed indicated that they believed that knee injuries were preventable and only 19% of respondents indicated that they had received information on how to prevent injuries. The parents who responded also exhibited limited knowledge on specific strategies (Orr et al., 2013). Emery, Hagel, & Morrongiello, 2006 suggested that there is a hierarchy of responsibility related to injury prevention strategies that starts with the player at the lowest level and then moves up to

the parents, coaches, and expands to include sports organizations up to the government. While parental involvement is crucial for success, there are limits to what parents can accomplish alone. For this reason, steps must be taken by individuals or groups that have a larger role in the hierarchy.

Frank et al. (2017) also included in their socio-ecological model that policy level changes may be a way to implement change. Policy changes from various levels of government and organizations have been used before in areas that were deemed vital to player safety and health. Examples of these include requirements of all teams to have access to an athletic trainer or more recently changes to how head injuries must be treated. As part of the changes regarding head injuries, coaches in many states, including Pennsylvania, have been required to receive mandatory training on concussions (PIAA, 2011). Among coaches in the current study, it was not suggested by any that ACL IPP should be made mandatory. It is possible despite the desire to promote player safety, coaches are hesitant to give up control over how they use their time with teams. Time was a frequently stated barrier to ACL IPP, and it is likely that coaches may deem any mandatory training as more competition for their limited time.

Consistent with the findings of the present study, the perception of time restraints on coaches has been consistently found as a barrier to the implementation of ACL IPP. Coaches have reported in several previous studies the belief that the use of injury prevention programs would take away from valuable training time (Steffen et al, 2018; Peterson et al, 2005; Thien-Nissenbaum, Brooks, 2016). The perception exists, despite the design of several programs to be implemented in a way that minimizes the impact on coaches' time. For example, FIFA 11, is designed to be implemented as a warm-up routine prior to practice or competition that only takes 10-15 minutes to complete and

requires no equipment other than a soccer ball (Bizzini, Junge, & Dvorak, 2013). Warm-up periods prior to practice or competition are an almost universal practice within competitive sports. By educating coaches that ACL IPP implementation could be as simple as replacing their current warm up procedure with a specific protocol, the perception of time as a barrier could be reduced.

Despite the higher rates of implementation of ACL IPP compared to other previously studied populations, implementation rates in PA are still less than 50% among high school coaches. Many coaches are unaware of the programs that are available and the time commitment it would take to implement such a program. Efforts must be made to increase the awareness of coaches, parents, players, and other stakeholders of the seriousness of ACL injuries and the programs that are available to reduce the risk of ACL Injury. More research is needed on developing implementation strategies that encourage collaboration among all involved parties.

CHAPTER II

DISSEMINATION

It is the intent of the author, to disseminate this research in a manner that will primarily allow for influence at the local level. The findings of the project have the potential to impact the practices of coaches, athletic trainers, athletic directors, sports leagues, and physicians. Results and suggestions for implementation of ACL injury prevention programs will be presented through a summary report that will be distributed to organizations that influence coaching decisions and dictate many of the policies for athlete safety while participating in high school sports in Pennsylvania. Organizations that have been selected for distribution of the summary report include the PIAA, WPIAL, and PSCA. These organizations were contacted during the development of this project and the leadership of all three organizations expressed an interest in the findings and acknowledged the need for ACL IPP. By disseminating the information through these organizations, the reports are likely to reach the individuals who carry influence for policy change within high school soccer in the state.

The following is an executive summary of the current research project designed to be distributed to the PIAA, WPIAL, and PSCA leadership.

Introduction

Injuries to the anterior cruciate ligament (ACL) of the knee are one of the most serious injuries sustained in sports.

- It has been estimated that 200,00 to 350,000 ACL injuries occur each year in the United States, (Mall et al, 2014; Pauda et al., 2018; Nessler, Denney, & Sampley,2017).
- Female athletes are at a risk 4-6 times greater than their male counterparts to sustain such an injury (Hewitt et al, 2010).
- Injury prevention programs (IPP) have been developed that have been shown to successfully reduce the risk of ACL injuries, but previous studies in other states have shown poor implementation by coaches at rates as low as 19% (Norcross, Johnson, Bobvbjerg, Koester, & Hoffman, 2016).

Due to the popularity of soccer and the high risk for injury of soccer players, high school girls' soccer coaches were selected as the target population for this study. Coaches are the primary decision makers for injury prevention practices and have the most control over practice and training time. The purpose of this project was to obtain data on the implementation of ACL IPP among high school girls' soccer coaches in Pennsylvania and to identify barriers that limit the implementation of such programs.

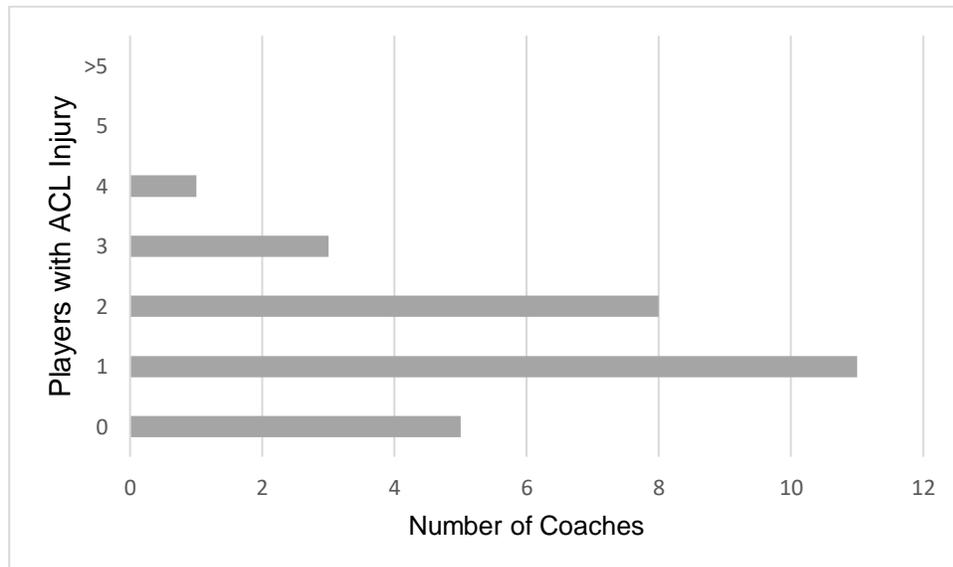
Methods

An online survey was created to assess ACL IPP knowledge, attitudes, implementation rates, and barriers to implementation experienced by Pennsylvania high school girls' soccer coaches. Participants were volunteers who were contacted via email to participate in the study. A total of 32 coaches responded to the survey. The survey also collected data on coaches' age, gender, years of experience, playing experience, injury history, and other related data that could be used to examine relationships between coaches and the implementation of ACL IPP.

Results

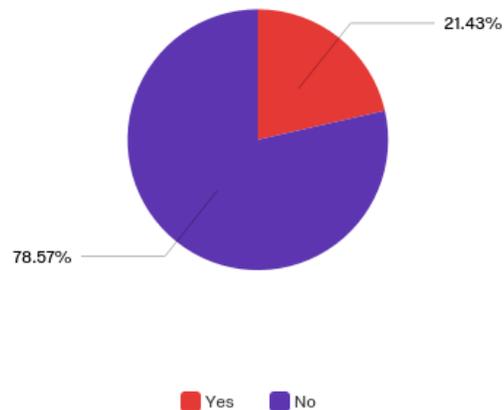
- 82% of coaches reported having at least one of their players suffer an ACL Injury within the last year, with 42% reporting more than one player suffered an ACL injury (Figure 2).

Figure 2. Within the Last Year, How Many of Your Players Sustained an ACL Injury?



- Responding coaches reported a 45% implementation rate of ACL IPP
- Only one commonly used ACL IPP was found to be familiar to greater than 50% of participating coaches, FIFA 11+.
- When reporting barriers to implementation, lack of knowledge of ACL IPP was reported by 37% of coaches.
- Only 21% of coaches reporting having received formal training on ACL IPP (Figure 3).

Figure 3. Have You Received any Formal Training Regarding ACL Injury Prevention Such as a Workshop or Course?



- Time was reported by 17% of respondents and was the most frequent response in open ended questions regarding barriers. When asked for suggestions to reduce barriers to ACL IPP implementation,
- Most frequently (n=11), coaches stated that they would like to see more opportunities for training as a way to increase implementation.

Discussion and Recommendations

The data suggest that coaches may benefit from training opportunities providing instruction on ACL IPP and specifically on the use of programs that can be utilized with minimal time requirements or that can be easily incorporated into practice or warm-up time. Previous studies on IPP implementation rates and strategies have shown that additional training may not be effective alone. More research is needed on

implementation strategies and the potential use of policy changes by regulating organizations to encourage the use of IPP.

In the state of Pennsylvania, the Pennsylvania Interscholastic Athletic Association (PIAA) may have the most influence in developing new policies and procedures for the implementation of ACL IPP. The PIAA oversees all high school athletic competition in PA and sets the rules for competition. The PIAA also maintains a Sports Medicine Advisory Committee that issues yearly Sports Medicine Guidelines to participating schools. The mission of this committee is to:

The current guidelines issued for 2018-2019 include promote the health and safety of interscholastic athletes by serving in a medical advisory capacity to the PIAA Board of Directors, to encourage continuing education (in-service) programs for physicians, certified athletic trainers, and others who contribute to the sports medicine effort at the interscholastic level, to promote more effective working relationships among all persons associated with interscholastic athletics, and to provide, upon request, site coverage at PIAA Inter-District Championship Contests.(PIAA, 2019)

The current guidelines issued for 2018-2019 include information regarding a variety of important issues related to high school athletes, including body composition, prevention of heat illness, nutritional ergogenic aids, menstrual dysfunction, and concussions. The current guidelines make no mention of ACL injuries or ACL IPP (Handbook - PIAA, 2018). In the past, the PIAA has recognized the need for updated policies and guidelines due increased knowledge of specific health conditions. One example of this, in 2011 the PIAA issued a rule change regarding the treatment of concussions during a contest and allowing an athlete to return to play. The organization also mandated annual concussion awareness training as a response to an increased awareness of the seriousness of concussion injuries and the potential long-term effects on athletes (“Eligibility Rules - PIAA,” 2011).

The PIAA should consider the inclusion of ACL IPP information in the annual guidelines manual. The inclusion of this information would be beneficial to coaches and other athletic personal that may rely on this document for advice on sports medicine issues. The PIAA could also include access to IPP resources on their webpage. Currently, the PIAA includes links to multiple concussion training programs required of coaches on their webpage. Since coaches are already required to visit this page, adding ACL IPP information here would be visible and beneficial to coaches. By addressing the issue of ACL injuries and ACL IPP within the guidelines and on their webpage, the PIAA would acknowledge the seriousness of such injuries and the importance of working to prevent these injuries from occurring.

CHAPTER III

ACTION PLAN

ACL injuries occur in females at a rate that is 4-6 times higher than their male counterparts. Due to the potential life-changing effect that such an injury can have on an individual, it is the long-term goal of this research to contribute the development of methods that reduce the occurrence of ACL injuries. The findings of this study will support the development of best practices for implementation of ACL IPP. There are many factors that can influence the decision to implement and ACL IPP, by better understanding the decisions that coaches make regarding these programs, it is more likely that changes can be made to the current programs and training methods that will positively impact implementation rates.

The findings of this research will be initially disseminated by a summary report, submitted directly to the leadership of the PIAA, WPIAL, and the PSCA. Through the course of the development of this project, contact was made with representatives from these organizations. These representatives expressed a desire to know more about ACL IPP and the findings of the presented project. By disseminating the report directly through these groups, it allows for the findings to reach those who have influence over the soccer coaches in the State of Pennsylvania. The PIAA governs all high school athletic competition in PA and sets the rules for competition. The PIAA also issues yearly Sports Medicine Guidelines to participating schools. The current guidelines for 2018-2019, make no mention of ACL injuries or ACL IPP (Handbook - PIAA, 2018). The inclusion of information on ACL injuries within the PIAA Sports Medicine Guidelines

would potentially increase the awareness among coaches and other athletic personal of the seriousness of ACL injuries. This information could also be used to direct coaches to additional resources for ACL IPP to aid in program implementation. The PIAA currently includes links on their webpage for concussion and head injury training that coaches are required to participate in. Several of the programs discussed in this project are available online for free and could easily be linked to for coaches and other interested parties. In addition to providing these groups with an executive summary of this research, information will be provided on where they can easily obtain information on ACL IPP programs as well as sample programs that can easily be distributed via their own websites.

As the primary organization providing oversight of athletics in Pennsylvania, the PIAA should take a leadership role the pursuit of player safety. The results of this study indicate the need and desire of coaches to have access to more information in the area of ACL IPP. The PIAA should also explore methods to increase awareness among other stakeholders in player safety such as parents and administrators. Parental involvement can be a driver of change, but as it stands, parents appear to be uninformed to the seriousness of ACL injuries and the ability to reduce the occurrence of such injuries. Collectively, these groups will likely achieve more success working towards a common goal than as individual groups.

The findings of the project have the potential to impact the practices of multiple professional groups that are involved in high school athletics and player safety decisions. These include coaches, athletic trainers, athletic directors, sports leagues, and physicians. In order to expand the dissemination beyond those only directly involved in PA high school sports, results and suggestions for implementation of ACL

injury prevention programs will be also presented through a presentation proposal submitted to the American College of Sports Medicine (ACSM) for presentation at their annual Mid-Atlantic Chapter annual meeting. The ACSM Mid-Atlantic Chapter (MARC-ACSM) annual meeting serves as one of the largest meetings of professionals and academics with an interest in exercise related disciplines in the region. The MARC-ACSM serves Delaware, Maryland, New Jersey, New York, Pennsylvania, West Virginia, and Washington, DC. The large attendance and diverse audience provide an excellent opportunity for distribution of these findings. Through the dissemination of this information with attendees of the MARC annual meeting, impact could be made with stakeholders in ACL IPP in not only PA, but also surrounding states.

As I continue my career in an academic setting, it is my plan to continue to conduct research in this area to develop a better approach to the implementation of ACL IPP. The efficacy of ACL IPP has been shown in the literature, but to date, there is no standard best practice for increasing the use of such a program. More research is needed in the area expanding knowledge of not only coaches, but also parents and administrators. It is my goal to continue to expand the knowledge in this area and work to find ways to decrease the research to practice gap in the area of ACL IPP and create a best practice for ACL IPP that can be used not only in Pennsylvania, but other states as well.

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APPENDIX A

SURVEY

ACL Injury Prevention Program Survey

Q1 Thank you for agreeing to take part in this survey. The following survey includes some demographic questions and then asks about your opinions and experience with ACL injury prevention programs. Your responses are voluntary and will remain confidential. Following the survey, you will be redirected to a new page that will allow you to enter your email address if you wish to be entered in a drawing for a \$50 gift card.

Please click the next button below to provide informed consent and access the survey.

Q2

How old are you?

Q3 What is your gender?

Male

Female

Other

Q4 What is your race/ethnicity?

White

Black or African American

American Indian or Alaska Native

Asian

Native Hawaiian or Pacific Islander

Hispanic

Other _____

Q5 In what state are you a soccer coach?

Alabama

Alaska

Arizona

Arkansas

California

Colorado

Connecticut

Delaware

Florida

Georgia

Hawaii

Idaho

Illinois

Indiana

Iowa

Kansas

Kentucky

Louisiana

Maine

Maryland

Massachusetts

Michigan

Minnesota

Mississippi

Missouri

Montana

Nebraska

Nevada

New Hampshire

New Jersey

New Mexico

New York
North Carolina
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
Wyoming

Q6 How many years have you been a high school soccer coach?

0-1
2-5
6-10
11-15
>15

Q7 How many years have you been a head coach?

0-1

2-5

6-10

11-15

>15

Q8 How many years have you coached girls' soccer?

0-1

2-5

6-10

11-15

>15

Q9 What levels of soccer have you coached?

Youth/Club

High School

College

Professional

Q10 What is your coaching position with your current team?

Head Coach

Assistant Coach

Other _____

Q11 If you are not currently a head coach, have you previously served as a head coach?

Yes

No

Not applicable

Q12 What competition levels of soccer have you played?

Youth/Club

High School

College

Professional

Q13 The following questions ask about your experiences with ACL injuries and injury prevention programs. Several programs exist, but they are not widely used. I'm interested in coaches views on these programs and why they might or might not use them.

Q14 Have you personally sustained an ACL injury?

Yes

No

Q15

Has a member of your family ever sustained an ACL injury?

Yes

No

Q16 Within the last year, how many of your players sustained an ACL injury?

- 0
- 1
- 2
- 3
- 4
- 5
- >5

Q17 Please indicate how familiar you are with any of the following programs?

	Not familiar at all	Slightly familiar	Moderately familiar	Very familiar	Extremely familiar
Sportsmetrics					
ACL Play it Safe					
FIFA 11+					
Prevent Injury Enhance Performance (PEP)					
Other					

Q18 Do you use a training program specifically for ACL injury prevention?

- Yes
- No

Skip To: Q22 If Do you use a training program specifically for ACL injury prevention? = No

Q19 Where did you learn of this program?

- Playing experience
 - Professional conference or clinic
 - Athletic trainer
 - Book
 - Website
 - YouTube
 - Program already in place
 - Other: Please describe
-

Q20 What influenced your decision to implement an ACL injury prevention program?

- Injury Prevention/Player Safety
- Performance enhancement
- Pressure from parents
- Pressure from other coaches
- Requirement by league, school, etc.
- Other _____

Q21 Does your program include any of the following drills or exercises? (Select all that apply)

- Jumping/Plyometrics
- Landing Techniques
- Core Training
- Hamstring Strengthening
- Balance/Proprioception
- Cutting/Agility
- Other _____

Q22 Have you received any formal training regarding ACL injury prevention such as a workshop or course?

Yes

No

Q23 If yes, how did you receive this training?

- Workshop
- Course
- Online resources
- Coaches Conference
- Other _____

Q24 Prior to coaching, were you required to receive any training regarding ACL injury prevention?

Yes

No

Q25 If no, do you use any type of injury prevention program/training with your team?

Yes, Please describe _____

No

Q26 Rate your knowledge or ACL injury prevention strategies

Not knowledgeable at all

Slightly knowledgeable

Moderately knowledgeable

Very knowledgeable

Extremely knowledgeable

Q27 Does your team have access to any of the following? (Check all that apply)

- Athletic Trainer
 - Strength and Conditioning Coach
 - Team Physician
 - Physical Therapist
 - Other sports medicine professional
-

None of the above

Q28 If you have not implemented an ACL injury prevention program, what has influenced your decision not to?

- Time
- Knowledge about programs
- No benefit to programs/waste of time
- No support/interest from players
- No support/interest from parents
- No support/interest from school
- Cost
- Complexity of Programs

Q29 Have you used an ACL injury prevention program in the past, but do not currently?

Yes

No

Q30 What prompted you to stop using an ACL injury prevention program?

- Time
- Cost
- Complexity of the program/exercises
- No benefit/waste of time
- No support/ interest from players
- No support/interest from parents
- Knowledge about the programs
- Program too rigid, wanted to include more activities
- Too monotonous, boring

Q31 Rate the extent that you agree with the following statements:

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
As a coach, injury prevention is my responsibility.							
ACL injuries are a major concern for female high school athletes.							
I am knowledgeable about ACL injury prevention strategies.							

Q32

As a coach, what are the challenges or barriers that would prevent high school coaches from using ACL injury prevention programs?

Q33

What could be done to address those challenges and help more coaches implement ACL injury prevention programs?

Q34 Would you like to make any additional comments regarding ACL injury prevention programs?

APPENDIX B
COACH RECRUITMENT LETTER

Dear Soccer Coach,

My name is Gregory Kingston and I am a doctoral student from the Kinesiology department at the University of North Carolina at Greensboro. I am writing to invite you to participate in my research study about ACL Injury Prevention Programs. You're eligible to be in this study because you are a high school soccer coach.

If you decide to participate in this study, you will be asked to complete an online survey that should take about 10 minutes to complete. We will use the information to better understand how ACL injury prevention programs can be implemented. As a thank you for participation, following the survey, you may choose to enter a drawing for a \$50 gift card.

Remember, this is completely voluntary. You can choose to be in the study or not. There is no risk to participation, and all answers will remain anonymous. If you'd like to participate, please follow this link: **[ACL Injury Prevention Program Survey](#)**

Absolute confidentiality of data provided through the Internet cannot be guaranteed due to the limited protections of Internet access. Please be sure to close your browser when finished so no one will be able to see what you have been doing.

If have any questions about the study, please email or contact me at 724-496-3891. Thank you very much. If you have any concerns about your rights, how you are being treated, concerns or complaints about this project or benefits or risks associated with being in this study please contact the Office of Research Integrity at UNCG toll-free at (855)-251-2351.

Sincerely,

Gregory Kingston, MS, CSCS
Doctoral Candidate, Kinesiology
gckingst@uncg.edu

Pam Kocher Brown, Ed.D.
Professor, Department of Kinesiology
336-479-6717
plkocher@uncg.edu

APPENDIX C
COACH FOLLOW-UP LETTER

Dear Soccer Coach,

Recently we sent you a request to participate in a survey of soccer coaches conducted by the Kinesiology Department at the University of North Carolina at Greensboro. If you have already completed and submitted the survey, thank you for your valuable input. If not, please consider completing the survey to help with this important research.

If you decide to participate in this study, you will be asked to complete an online survey that should about 10 minutes to complete. We will use the information to better understand how ACL injury prevention programs can be implemented. As a thank you for participation, you may choose to be entered into a drawing for one of several \$50 gift cards following the survey.

Remember, this is completely voluntary. You can choose to be in the study or not. If you'd like to participate, please follow this link: **[ACL Injury Prevention Program Survey](#)**

Absolute confidentiality of data provided through the Internet cannot be guaranteed due to the limited protections of Internet access. Please be sure to close your browser when finished so no one will be able to see what you have been doing.

If have any questions about the study, please email or contact me at 724-496-3891. If you have any concerns about your rights, how you are being treated, concerns or complaints about this project or benefits or risks associated with being in this study please contact the Office of Research Integrity at UNCG toll-free at (855)-251-2351.

Thank you very much.

Sincerely,

Gregory Kingston, MS, CSCS
Doctoral Candidate, Kinesiology
gckingst@uncg.edu

Pam Kocher Brown, Ed.D.
Professor, Department of Kinesiology
336-479-6717
plkocher@uncg.edu

APPENDIX D
WPIAL LETTER

Tim O'Malley
WPIAL Executive Director
615 Iron City Drive, Suite 300
Pittsburgh, PA 15205

Dear Mr. O'Malley,

My name is Greg Kingston, and I am an Ed.D. student at the University of North Carolina at Greensboro. I am writing to request the assistance of the WPIAL with a research study that I am conducting about ACL injury prevention programs. The study is being conducted through the department of Kinesiology at UNCG under the supervision of Dr. Pam Brown.

The study is aimed at assessing knowledge and identifying barriers that high school girls' soccer coaches experience regarding implementation of ACL injury prevention programs. As you may know, ACL injuries are very serious, and occur in girls at a rate that is 4-6 times greater than boys. Throughout my career working in sports medicine clinics in the Pittsburgh area, I have witnessed the effects of this on our young athletes. Programs for the prevention of ACL Injuries have been developed, but to date, participation in these programs has been low. For this reason, we hope to survey as many coaches in Pennsylvania as possible to gain insights into the barriers that are preventing coaches from using such programs. It is our goal that this information will lead to the development of new methods to reduce the number of injuries sustained.

I would like the assistance of the WPIAL in disseminating the survey via email to girls' high school head soccer coaches from WPIAL schools through the use of the WPIAL email database or alternatively, sent from the WPIAL on my behalf. The survey is brief and will only take about 10 minutes to complete. All responses will remain anonymous and no personal information will be shared. As a thank you for participation, coaches may choose to enter into a drawing for one of several \$50 gift cards.

If you have any questions regarding the project, I would be happy to answer them for you. Please feel free to contact me by email or telephone. Thank you very much for your time and consideration.

Sincerely,

Gregory Kingston, MS, CSCS
Doctoral Candidate, Kinesiology
University of North Carolina at Greensboro
gckingst@uncg.edu

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