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Prevelance of Anterior Cruciate Ligament Injury Prevention Programs in High School Sports

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PREVALENCE OF ANTERIOR CRUCIATE LIGAMENT INJURY PREVENTION PROGRAMS IN HIGH SCHOOL SPORTS

By

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ABSTRACT

PREVALENCE OF ANTERIOR CRUCIATE LIGAMENT INJURY PREVENTION PROGRAMS IN HIGH SCHOOL SPORTS

By

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Current literature supports the premise that female athletes have a higher incidence of ACL injuries in competitive sports compared to male athletes. In response to this issue several ACL injury prevention programs have been designed. The next issue is whether coaches are implementing these prevention programs and are they being informed that these programs are available?

This study was designed to survey coaches in the Capital Area Activities Conference, in order to determine if they are aware of and/or implementing ACL injury prevention programs. From the 105 coaches surveyed, 45 responded. Of those 45, 16 reported being aware of the ACL prevention programs, only 5 reported implementing an ACL injury prevention program in their strength and conditioning regimen. From these data it can be concluded that few coaches in the Capital Area Activities Conference are aware of ACL injury prevention programs and significantly fewer are implementing an ACL injury prevention program. It was also found from this study that 42 respondents stated implementing one or more training techniques that were consistent with ACL injury prevention programs. Future research directions should be aimed at educating the public about ACL injury prevention programs.

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Chapter 1

INTRODUCTION

Female participation in sports has increased dramatically over the last decade. The National Federation of State High School Associations' data shows that there were just under 2 million females participating in athletics at the high school level in 1993. There has been an increase to just under 3 million in 2003. This is over a 30% increase in one decade. Boys' athletic participation over this same period has been less dramatic with approximately a 14% increase. Participation in sports where anterior cruciate ligament (ACL) injuries are more likely to occur, basketball, volleyball and soccer has also increased. All three sports are among the top ten most popular girls' athletic programs at the high school level, with basketball ranking the most popular [1].

Along with this dramatic increase in female athletic participation has come an increased awareness of the female ACL problem within the medical community. This awareness has brought about extensive research in the area of female ACL injuries.

There is a general consensus that females have a higher incidence of ACL injuries, and there are many ideas as to why this occurs. Some researchers focus on the anatomical reasons [2] while others feel the causes are multifactoral and cannot be considered independent in nature[3]. The research has also found that in soccer, basketball, and volleyball, the rate of noncontact ACL injury is 2.4 to 9.5 times higher in women than in men [4]. In response to this, some researchers have developed prevention programs [5-10]. The question is: are these researchers making this information available to

coaches? Also, if the coaches have been educated: are coaches aware of and implementing programs as a result of this research?

In 1995, the National Association for Sport and Physical Education published the National Standards for Athletic Coaches [11]. Within the coaching community, there are numerous formal coaches' education programs available to coaches that want to improve their coaching skills. This publication was developed because of the increase in sport participation and in return the increased need for educated coaches. The publication fostered an increase in the standards of coaching education and an increase in the amount of coaching education available.

Despite the increase in coaching education availability the question still remains, are the coaches being informed of the specific ACL injury prevention programs and techniques these programs use to prevent injury? The objective of this study is to determine the awareness and implementation of ACL injury prevention programs and techniques in the Capital Area Activities Conference for the sports of boys' and girls' basketball, boys' and girls' soccer, and girls' volleyball.

Hypothesis I: Coaches are not aware of or implementing ACL injury prevention programs.

Hypothesis II: Coaches are aware of and implementing ACL injury prevention techniques unknowingly.

Chapter 2

REVIEW OF LITERATURE

Anatomy of the Knee Joint

The knee joint is classified as a diarthrodial joint with a subclassification as a modified ginglymus or hinge joint. Its support structures include six ligaments, other soft tissues, and the geometric constraints of the joint surfaces. The integrity of these structures determines the movement of the knee joint. As long as each is intact and functioning properly, the knee joint has six degrees of freedom, which includes three rotations and three translations. There are three principle axes used to describe the movement occurring at the knee joint: the tibial shaft axis, the epicondylar axis, and the anterior-posterior axis, which is perpendicular to the other axes. The translations that occur along these axes include: proximal-distal, medial-lateral, and anterior-posterior translation respectively. The rotations that occur along these axes include: internal-external rotation, flexion-extension, and varus-valgus rotation, respectively [12].

The ligaments of the knee joint provide stability to the joint throughout its range of motion. Each ligament restrains the knee motion in response to externally applied loads as well as provides stability in more than one degree of freedom. The overall stability of the joint depends on the contribution of all the ligaments both individually and the interaction between ligaments [12].

The anterior cruciate ligament (ACL) prevents anterior translation, internal and external rotation of the tibia on the femur. It also acts as a secondary restraint against valgus and varus rotation of the tibia on the femur. A force applied in one or all of these

directions that exceeds the elastic limit of the ligament will cause injury. An understanding of the forces applied to the ligaments during normal knee function plays a role in injury mechanisms and aids in the development of ACL injury prevention techniques [12].

Mechanism of ACL Injury

Research has shown that ACL injuries frequently occur during non-contact situations such as pivoting, cutting or landing from a jump on one or both legs [13, 14]. The ACL is most at risk of injury during anterior tibial translation and valgus tibial rotation. Activation of the hamstring musculature is thought to protect the ACL from injury at knee flexion angles greater than 30 degrees [13].

It was theorized by Fagenbaum [13] that it is possible that ACL injuries in women occur primarily during landings when the athlete intends to immediately change direction or jump again, thus employing the internal tibial rotation component of injury. Arendt and Dick [3] found that women land from jumps with smaller angles of knee flexion thus predisposing them to ACL injury. The research done by Fagenbaum[13] contradicted the previous research in that women did not demonstrate lower hamstring muscle activity or reduced knee flexion in response to fatigue. Their conclusions to this research indicated that when speed is of most importance in a competitive situation, it is possible that female athletes use less knee flexion when landing from a jump than male athletes and thereby predispose themselves to injury. Under more controlled laboratory conditions as used in their experiment, it may be that female basketball players landed in a manner that is protective of the ACL.

Incidence of ACL Injury in Female Athletes

The preponderance of the research indicates that there is a higher number of ACL injuries occurring in the female athletic population compared to the male athletic population [1]. Hewett reported that female athletes participating in jumping and cutting sports demonstrate a four-to-six fold higher incidence of knee injury than do male athletes participating in the same sports [9]. Chandy and Grana reported that female high school athletes had knee surgery nearly five times more often than their male peers and that knee surgery accounted for almost 70% of all surgeries in the female athletic population [15]. Chandy and Grana reported that female high school athletes have an occurrence of ACL injuries of 1 out of every 100 participants. With the larger numbers of participants this translates to more than 20,000 knee injuries each year at the high school level [9].

The increased risk of ACL injuries is also prevalent in the female collegiate athlete population. A 1990 to 1993 injury survey done of approximately 15% of NCAA member institutions reported that more than 1 out of every 10 female athletes participating at the collegiate level will sustain a knee injury each year. Also from this survey it was concluded that 2200 ACL ruptures are expected to occur in female collegiate athletes each year [9].

ACL Injury Risk Factors

Many researchers have attempted to pinpoint risk factors, whether intrinsic or extrinsic, that predispose an athlete to sustaining an ACL injury. Rather than pinpoint a single risk factor it has been concluded that the increased risk of ACL injuries among female athletes is likely multifactoral, with no single structural, anatomic, or

biomechanical factor solely responsible [3]. Rozzi [2] stated, "Since women often incur ACL injuries during routine noncontact activities, one might speculate that the coordinated motor program that provides dynamic stability fails as a result of some external influence such as fatigue or loss of motor control." This concludes that an intrinsic factor is influenced by an extrinsic factor. The factors that are of the most concern are those that are reversible, allowing for injury prevention for example, shoe-surface interface, neuromuscular deficits, and strength imbalances.

A group of sports medicine team members consisting of 22 orthopaedists, family physicians, biomechanists, and athletic trainers met in Hunt Valley, Maryland in June 1999. These individuals met because they recognized a need to critically examine and summarize existing data on prevention strategies and the implied risk factors for noncontact ACL injuries. The goals of the 1999 Hunt Valley Consensus Conference on Prevention of Noncontact ACL Injuries were to increase awareness in the at-risk population and medical support personnel about prevention strategies for ACL injury and to stimulate increased effort in ACL injury prevention research. During the conference, participants carefully reviewed available data on injury risk factors and developed consensus statements based on the research [16].

Environmental Risk Factors

There is no current research to support the use of knee braces to prevent ACL injuries. By increasing the shoe-surface interaction the athlete may see performance enhancement, but may be increasing their risk of ACL injury as well. It is undetermined what the optimal shoe-surface interaction is for each playing surface in order to optimize performance and decrease injury, therefore this topic warrants further investigation.

Anatomic Risk Factors

Anatomic risk factors that have been investigated by researchers include femoral notch size, ACL size, and lower-extremity anatomic alignment and their role in ACL injury. None of the research has proven any of these factors to be instrumental in ACL injury, and there needs to be continued research and reliable measures developed for each before a consensus on the role of these factors can be made.

Hormonal Risk Factors

Hormonal risk factors have been a topic in a lot of current ACL injury research. There is no consensus as to what role sex-specific hormones play in the increased incidence of ACL injury, therefore this area warrants further research.

Biomechanical Risk Factors

The research to date has shown that the biomechanical factors involved in many injuries include impact on the foot rather than the toes during landing or changing directions, awkward dynamic body movements, and biomechanical irritation prior to injury.

According to Teitz [17], videotape analysis of ACL injuries revealed that athletes contacting the ground in a flat foot position were noted in two thirds of the injured female basketball players, all the soccer players, and all injured male players. The analysis also showed that 100% of male basketball players were injured landing from a jump, whereas roughly half the women were injured landing from a jump, and half were injured when they stopped suddenly while running down the court. The lower limb position of the injured athletes was frequently less than 30 degrees of knee flexion, knee valgus, and external rotation of the foot relative to the knee.

It must also be kept in mind that the knee is only a single part of the kinetic chain. The trunk, hip, and ankle may also have a role in ACL injury. From the video analysis it also appeared that the center of gravity was behind the knee in two thirds of the injuries. If an athlete makes ground contact at the toes rather than in a flat-foot position it is nearly impossible for the center of gravity to be behind the knee. When one lands with the center of gravity behind the knee, the rectus femoris contracts to bring the trunk over the leg, thus placing a large anterior force on the tibial tubercle [17].

Most non-contact ACL injuries occur when the athlete cuts, changes direction or lands from a jump. The deceleration portion of these actions places a large anterior force on the tibia thus also placing a strain on the ACL [17].

ACL Injury Prevention Programs

Available risk factor data suggests that a change in a biomechanical risk factor is the most likely link to decreasing the risk of ACL injuries. The following hypothesis that Teitz [17] made from video analysis should be considered when designing an ACL prevention program. "A neuromuscular training program to aid the prevention of noncontact ACL injuries sustained in pivoting sports should include the following elements; a kinesthetic program to keep the center of gravity forward and the athlete on his or her toes, and a program to encourage better lower extremity rotational and angular control. The first portion of the program would include strength and endurance training of the rectus abdominis, iliopsoas, and gastrocnemius-soleus muscles while the second portion would include strength and endurance training of hip abductor and external rotator muscles" [17].

There have been several ACL injury prevention programs developed that are based on altering the biomechanical risk factors through neuromuscular training. Frank Noyes and Timothy Hewett from Cincinnati, Ohio developed Sportsmetrics, a three-part ACL injury prevention program consisting of stretching, plyometrics, and strength training activities designed to address the potential deficits in neuromuscular strength and coordination of stabilizing muscles around the knee joint [18].

From a 1996 study, Hewett, et al found striking neuromuscular imbalances between young female athletes prior to training. When landing from a jump, male athletes activated their knee flexors at three times the level of the female athletes in this study, and it was discovered that jump training corrected hamstrings and quadriceps imbalances, decreased impact forces, and increased strength and jump height [18].

In 1999, Hewett, et al did an additional study in order to test the effectiveness of the program developed previously. There were 1263 athletes from 43 soccer, volleyball, and basketball teams from 12 high schools participating in the program, and they were monitored over their entire sports season. The program is a six week, three time weekly regimen that consisted of 20 to 25 minutes of stretching exercises, a 30 minute plyometrics jump training program, and 30 minutes of upper and lower extremity strength training. The plyometric jump training portion was broken up into 3-2 week phases. Phase I, Technique, focuses on teaching the athlete the proper jumping techniques. It instructs the athlete to "land soft as a feather", "recoil like a spring", and "jump straight as an arrow". Phase II, Fundamentals, is a phase that adds specific techniques to build a base of strength, power and ability. Phase III, Performance, is

aimed at increasing the athlete's vertical jump height, coordination, and balance while landing from a jump [9].

In this study, it was found that the use of this program reduced the risk of a serious knee injury significantly. It was also concluded that the decreased injury incidence in trained athletes might be due to increased dynamic stability of the knee joint after training [9].

The late Chuck Henning developed another ACL injury prevention program, The Henning Program. Henning was a well-known orthopaedist that focused his sports medicine research on what he called the "quad-cruciate interaction" and its role in noncontact ACL injuries. Henning's research was halted at his untimely death in 1991. Just before his death, he had found in his study of videotaped ACL injuries that the most common mechanisms were planting and cutting (29%), straight knee landing (28%), and one step stop with knee hyperextended (26%). Only 7% of the injuries were caused by a direct hit on the knee. He also found that the most common play situations in the noncontact group of injuries included shifting while on defense, jumping for a loose ball, dribbling to avoid a defender, going up for a layup, jumping and landing for a rebound, and attempting to block a shot. From his research endeavors, Henning believed that the ACL acts as a major restraint of forward movement of the tibia on the femur when the knee is straight while weight bearing. He believed the ACL provides 86% of the total resistive force, and when the quadriceps contract they cause more strain on the ACL. If the knee is flexed to 60 degrees or greater the contraction of the quadriceps causes a smaller anterior tibial translation and smaller load on the ACL.

From these conclusions, Henning developed his ACL injury prevention program. Henning's program consisted of drills in which he had athletes practice substituting an accelerated rounded turn off a bent knee for the plant and cut, landing on a bent knee instead of straight knee landing, and three-step stop with knees bent instead of one-step stop with knees straight. Prior to his death, Henning was able to make an instructional video of these three techniques and conduct a pilot study. In the study, he instituted his program at two division one basketball programs in Witchita, Kansas. The pilot study showed an 89% decrease in the rate of occurrence of ACL injuries [5].

Carraffa Orthopedic Clinic in Terni, Italy developed another program in 1996. This program is a five-phase proprioceptive program based on increasingly difficult skills performed initially without a balance board and progressing through the use of a series of balance boards. The study, a prospective study on the effect of proprioceptive training on noncontact ACL injury rates in soccer players, was published in 1996 by Caraffa and associates. The idea behind this study was that proprioception training is essential during the rehabilitation process of a knee ligament injury and the role that prophylactic proprioception training would have in preventing knee ligament injury? To test their program, Caraffa and associates implemented their balance training program to the standard training routine for 300 from 20 semiprofessional and amateur Italian soccer teams. The controls were 300 players from 20 teams that continued their normal training routine. The results showed a significant decrease in injury rate for the trained group, 0.15 injuries per team per season, compared to 1.15 injuries per team per season for the untrained group [8].

The program consisted of five phases of progressively difficult balance exercises. During phase one, the athlete balances on a single leg with no board. They then progress to a rectangular board in phase two, a round board in phase three, and alternates between rectangular and round boards in phase four. Finally in phase five, the athlete uses a multiplanar board, also called a biomechanical ankle platform system, BAPS. These exercises were recommended to be done 20 minutes each day for 30 days prior to the season and continue the program three days a week during the regular season [8].

Anterior cruciate ligament injury is not only common among basketball, volleyball, and soccer players, but also among female skiers. There has been an ongoing case control study at the Sugarbush Ski Area in Vermont. The data in 1998 showed that ACL injuries accounted for 19.3% of all injuries sustained on the slopes, a notable increase from the 4.5% in 1972 [10].

The Vermont Safety Research based in Underhill, Vermont recognized the increased risk and described what is known as the "phantom foot". Phantom foot is a phenomenon that occurs when the following elements occur: (1) skier off balance to the rear; (2) uphill arm back; (3) hips below the knees (knees flexed greater than 90 degrees); (4) uphill ski unweighted; (5) weight on the inside edge of the downhill ski tail; and (6) upper body generally facing the downhill ski. From their awareness of this phenomenon the researchers designed an injury awareness program to address and minimize these actions. The program was developed into a videotape that describes the mechanism of phantom foot and several ways to prevent being in the position of injury. An interesting point about ACL injuries in the ski population is that the risk of sustaining an injury does not appear to be effectively reduced by improvement in the skier's ability or by increase

in the skier's strength or experience. Ski instructors and patrollers who devised prevention programs after viewing videotapes of ACL injury and near-injury situations sustained fewer ACL injuries than those in the control group [10].

In response to the Hunt Valley Consensus Conference the Santa Monica ACL Prevention Project was developed. Their goal was to develop a program that could be done as part of the normal practice and that would also decrease the number of ACL injuries in female soccer. They developed PEP, Prevent Injury and Enhance Performance. PEP consists of a warm-up, stretching, strengthening, plyometrics, and sport specific agilities. The program is designed to take 15 minutes plus a cool down and stretching. It is recommended that athletes perform this program 2-3 times per week [7].

Girls' Can Jump is an 8-week training program, which focuses on addressing four problem areas for female athletes: flexibility differences, strength imbalances, balance deficits, and jumping technique error. The program includes a dynamic warm-up, correct jumping technique that includes posture, take off, and landing. Plyometric jumps will also be done progressing from less difficult to more difficult exercises, beginning with double leg jumps progressing to single leg jumps, and finishing with multi-directional jumps. The program also addresses balance deficits by translating balance into a functional strength training program including strengthening for the arms, legs, and core. This program was developed by Laura Ramus PT, ATC, CSCS for the Detroit Shock, and has been implemented in the Detroit Shock strength and conditioning program for the last three years. Since the implementation of the program the athletes on the Detroit Shock team have suffered no ACL injuries, and report improved performance in vertical jump height [6].

Coaches' Education

As previously stated, there are numerous opportunities for coaches' education. Several associations have developed credentialing programs for coaches in order to increase the level of education that occurs between coach and athlete. It is estimated that 2.5 million coaches are involved in non-scholastic sports, and approximately 400,000 are involved in scholastic sports in the United States. The Institute for the Study of Youth Sports at Michigan developed PACE, Program for Athletic Coaches' Education, in response to the increased number of youth participating in organized sports and the increased demand for educated coaches [19].

Michigan High School Athletic Associations, Michigan Interscholastic Athletic Administrator Associations, and the Youth Sports Institute designed and endorsed the PACE program. PACE provides interscholastic coaches with information about their daily coaching responsibilities, and credentialing through PACE has been made a requirement for several school districts as part of their coaching continuing education. PACE is offered in two levels, Level I and Level II, and is not sport specific therefore is ideal for all coaches [20].

Another education program that is not sport specific is ASEP, American Sport Education Program, and NFHS, National Federation of State High School Associations' Coaches' Education Committee. The ASEP develops and delivers online and instructor-led courses and resources for coaches, officials, sport administrators, athletes, and parents of athletes. ASEP consists of two levels of certification, the Volunteer Education Program and the Professional Education Program. The Volunteer Education Program is designed for those working with the less competitive, recreational sports

program with athletes 13 years of age and younger. The Professional Education Program allows coaches working with athletes 14 years of age and older to increase their skills and enhance their careers [21].

The National Federation of State High School Coaches' Education Committee also has coaches' education programs in place. Their mission is "to assist member state associations by providing a coaches' education program which will enhance the skills and knowledge necessary to teach meaningful life-long lessons to all student participants and to support the achievement of educational goals" [22].

The NFHS encourages coaches to earn professional credentials and they have partnered with the ASEP to provide the Bronze, Silver, and Gold level courses [22]. The NFHS has also developed a Sports Medicine Handbook in response to the need expressed by state organizations for a publication focused on Sports Medicine. This publication includes information on administrative issues like coaches training, emergency planning, guidelines for lightening safety, and pre-participation examinations. In the section regarding medical issues the topics covered include: cold illness, heat-related illness, infectious disease, skin disorders, nutritional concerns: female athlete triad, supplements, weight control, mild head injury, asthma, and fluid replacement. The final section discusses equipment issues and covers the topics of helmet removal and mouthguard use [23].

In addition to the non-sport specific programs, there are also sport specific education programs available to coaches. The Michigan State Youth Soccer Association, MSYSA, provides educational courses for coaches working with youth soccer. Coaches can receive credentialing for all levels of coaching experience. According to the

Michigan State Youth Soccer Association's website, the U6, U8, U10 modules are three-hour courses, recommended for parents, new coaches, and those working with children under the age of ten. The E license is a 16 hour course that consists of theoretical and practical instruction on the teaching of techniques and tactics of small-sided games between 1v1 and 6v6. The emphasis is to build on the player's technical development by applying tactical concepts with game situations. The D license is a 36 hour course that consists of theoretical and practical instruction on teaching the four components of soccer: technique, tactics, fitness and psychology, as they relate to games from 1v1 to 11v11. This level of certification is recommended for all travel level coaches working in the 11-a-side game. To obtain this certification coaches are required to pass two written tests and a practical field test. When taking this course, there are three possible outcomes.

1. Coaches can pass outright and become National D and proceed to the next national level courses, C, B, and A after a mandatory one year wait.

2. Coaches can earn a restricted pass, State D, which requires a two year wait, or

3. Coaches can fail the course [24].

Along with the certification coaches are required to attend Continuing Education Program, CEP, in order to maintain their "A" License. According to the U.S. Soccer website coaches that are currently "A" Licensed must accumulate eight credits within every four-year cycle in order to maintain their "A" License. Coaches that do not obtain enough Continuing Education, CE, credits will revert into a "B" License [25].

According to the Basketball Coaches Association of Michigan, they are promoting the new Graduate Certificate in Coaching offered online through Michigan

State University's Department of Kinesiology and Youth Sports Institute. Upon completion of the three 3-semester hour courses that address legal, administrative, psychological, sociological, and biological issues as they relate to the coaching of amateur athletes, a Certificate of Completion will be awarded by the Department of Kinesiology [26, 27].

According to the U.S. Volleyball website, they provide the CAP Cadre Program for their coaches' education. This program consists of six levels: Home Equivalency Course, Level I, Level II, Level III, Level IV, and Volleyball Conditioning Specialist (VCS) Course. The Home Equivalency Course is aimed toward the well experienced coaches who have taken prior coaching education foundation course work and possess established competencies in facilitating athlete development. The Level I certification is targeted towards coaches of all coaching and teaching levels, especially those who have had no or limited formal coaching education courses. The Level II follows Level I, and puts an emphasis on team offense/defense systems, blocking and setting development, problem solving, social issues, and drill development. The Level III course follows Level II and focuses on critical thinking about the sport of volleyball. It also includes peer presentations and an Outreach Project to coach in the community. The Level IV certification is granted on an honorary basis to those individuals who have been head coaches for an official USA National Volleyball Team. The VCS course is a course provided by the USA Volleyball's Sports Medicine and Performance Commission and Performance Conditioning for Volleyball. The course is designed to help those that have a large role in their team's strength and conditioning program. The course covers on and

off the court conditioning, court movement, evaluation, individualization, jump improvement, over-training and injury prevention [28].

Chapter 3

METHODS

Subjects

The subjects in this study included the coaches from the 21 schools participating in the Capital Area Activities Conference, CAAC the sports of boys' and girls' basketball, boys' and girls' soccer and girls' volleyball will be mailed questionnaires pertaining to their knowledge in the area of ACL prevention. The schools in Division 1 inlcude: East Lansing, Eastern, Everett, Grand Ledge, Holt, Jackson, Okemos, and Sexton. The schools in Division 2 include: Charlotte, Eaton Rapids, Ionia, Lumen Christi, Mason, Northwest, and Waverly. The schools in Division 3 include: Catholic Central, Dewitt, Fowlerville, Haslett, Lakewood, and Williamston.

Instrumentation

A survey was designed to answer questions regarding coaches' demographics, their awareness of ACL injuries, awareness and implementation of ACL injury prevention programs and techniques. (See Appendix B)

Protocol

Survey materials were distributed by mail, addressed to each of the varsity coaches for the sports of boys' and girls' basketball, boys' and girls' soccer, and girls' volleyball at each of the schools listed above. It included a letter (see Appendix A) explaining the research being conducted, an informed consent statement, and a request to return the survey within two weeks. Also included with the survey was information on obtaining a reference list of current research in the area of ACL injury prevention. At three weeks, the participants that had not returned their survey were mailed a second

survey and a second letter (see Appendix C). In response for their participation, each respondent was mailed a reference list of current prevention programs and relevant articles (see Appendix D).

Statistical Analysis

The statistical analysis was done by entering the raw data into an excel file. The data was then processed using SPSS 10.0 software (SPSS Inc, Chicago, IL) to determine the descriptive statistics. Frequencies, percents, and simple comparisons were made.

Chapter 4

RESULTS

There were 105 surveys mailed to coaches participating in the Capital Area Activities Conference. Of these 45 (42.8%) were returned. Table 4.1 shows which sport the respondents coached, and how many years they have been coaching their sport. Coaches were able to answer multiple sports coached. Of the 45 respondents, 15 (33.3%) had coached boys' basketball, 13 (28.9%) had coached girls' basketball, 7 (15.6%) had coached boys' soccer, 10 (22.2%) had coached girls' soccer, and 9 (20%) had coached volleyball.

For the boys' basketball respondents the majority, 9 (20%) had $\geq$16 years of coaching experience. For girls' basketball, 4 (8.9%) respondents had $\leq$5 years experience, 4 (8.9%) respondents had 6-10 years experience, and 4 (8.9%) respondents had 11-15 years of coaching experience. For the boys' soccer respondents the majority, 5 (11.1%) respondents had 6-10 years boys' soccer coaching experience. For the girls' soccer respondents the majority, 7 (15.6%) respondents had 6-10 years girls' soccer coaching experience. For the volleyball respondents the majority, 4 (8.9%) respondents had 11-15 years volleyball coaching experience.

There are three divisions within the Capital Area Activities Conference. Schools are placed into a division based on the number of students enrolled in their school. There were 16 out of 40 possible respondents (40%) from the Division I level. 14 out of 35 possible respondents (40%) from the Division II level, and 15 out of 30 possible respondents (50%) in the Division III level.

Table 4.1

Years of Coaching Experience

Boys' Basketball	**≤5 yrs**	**6-10 yrs**	**11-15 yrs**	**≥16 yrs**	**Total**
Frequency	1	3	2	9	15
Percent	2.2%	6.7%	4.4%	20.0%	33.0%
Girls' Basketball					
Frequency	4	4	1	4	13
Percent	8.9%	8.9%	2.2%	8.9%	28.9%
Boys' Soccer					
Frequency	1	5	0	1	7
Percent	2.2%	11.1%	0%	2.2%	15.6%
Girls' Soccer					
Frequency	2	7	0	1	10
Percent	4.4%	15.6%	0%	2.2%	22.2%
Volleyball					
Frequency	1	2	4	2	9
Percent	2.2%	4.4%	8.9%	4.4%	20.0%

Percentages indicate percent of total respondents (45).

Tables 4.2-4.7 show the coaching level of the 45 coaches that participated in the survey. All coaches were involved in coaching at the high school level. The interesting piece of data is the number of coaches that were involved at other levels besides scholastic high school. Twenty-eight percent of the total respondents also coached at the elementary school level, 37.8% also coached at the middle school level, 46.7% also coached at the junior high level, 24.4% also coached at the collegiate level, and 24.4% also coached at the adult recreational level.

Table 4.2

Coaching at High School Level

	Frequency	**Percent**
Scholastic 9 - 12th grade	39	86.7%
Non-Scholastic	0	0%
Both Scholastic and Non-Scholastic	6	13.3%
Total	45	100%

Percents are based on the total respondents (45).

Table 4.3

Coaching at Elementary Level

	Frequency	Percent
Scholastic K – 4th grade	5	11.1%
Non-Scholastic 5 - 9 years of age	8	17.8%
Total	13	28.9%

Percents are based on the total respondents (45).

Table 4.4

Coaching at Middle School Level

	Frequency	Percent
Scholastic 5 - 6th grade	7	15.6%
Non-Scholastic 10 - 11 years of age	9	20.0%
Both Scholastic and Non-scholastic	1	2.2%
Total	17	37.8%

Percents are based on the total respondents (45).

Table 4.5

Coaching at Junior High Level

	Frequency	Percent
Scholastic 7 - 8th grade	14	31.1%
Non-Scholastic 12 -13 years of age	6	13.3%
Both Scholastic and Non-scholastic	1	2.2%
Total	21	46.7%

Percents are based on the total respondents (45).

Table 4.6

Coaching at Collegiate Level

	Frequency	Percent
Intercollegiate	4	8.9%
Club/Intramural	5	11.1%
Both Intercollegiate and Club/Intramural	2	4.4%
Total	11	24.4%

Percents are based on the total respondents (45).

Table 4.7

Coaching at Adult Level

	Frequency	Percent
Yes	8	17.8%
No	3	6.7%
Total	11	24.4%

Percents are based on the total respondents (45).

Table 4.8 shows the number of coaches that are currently or have been certified in CPR. It is interesting to note that 62.2% of total respondents were currently CPR certified and of those that were not current, 58.8% had been certified but were not maintaining these credentials.

Table 4.8

CPR Certification of Coaches

Currently CPR Certified	**Yes**	**No**	**Total**
Frequency	28	17	45
Percent	62.2%	37.8%	100%
Previously CPR Certified			
Frequency	10	7	17
Percent	58.8%	41.2%	100%

Coaches that responded to the survey held very few coaching credentials, which the pattern of their responses are portrayed in Tables 4.9-4.10. Ten (22%) reported taking the PACE program. Five (11.1%) of the respondents reported credentialing through Michigan State Youth Soccer Association (MSYSA). No one reported having credentialing through the American Sport Education Program (ASEP), and only 1 (2.2%) respondent was credentialed through National Federation of State High School Associations (NFHS).

Table 4.9

Program of Athletic Coaches Education (PACE)

	Frequency	Percent
Level 1	1	2.2%
Level 2	7	15.6%
Both Level 1 and 2	2	4.4%
Total	10	22.2%

Percentages indicate the percent of total respondents (45).

Table 4.10

Michigan State Youth Soccer Associations (MSYSA)

	Frequency	Percent
U6, U8, or U10 Module	0	0%
E License	0	0%
D License	5	11.1%
Multiple Certifications	5	11.1%
Total	10	22.2%

Percentages indicate the percent of total respondents (45).

Table 4.11 shows the number of respondents involved in education courses related to coaching. The majority of respondents reported taking coaching seminars for their continuing education with 41 (91%) of total respondents answering in the affirmative. Only 13 (28%) have taken injury prevention courses. There were 28 (62.2%) of the respondents that have taken a strength and conditioning course, 27 (60%) of the respondents that have taken a coaching education course, and 15 (33.3%) of the respondents have taken an athletic training course.

Table 4.11

Coaches' Education

Coaching Education Course	**Yes**	**No**	**Total**
Frequency	27	18	45
Percent	60.0%	40.0%	100%
Coaching Seminars			
Frequency	41	4	45
Percent	91.1%	8.9%	100%
Strength and Conditioning Course			
Frequency	28	17	45
Percent	62.2%	37.8%	100%
Athletic Training Course			
Frequency	15	30	45
Percent	33.3%	66.7%	100%
Injury Prevention Course			
Frequency	13	32	45
Percent	28.9%	71.1%	100%

Coaches that have been affected by an ACL occurrence within the athletic population they coach may be more likely to investigate ACL injury prevention. Table 4.12 shows the number of coaches affected by an ACL injury in their coaching career. The majority, 29 (64.4%) of respondents have had 1-5 ACL injuries in their athletic population. It is also interesting to note that 15 (33.3%) of the respondents reported zero ACL injuries in the population they coach.

Table 4.12

Number of Coaches Affected by ACL Injuries

Number of ACL Injuries	**0 Injuries**	**1-5 Injuries**	**6-10 Injuries**	**Total Respondents**
Frequency	15	29	1	45
Percent	33.3%	64.4%	2.2%	100%

Coaches must know that ACL injuries occur, and believe they can be prevented before they implement a program to reduce the injury rate. Table 4.13 shows the number of respondents that are aware of ACL injuries, and how many feel that ACL injuries can be reduced. All coaches that responded to the survey are aware of ACL injuries and 97.8% report believing that the occurrence of ACL injuries can be reduced. There was one missing data point and this was from a coach that did not respond negatively or affirmatively to the question.

Table 4.13

Coaches' Awareness and Belief of Reduction of ACL Injury

Awareness of ACL Injuries	**Yes**	**No**	**Total**
Frequency	45	0	45
Percent	100%	0%	100%
Reduction of ACL Injuries			
Frequency	44	0	45
Percent	97.8%	0	100%

Table 4.14 shows how many respondents were aware of ACL injury prevention programs. Sportsmetrics was the most commonly recognized prevention program at 9 (21.9%) of the respondents being aware. The PEP program and RIFA were the next most common with 5 (12.2%) responses each. Henning's and Caraffa were tied for the least awareness with 1 (2.4%) response each.

Table 4.15 shows how many respondents are implementing ACL prevention programs in their strength and conditioning programs. Sportsmetrics was the most commonly implemented program with 5 (12.2%) respondents saying they use Sportsmetrics in their strength and conditioning program. Reduce Injury in Female Athletes (RIFA) was implemented by 2 (4.9%) of respondents. One respondent

implements the program Girls Can Jump. No other program was being implemented by any of the respondents.

Few coaches were aware of specific ACL injury prevention programs. They were more familiar with the techniques used in these programs. Table 4.16 shows that plyometric jump training and agility running were the prevention techniques that the respondents were most aware of with 42 (95.5%) saying they were aware of these techniques. Lower extremity strengthening had a frequency of 36 (81.8%) affirmative responses. Proprioception and balance training was the technique that respondents were least aware of with 18 (40.9%) of the respondents answering in the affirmative.

Table 4.14

ACL Injury Prevention Program Awareness

		Yes	No	Total
Sportsmetrics				
	Frequency	9	32	41
	Percent	21.9%	78.1%	100%
Prevent Injury and Enhance Performance - PEP				
	Frequency	5	36	41
	Percent	12.2%	87.8%	100%
Henning's Program				
	Frequency	1	40	41
	Percent	2.4%	97.6%	100%
Reduce Injury in Female Athletes – RIFA				
	Frequency	5	36	41
	Percent	12.2%	87.8%	100%
Caraffa Program				
	Frequency	1	40	41
	Percent	2.4%	97.6%	100%

Four respondents did not answer the question, so the percentages are based on the 41 respondents.

Table 4.15

ACL Injury Prevention Program Implementation

Sportsmetrics	**Yes**	**No**	**Total**
Frequency	5	36	41
Percent	12.2%	87.8%	100%
Prevent Injury and Enhance Performance – PEP			
Frequency	0	41	41
Percent	0%	100%	100%
Henning's Program			
Frequency	0	41	41
Percent	0%	100%	100%
Reduce Injury in Female Athletes – RIFA			
Frequency	2	39	41
Percent	4.9%	95.1%	100%
Caraffa Program			
Frequency	0	41	41
Percent	0%	100%	100%

Four respondents did not answer the question, so the percentages are based on the 41 respondents

Table 4.16

ACL Injury Prevention Technique Awareness

Plyometric Jump Training	**Yes**	**No**	**Total**
Frequency	42	2	44
Percent	95.5%	4.5%	100%
Lower Extremity Strengthening			
Frequency	36	8	44
Percent	81.8%	18.2%	100%
Agility Running			
Frequency	42	2	44
Percent	95.5%	4.5%	100%
Proprioception and Balance Training			
Frequency	18	26	44
Percent	40.9%	59.1%	100%

One respondent did not answer this question, so percentages are based on the 44 respondents.

Few coaches' implemented ACL injury prevention programs, but a significant amount implements the techniques used in these programs. Table 4.17 shows that agility running was the most common prevention technique being implemented by the

respondents with 42 (95.5%) saying they use it in their strength and conditioning regimen. Plyometric jump training and lower extremity strengthening were the next most common techniques being used with 33 (75.0%) of the respondents saying they use these techniques. Proprioception and balance training was the least implemented technique with 12 (27.2%) of the respondents implementing the technique.

Table 4.18 shows how many times per week the coaches implemented the ACL prevention technique. Of the 42 respondents implementing the agility running technique, the majority, 30 (71.4%) of them are doing this 1-2 times per week. Of the 33 respondents implementing the plyometric jump training technique the majority, 29 (87.9%) are doing this 1-2 times per week. Of the 33 respondents implementing the lower extremity strengthening technique, the majority, 23 (69.7%) are doing this 1-2 times per week. Of the 12 respondents implementing the proprioception or balance training technique, the majority, 9 (75%) are doing this 1-2 times per week.

Table 4.17

ACL Injury Prevention Technique Implementation

Plyometric Jump Training	**Yes**	**No**	**Total**
Frequency	33	11	44
Percent	75.0%	25.0%	100%
Lower Extremity Strengthening			
Frequency	33	11	44
Percent	75.0%	25.0%	100%
Agility Running			
Frequency	42	2	44
Percent	95.5%	4.5%	100%
Proprioception and Balance Training			
Frequency	12	32	44
Percent	27.2%	72.7%	100%

One respondent did not answer this question, so percentages are based on the 44 respondents.

Table 4.18

ACL Injury Prevention Technique Frequency

Plyometric Jump Training	**1-2 times/wk**	**3-4 times/wk**	**Total**
Frequency	29	4	33
Percent	87.9%	12.1%	100%
Lower Extremity Strengthening			
Frequency	23	10	33
Percent	69.7%	30.3%	100%
Agility Running			
Frequency	30	12	42
Percent	71.4%	28.6%	100%
Proprioception and Balance Training			
Frequency	9	3	12
Percent	75.0%	25.0%	100%

The percents are reflective of the total respondents implementing each technique.

Table 4.19 shows during what part of the season the coaches implemented plyometric jump training. Of the 33 respondents implementing the plyometric jump training technique all are implementing this technique during their preseason conditioning. There were also 25 (75.8%) that reported implementing this technique during the season, and 11 (33.3%) implementing it postseason.

Table 4.19 shows during what part of the season coaches are implementing lower extremity strengthing. Of the 33 respondents implementing the lower extremity conditioning technique, the majority, 31 (93.9%) are implementing this technique during their preseason conditioning. There were also 25 (75.8%) that reported implementing this technique during the season, and 15 (45.5%) that implemented this technique postseason.

Table 4.20 shows during what part of the season coaches are implementing agility running. Of the 42 respondents implementing the agility running technique, the majority, 38 (84.4%) are implementing this technique during their preseason conditioning.

Table 4.21 shows during what time coaches implemented proprioception and balance training. Of the 12 respondents implementing the proprioception and balance training technique the majority, 10 (83.3%) are implementing this technique during their preseason conditioning. There were 9 (75%) implementing this technique during season, and 4 (33.3%) implementing it postseason.

Table 4.19

Plyometric Jump Training Implementation Timing

Plyometric Jump Training Preseason	**Yes**	**No**	**Total**
Frequency	33	0	33
Percent	100%	0%	100%
Plyometric Jump Training During Season			
Frequency	25	8	33
Percent	75.8%	24.2%	100%
Plyometric Jump Training Postseason			
Frequency	11	22	33
Percent	33.3%	66.7%	100%

Table 4.20

Lower Extremity Training Implementation Timing

Lower Extremity Strengthening Preseason	**Yes**	**No**	**Total**
Frequency	31	2	33
Percent	93.9%	6.1%	100%
Lower Extremity Strengthening During Season			
Frequency	25	8	33
Percent	75.8%	24.2%	100%
Lower Extremity Strengthening Postseason			
Frequency	15	18	33
Percent	45.5%	54.5%	100%

Table 4.21

Agility Running Implementation Timing

Agility Running Preseason	**Yes**	**No**	**Total**
Frequency	38	4	42
Percent	90.8%	9.2%	100%
Agility Running During Season			
Frequency	35	7	42
Percent	83.3%	16.7%	100%
Agility Running Postseason			
Frequency	11	31	42
Percent	26.2%	73.8%	100%

Table 4.22

Proprioception and Balance Training Implementation Timing

Proprioception and Balance Training Preseason	**Yes**	**No**	**Total**
Frequency	10	2	12
Percent	83.3%	16.7%	100%
Proprioception and Balance Training During Season			
Frequency	9	3	12
Percent	75.0%	25.0%	100%
Proprioception and Balance Training Postseason			
Frequency	4	8	12
Percent	33.3%	66.7%	100%

When the respondents were regrouped according to boys' versus girls' coaching experience there were 23 (51.1%) respondents coaching only girls' sports, 13 (28.9%) respondents coaching only boys' sports, and 9 (20%) respondents coaching both boys' and girls' sports. Table 4.23 shows the data separated between coaches with boys' only, girls' only, coaches with both boys' and girls' experience, and a combination of girls' only experience and both girls' and boys' coaching experience. There were 4 (17.4%) girls' coaches, zero boys' coaches, and 2 (22.2%) of coaches with both boys' and girls' coaching experience that reported implementing an ACL injury prevention program.

All of the individuals that had girls' coaches and 11 (84.6%) of the individuals that had boys' coaches reported implementing one or more ACL injury prevention techniques. There were 8 (34.8%) individuals with both boys' and girls' coaching experience who reported implementing one or more ACL injury prevention technique.

Four (30.8%) of those individuals that had coaching experience for only boys' sports had some type of coaching credential, while 13 (56.5%) of the individuals that coached only girls' sports reported a coaching credential. There was only one (11.1%) coach that had both boys' and girls' coaching experience that reported a coaching credential.

All coaches reported taking a strength and conditioning course more frequently than an athletic training or injury prevention course. Strength and conditioning course was reportedly taken by 7 (53.8%) of coaches with boys' only experience, 15 (65.2%) of coaches with girls' only experience, and 5 (55.6%) of coaches with boys' and girls' coaching experience.

Table 4.23

Differences Among Coaching Experience

	Boys' Only Coaching Experience	Girls' Only Coaching Experience	Boys' and Girls' Coaching Experience	Girls' Only and Girls' and Boys' Coaching Experience
Number of Respondents	13	23	9	32
ACL Injury Prevention Program Implementation				
Frequency	0	4	2	6
Percent	0%	17.40%	22.20%	18.80%
ACL Injury Prevention Technique Implementation				
Frequency	11	23	8	31
Percent	84.60%	100%	88.80%	96.90%
Currently CPR Certified				
Frequency	12	13	3	16
Percent	92.30%	56.50%	33.30%	50%
Previously CPR Certified				
Frequency	1	5	4	9
Percent	7.70%	21.70%	44.40%	28.10%
Coaching Credentials				
Frequency	4	13	6	19
Percent	30.80%	56.50%	66.70%	59.40%
Athletic Training Class				
Frequency	4	8	1	9
Percent	30.80%	34.80%	11.10%	28.10%
Strength and Conditioning Class				
Frequency	7	15	5	20
Percent	53.80%	65.20%	55.60%	62.50%
Injury Prevention Class				
Frequency	1	7	3	10
Percent	7.70%	30.40%	33.30%	31.30%

Chapter 5

DISCUSSION

Anterior cruciate ligament injuries are more common in female athletes who participate in sports where jumping, cutting and pivoting are essential. The researchers have identified possible risk factors, some of which can be changed in order to decrease the risk of ACL injury. In response, some researchers have developed prevention programs, and demonstrated improvements in the biomechanical risk factors that can reduce the incidence of ACL injuries. At the Hunt Valley Conference on ACL injury prevention, all the ACL injury research was taken into consideration and consensus statements were made regarding risk factors, current prevention programs, and future research directions. The conference concluded that "there is a pressing need to improve public and participant awareness of the risk of ACL injury and the possibilities of prevention"[29].

This research study was done to identify Capital Area Activity Conference coaches' awareness and implementation of specific ACL injury prevention programs or techniques. The results support the hypothesis that coaches are not aware of or implementing specific ACL injury prevention programs, but they are unknowingly implementing ACL injury prevention techniques.

It was found that few coaches participating in the Capital Area Activities Conference are aware of ACL injury prevention programs. Coaches were most commonly aware of Sportsmetrics with only 21% reportedly being familiar with the program. The majority of coaches reported being aware of one or more ACL injury

prevention technique. Ninety-five percent of respondents said they were aware of agility running and plyometric jump training. These finding support the hypothesis that coaches were not aware of specific ACL injury prevention programs, but they are aware of the techniques that have been used in these programs.

From the results of this study it was found that few coaches in the Capital Area Activities Conference are implementing ACL injury prevention programs, but the majority of these coaches are implementing one or more of the techniques included in the programs. It is interesting to note that the majority, 42 (95.5%) of coaches reported implementing agility running as part of their strength and conditioning program. This technique is used in the Prevention injury and Enhance Performance (PEP) program, which was recognized by only five coaches and implemented by zero. Plyometric jump training and lower extremity strengthening were the next most commonly implemented techniques and these are the basis of Sportsmetrics and Girls Can Jump. Nine coaches reported being aware of Sportsmetrics and only five were implementing it. There was only one coach that reported being aware of and implementing Girls Can Jump. Proprioception and balance training was the least likely to be implemented by the coaches and is the foundation of the Caraffa program. Only one respondent was aware of the Caraffa program and none reported implementing it. These results support the hypothesis that coaches were unknowingly implementing techniques used in ACL injury prevention.

No relationship could be made between holding a coaching credential and implementing an ACL injury prevention program or technique. There was also no relationship found between occurrence of ACL injury and implementation of and ACL

injury prevention program. This result was surprising because it would be logical to think that coaches that have been affected by an ACL injury would be more likely to seek out information on ACL injury prevention. These results may be distorted because of the small number of respondents.

The most interesting findings from this survey came when the respondents were divided into boys' versus girls' coaching experience. The ACL injury research has focused on the female athlete, thus the focus of ACL injury prevention has also been on the female athlete. It was found that coaches that had experience coaching girls' were more likely to implement ACL injury prevention programs. There were no coaches with boys' only experience that implemented ACL injury prevention programs versus the 17.4% with girls' only experience and 11.1% of coaches with both boys and girls' coaching experience.

There was no notable difference between boys' and girls' coaching experience and ACL injury prevention technique implementation. All coaches with girls' only coaching experience implemented one or more ACL injury prevention technique and all but two coaches with boys' only experience implemented a technique.

Coaches involved in girls' sports implement ACL injury prevention programs and techniques more often than those with only boys' coaching experience. When considering the literature, it makes sense that girls' coaches would be more likely to implement ACL injury prevention programs and/or techniques in the strength and conditioning program. The incidence of ACL injuries is 2-8 times higher in girls' sports compared to boys' sports[29]. It is more likely that a coach involved in only girls' sports will be affected by an ACL injury than a coach involved in only boys' sports, which

could cause them to seek out prevention for such a devastating injury. As was evident in the results of this study coaches involved in girls' sports were more likely to be affected by an ACL injury.

The results of this survey also show that coaches involved in girls' sports were more likely to hold coaching credentials, take an athletic training, strength and conditioning, and injury prevention course. It was evident that coaches involved in female sports tend to seek continuing education courses more often than coaches that work with only boys' sports. . If ACL injury prevention was discussed in any of these courses it is more likely to reach the female athletic population.

One program that was reportedly being implemented by one respondent is Girls Can Jump (GCJ). This program is available on video, and during her off season from the WNBA Detroit Shock, Laura Ramsus performs a GCJ community outreach program. This program is designed for coaches involved in the sports of girls' basketball, volleyball, and soccer. In the outreach program Ms. Ramsus will personally present the Girls Can Jump athletic training and knee care program to the group of community members. The goal of the program is to reach as many female athletes and those involved in female athletics as possible, and help the athletes, parents, and coaches understand ways to prevent ACL injury [30]. This outreach program is an excellent way to do exactly what needs to be done to increase the public and participant awareness of ACL injury and ACL injury prevention.

Another program that has attempted to increase the public and participant awareness of ACL injury and ACL injury prevention is Sportsmetrics. Sportsmetrics was highlighted on the ABC's Wide World of Sports, "Game for Anything-The Strength in

Women's Sports". It was also featured on the U.S. News and World Report's health section, "News You Can Use". There has also been remarkable coverage in the Cincinnati area over the last couple years with the continued research at the Cincinnati Sports Medicine Research and Education Foundation.

Those at Cincinnati Sportsmedicine have recently made available a certification program for Sportsmetrics. There are several ways to go about performing the program with a certified trainer. Those in the local Cincinnati area can train with Cincinnati Sportsmedicine where they perform a Sports Injury Test Report to assess the athlete's needs prior to and at the completion of the program. They will also be supervised during all training sessions with a Certified Sportsmetrics instructor [31].

Athletes can also train in a Sportsmetrics Certified Clinical Site, which are located all over the country, with four locations in northern Michigan. These locations can provide the latest in Sportsmetrics testing, training, and educational consultation for coaches, athletes, and patients in their local community [31]. For those athletes that do not have a site within the locale, Cincinnati Sportsmedicine has developed an instructional video series. This series includes a step-by-step instructional video as well as a follow along video for group or individual training[31].

There has been an obvious attempt to increase the public and participant awareness of ACL injury and ACL injury prevention by both of these programs. From the results of this study, the awareness is low among coaches involved in the Capital Area Activities Conference. Hosting a Girls Can Jump Community Outreach or gaining a Certified Clinical Site in the Lansing area could dramatically change the awareness level of ACL injury and ACL injury prevention for those participating in the Capital Area

Activities Conference. This would in turn decrease the number of ACL injuries sustained by athletes participating in this conference.

The findings of the current project support the recommendation made at the Hunt Valley Consensus Conference. One of their key findings was that "there is a pressing need to improve public and participant awareness of the risk of ACL injury and the possibilities of prevention"[29]. The low number of coaches that were aware of ACL injury prevention programs indicate a strong need to enhance public awareness of the ACL injury prevention programs.

Considerations for Future Research

Michigan does not have requirements for coaches' education. It would be interesting to distribute this survey in a state where coaches' education is a requirement.

Limitations of the Study

The population surveyed included only coaches within a single Mid-Michigan high school athletic conference. The return was better than expected for the type of study done. Regardless the numbers were still too low to make any generalizations outside the population studied.

APPENDIX A

ACL Injury in High School Sports

Participant Informed Consent Form

Dear Coach,

My name is Missy Erwin and I am a Graduate Student at Michigan State University. I am doing my Master's Thesis in the area of ACL injury prevention. I am surveying coaches in the Capital Area Activities Conference regarding my topic and I ask that you please complete the survey that is enclosed.

Participation in the survey is voluntary, and you may chose not to participate, or you may refuse to answer certain questions. Your participation will contribute to the research in the area of ACL injury prevention, and it should take less than 15 minutes to complete and return the survey. A self addressed stamped envelope is included for you to return the survey to me. I ask that you please return it within two weeks of its receipt.

Your privacy will be protected to the maximum extent allowable by law. In return for the surveys completion you will be sent a reference list of current research in the area of ACL injury prevention.

Thank you for your participation; it is greatly appreciated. If you have any questions or concerns about this study, please contact Missy Erwin, Secondary Investigator by phone: (517)-214-4054, by regular mail: 2910 Beau Jardin Dr. Apt #208, Lansing, MI 48910, or by email: erwinmel@msu.edu. You may also contact Dr. John Powell, Principle Investigator by phone: (517)-432-5018, by regular mail: 105 IM Sports Circle, E. Lansing, MI 48824, or by email: powellj4@msu.edu.

If you have any questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Peter Vasilenko, Ph.D, Chair of University Committee on Research Involving Human Subjects (UCHRIS) by phone: (517)-355-2180, fax: (517)-432-4503, email: uchris@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824.

Again, I thank you for your time and participation.

Sincerely,

Missy Erwin, Certified Athletic Trainer
Graduate Assistant Michigan State University

APPENDIX B

ACL Injuries in High School Sports
Missy Erwin, Certified Athletic Trainer
Graduate Student Michigan State University

Please answer all questions to the best of your knowledge. Please use a dark pen and clearly mark each response. You may answer as many responses to each question as is appropriate.

1. **Which sport do you coach? And how many seasons have you coached the sport?**

O	Boys' Basketball	O	≤ 5	O	6-10	O	11-15	O	≥ 16
O	Girls' Basketball	O	≤ 5	O	6-10	O	11-15	O	≥ 16
O	Boys' Soccer	O	≤ 5	O	6-10	O	11-15	O	≥ 16
O	Girls' Soccer	O	≤ 5	O	6-10	O	11-15	O	≥ 16
O	Girls' Volleyball	O	≤ 5	O	6-10	O	11-15	O	≥ 16

2. **What level have you coached?**

5 – 9 years of age	O	Scholastic K - 4th	O	Non-scholastic
10 – 11 years of age	O	Scholastic 5^{th} – 6^{th}	O	Non-scholastic
12 – 13 years of age	O	Scholastic 7^{th} – 8^{th}	O	Non-scholastic
14 – 18 years of age	O	Scholastic 9^{th} – 12^{th}	O	Non-scholastic
Collegiate	O	Intercollegiate	O	Club/Intramural
Adult	O	Yes	O	No

3. **Are you currently certified in American Red Cross or American Heart Association CPR and First Aid?**

O Yes O No

4. **If no, have you ever been certified in American Red Cross or American Heart Association CPR and First Aid?**

O Yes O No

5. **Do you have credentialing or certification from any of the following?**

Program of Athletic Coaches Education (P.A.C.E)	O Level 1	O Level 2	
American Sport Education Program (A.S.E.P)	O Volunteer	O Professional	
National Federation of High School Associations (NFHSA)	O Bronze	O Silver	O Gold
Michigan Youth Soccer Association (M.Y.S.A)	O U6, U8, or U10 Module	O E License	O D License

Other, Please Specify_____

6. **Have you participated in any of the following coaches education classes?**

- O Coaching education courses (University or Collegiate)
- O Coaching seminars
- O Strength and Conditioning courses
- O Athletic Training course
- O Injury Prevention course
- O Other, please specify_____

7. **Are you aware of anterior cruciate ligament (ACL) injuries?**

O Yes O No

8. **Do you believe the risk of ACL injury can be reduced?**

O Yes O No

9. **Are you aware of any of the ACL prevention programs below?**

Sportsmetrics	O Yes	O No
Prevent Injury and Enhance Performance: PEP	O Yes	O No
Henning's Program	O Yes	O No
Reduce Injury in Female Athletes: RIFA	O Yes	O No
Caraffa Program	O Yes	O No

Other, please specify_____

10. **Are you implementing any of the following ACL injury prevention programs in your strength and conditioning programs?**

Sportsmetrics	O Yes	O No
Prevent Injury and Enhance Performance: PEP	O Yes	O No
Henning's Program	O Yes	O No
Reduce Injury in Female Athletes: RIFA	O Yes	O No
Caraffa Program	O Yes	O No

Other, please specify_____

11. Are you aware of the following ACL injury prevention techniques?

Plyometric jump training	O Yes	O No
Lower extremity strengthening	O Yes	O No
Agility running	O Yes	O No
Proprioception/balance training	O Yes	O No

12. Are you implementing any of the following ACL injury prevention techniques in your strength and conditioning programs?

Plyometric jump training	O Yes	O No
Lower extremity strengthening	O Yes	O No
Agility running	O Yes	O No
Proprioception/balance training	O Yes	O No

If you answered yes to any part of question 12 please answer questions 13 and 14. If you answered no to all parts of question 12 please move on to question 15.

13. How frequently do you perform each of the following techniques?

Plyometric jump training	O 1-2 times/week	O 3-4 times/week
Lower extremity strengthening	O 1-2 times/week	O 3-4 times/week
Agility running	O 1-2 times/week	O 3-4 times/week
Proprioception/balance training	O 1-2 times/week	O 3-4 times/week

14. During what time of season do you perform each of the following techniques?

Plyometric jump training	O Preseason	O During season	O Post season
Lower extremity strengthening	O Preseason	O During season	O Post season
Agility running	O Preseason	O During season	O Post season
Proprioception/balance training	O Preseason	O During season	O Post season

15. How many of the athletes you have coached sustained an ACL injury?

O 0	O 11-15
O 1-5	O 15 – 20
O 6-10	O > 20

APPENDIX C

ACL Injury in High School Sports

Participant Informed Consent Form

Dear Coach,

My name is Missy Erwin and I am a Graduate Student at Michigan State University. I am doing my Master's Thesis in the area of ACL injury prevention, and I am surveying coaches in the Capital Area Activities Conference regarding my topic. Recently you should have received a packet from me. I am resending the information because I have not received a copy of your survey. If you are willing to participate I ask that you please fill out this survey and return it to me as soon as possible.

Participation in the survey is voluntary, and you may chose not to participate, or you may refuse to answer certain questions. Your participation will contribute to the research in the area of ACL injury prevention, and it should take less than 15 minutes to complete and return the survey. A self addressed stamped envelope is included for you to return the survey to me. I ask that you please return it within two weeks of its receipt.

Your privacy will be protected to the maximum extent allowable by law. In return for the surveys completion you will be sent a reference list of current research in the area of ACL injury prevention.

Thank you for your participation; it is greatly appreciated. If you have any questions or concerns about this study, please contact Missy Erwin, Secondary Investigator by phone: (517)-214-4054, by regular mail: 2910 Beau Jardin Dr. Apt #208, Lansing, MI 48910, or by email: erwinmel@msu.edu. You may also contact Dr. John Powell, Principle Investigator by phone: (517)-432-5018, by regular mail: 105 IM Sports Circle, E. Lansing, MI 48824, or by email: powellj4@msu.edu.

If you have any questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Peter Vasilenko, Ph.D, Chair of University Committee on Research Involving Human Subjects (UCHRIS) by phone: (517)-355-2180, fax: (517)-432-4503, email: uchris@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824.

Again, I thank you for your time and participation.

Sincerely,

Missy Erwin, Certified Athletic Trainer
Graduate Assistant Michigan State University

APPENDIX D

ACL Injuries in High School Sports
Reference List
Missy Erwin, Certified Athletic Trainer
Graduate Student Michigan State University

Dear Coach,

Thank you for taking the time to participate in my study. In appreciation, I have included a reference list that will guide you to the prevention programs that have been developed to address the ACL injury problem.

Prevention of Noncontact ACL Injuries
Edited by Letha Y. Griffin MD, PhD
This book can be ordered through the following website:
http://www4.aaos.org/product/prt_item.cfm?code=02533

Sportsmetrics
Cincinnati Sportsmedicine Research and Education Foundation
311 Straight Street
Cincinnati, Ohio 45219
Information about this program can also be found at:
http://www.sportsmetrics.net/

Prevent Injury and Enhance Performance: PEP
Santa Monica Orthopaedic and Sports Medicine Group
Holly Silvers, MPT Hollypt99@aol.com
(310) 315-0292 ext. 1283
Information about this program can also be found at:
http://www.aclprevent.com/protected/pepfield.pdf

Henning Program
Dean Griffis
240 South Forest View Court
Wichita, Kansas 67235

Caraffa Program
A. Caraffa Orthopedic Clinic
S. Maria Hospital
University of Perugia
1-05106 Terni, Italy

Again, thank you for your participation. If you have any further questions feel free to contact me through email erwinmel@msu.edu

Sincerely,

Missy Erwin, ATC

APPENDIX E

HUNT VALLEY CONSENSUS CONFERENCE ON ACL INJURY PREVENTION

(Adapted from Griffin [16])

During the Hunt Valley Consensus Conference participants carefully reviewed available data on injury risk factors and their associated prevention programs. They then formulated the following consensus statements.

Environmental Risk Factors

1. At present there is no evidence that knee braces prevent ACL injury.

2. Increasing the shoe-surface coefficient of friction may improve performance but also may increase the risk of injury to the ACL. Because shoe-surface interaction is modifiable, this area merits further investigation.

Anatomic Risk Factors

1. There is much literature on the role of the femoral notch size and ACL injury, but because of the difficulty of obtaining valid and reliable measurements, no consensus on the role of the notch in ACL injury has been reached as yet.

2. At present, there are insufficient data on ACL size (absolute or proportional) to support the concept that ligament size is related to the risk of injury.

3. There are insufficient data to relate lower-extremity anatomic alignment to ACL injury; therefore, further research is needed.

Hormonal Risk Factors

1. At present, there is no consensus in the scientific community that sex-specific hormones play a role in the increased incidence of ACL injury, but further research in this area is encouraged.

2. Hormonal intervention for ACL injury prevention cannot be justified.

3. There is no evidence to recommend modification of activity or restriction from sport for females at any time during menstrual cycle.

Biomechanical Risk Factors

1. The knee is only one part of a kinetic chain; therefore it must be borne in mind that anatomic sites other than the knee, including the trunk, hip, and ankle, may have a role in ACL injury.

2. Common biomechanical factors involved in many injuries include impact on the foot rather than the toes during landing or changing directions, awkward dynamic body movements, and biomechanical perturbation prior to the injury.

3. The common at-risk situation for noncontact ACL injuries appears to be deceleration, which occurs when the athlete cuts, changes direction, or lands from a jump.

4. Neuromuscular factors are important contributors to the increased risk of ACL injuries in females and appear to be the most important reason for the differing ACL injury rates between males and females.

5. Strong quadriceps activation during concentric contraction was considered to be a major factor in injury to the ACL.

Prevention

After reviewing the existing neuromuscular training prevention programs, participants agreed on the following statements regarding prevention strategies:

1. Early data show that specific training programs that enhance body control reduce ACL injury rates in female athletes and may increase athletic performance.

2. Training and conditioning programs for male and female athletes in the same sport may need to be different.

3. Those involved in the care of athletes should identify sport-specific at-risk motions and positions and encourage athletes to avoid these situations when possible.

4. Strategies for activating protective neuromuscular responses when at-risk situations are encountered should be identified

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