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Recognizing Anterior Cruciate Ligament Tears in Female Athletes: What Every Primary Care Practitioner Should Know

Sarah E. Hirst, PA-S
Elin Armeau, PhD, PA-C
Thomas Parish, DHSc, PA-C

Eastern Virginia Medical School
Norfolk, VA
United States

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Abstract
Purpose: Women have a much higher rate of anterior cruciate ligament injury than men. Anterior cruciate ligament injuries are very expensive as well as physically and emotionally debilitating. Understanding why anterior cruciate ligament injuries are more prevalent in women as compared to men is crucial and addressing these issues to possibly prevent their high occurrence is important. **Review of Literature***:* Hormonal differences, structural differences, musculature differences, and mechanical differences between men and women leave women more susceptible to anterior cruciate ligament injury. While there are many factors contributing to the higher rate of anterior cruciate ligament injury in women versus men, newer research has been devoted to addressing the issues that can be corrected and the discrepancies that can be decreased. Investigators are now taking the results from such research and applying them to women to decrease the occurrence of anterior cruciate ligament injury among this group. **Results:** Promising outcomes have occurred in neuromuscular and proprioceptive training programs designed to help women strengthen and train the muscles around their knee thus leading to better stabilization and therefore decreasing the incidence of anterior cruciate ligament injury. **Conclusion:** Future research should be devoted to finding all of the possible factors of the increased incidence of anterior cruciate ligament injury in women and all potential avenues for preventing these injuries should be studied.

Background

Women have a significantly higher rate of ACL tears than do men. Much research has been done and has supported this theory. In a recent study done at the US Naval Academy, researchers found that the women's relative risk for ACL injury was 3.96 compared with men. The relative risk in women soccer players was 9.48 compared to their male counterparts.[1] Given the number of women who participated in high school and collegiate athletics from 1996-1997 and the average knee injury rate, approximately 13,000 knee injuries will occur in females who participate in collegiate athletics and over 25,000 knee injuries can be expected from high school female athletes in any given year. In 1997, the cost of surgical treatment as well as rehabilitation for an athlete who sustained an ACL injury was approximately $17,000. The total cost for ACL injuries, therefore, could climb to $646 million each year for female high school and collegiate athletes.[2] Anterior cruciate ligament injuries are extremely prevalent in women. Injuries to the ACL are very costly and are emotionally and physically taxing on the women who incur them.

Review of Literature

Many factors account for the prevalence of ACL tears in women as opposed to men. Major studies have supported the hypothesis that certain serum hormone levels during

the menstrual cycle can lead to joint laxity and thus an increase in the incidence of injury.[3]

Women are also very different from men structurally. For example, women have a wider pelvis and have more flexible hips leading to more rotation.[4] Furthermore; men are usually much stronger than women. The muscles around the knee are crucial in stabilizing the knee and preventing injury to the ACL. The *vastus medialis oblique* in particular is crucial in patella alignment and joint stability.[5] Women, not being as strong as men; tend to rely more on their ACL for knee joint stability.

Studies have also been done on the physical mechanisms that differ between men and women. Women tend to have a straighter knee during maneuvers such as running and cutting.[3] Further research and literature needs to be devoted to this topic due to the numerous causes and the prevalence of ACL tears in women as opposed to men. This issue should be addressed in terms of prevention in order to keep women from going through the pain and suffering of reconstructive surgery and rehabilitation. A study by Haverbush found that 2,200 ACL injuries that occurred in one year to female collegiate athletes cost approximately $44 million for surgery and rehabilitation.[3] Decreasing the number of injuries will benefit the patient emotionally, physically, and financially. Perhaps women can be taught the correct way to maneuver and keep the knee stable. A weight training program can be developed specifically to strengthen the muscles around the knee improving joint stability. Also, the changes in hormones warrants further research since they could be contributing factors. Many avenues and ideas must be researched. As health professionals, we should focus on the problem and concentrate more research on this topic. The many variables that contribute to the prevalence of ACL tears in women, as compared to men, is an important topic in medicine and attempting to decrease the incidence based on the findings of the research is of clinical significance.

Hormonal Differences

Wojtys suggests that the menstrual cycle might play a part in the occurrence of ACL tears in women.[6] The author hypothesized that the hormones in women may play a role in the increased susceptibility to ACL injuries in women. This cycle is based on the coordination between the endocrine and the hypothalamus, the pituitary gland, and the ovaries. These centers communicate with hormones through the circulatory system. Among the hormones that affect tissues and systems far away from the ovarian follicles are estrogen, progesterone, and relaxin. The effects of progesterone are not well understood, but it is known to act as an anesthetic for the central nervous system. Relaxin has been found to significantly decrease collagen tension. The hormone with the most influences estrogen. Estrogen appears to affect the strength of soft tissue, the function of muscle, and the central nervous system. Each of the hormones, as well as the interactions between all of them, may contribute to the increased susceptibility of women to ACL and other serious knee injuries. This study featured forty women who attended the University of Michigan MedSport Center and the Cincinnati "Sportsmedicine and Orthopaedic Center" and who met two main criterions: an acute (<3 months) ACL tear from a non-contact injury and a regular menstrual cycle. Twenty-eight of the forty women met these entire criterion and their activity levels ranged from recreational to competitive sport participation.[6] The average age of the women involved was 23 +/- 11 years. Basketball (29%), skiing (21%), and soccer (14%) were the most common activities at the time of ACL injury. A higher percentage of the ACL injuries were due to landing after a jump than due to a pivoting motion.[6]

The most important discovery through this study was a significant association between the likelihood of an ACL injury and the stage of the menstrual cycle. Women had an increased incidence of ACL injury during the ovulatory phase of their monthly menstrual cycle. During the ovulatory phase, there is a dramatic increase in estrogen production. These findings suggest that many of the non-contact ACL injuries sustained by female athletes may be due to hormonal influences.[6] The findings of this study are crucial because they point to a major difference between men and women and highlight a possible cause for a higher occurrence of female ACL tears as opposed to male. Men do not experience the hormonal cycle and surges that women do. As a consequence, men do not have periodic increases in estrogen, progesterone, and relaxin that affect soft tissue strength, diminish collagen tension, and anesthetize the central nervous system. This study did have limitations.[6] While the questionnaire was tested for test-retest reliability and a specialist in adolescent medicine reviewed the questions, this study relied solely on the ability of the participants to accurately recall the stage of their menstrual cycle when they were injured.[6] This could lead to a recall bias and incorrect information. Neither urine nor blood samples were obtained from the participants to validate their recall of the stage of the menstrual cycle they were in.

This limitation was corrected in the next study performed by Wojtys.[7] The same questionnaire was used, but the researchers measured the levels of estrogen, progesterone, and luteinizing hormone metabolites in the urine within 24 hours of injury. Levels were then measured at the start of the next menstrual cycle.[7] In this study, a Pearson chi-square test was utilized to test the hypothesis that the number of ACL tears that were observed, compared to what the expected number was, is independent of the menstrual cycle. To compute the expected rate, researchers divided the number of days of that phase (follicular: days 1 to 9, ovulation: days10-14,

and luteal: days 15 to end of cycle) by the total number of days in the cycle, while the observed rate was calculated by dividing the actual number of injuries that happened in each phase by the total number of injuries. With these calculations, researchers found that more ACL injuries occurred during the ovulatory phase than expected and less than expected during the luteal phase.[7] This study further confirmed what was already suspected after the first study. Estrogen does in some way increase the chances of a woman injuring thier ACL. This study took out the possibility of recall error by analyzing the urine and blood samples of the women that incurred the injuries.

Liu, Al-Shaikh, Panossian, Finerman, and Lane, studied the effects of hormones on ACL fine structure.[8] Their study showed that increases in estrogen decreased total collagen in rat tendon and fascia. Collagen is produced by fibroblasts and is the major load-bearer of the ACL. There was a decreased fibroblast proliferation and collagen synthesis when estradiol is at physiologic (dealing with the processes, activities, and phenomena of life) levels of 0.025 to 0.25 ng/ml. The decreased fibroblast proliferation and collagen synthesis also occurs at nonphysiologic levels of 2.5 to 25 ng/ml. Estradiol is a hormone that is found in the human menstrual cycle. The overall effect exhibited by this study was that the fluctuation in hormones in females changes ACL fibroblast metabolism leading to an altered ACL structure and ligamentous composition. Specifically, increasing levels of estradiol decreases fibroblast proliferation and the rate of collagen synthesis.[8] This study is not completely definitive as it uses rats as the subjects. Further research needs to be done to explain the function of estrogen on ACL fibroblast metabolism in humans.

Structural Differences

In addition to hormonal influences, there are also structural differences in the knees of men and women. The value of the Q angle is smaller in men than in women. The Q angle is measured by making a line connecting the anterior superior iliac spine and the midpoint of the patella. Another line is drawn from the tibial tubercle to the midpoint of the patella. The actual Q angle is the angle between these two lines. Women experience an increase in pelvic width during puberty. They also have a shorter femoral length than men. Both of these reasons lead to a higher value for female Q angle than men. The larger the Q angle, the greater the lateral pull on the patella by the quadriceps femoris, causing more medial stress on the knee.[2]

Differences in femoral notch morphology also contributes to the increased risk of ACL tears in women. Upon flexion, the ACL comes in contact with the medial margin of the lateral femoral condyle and upon extension the ACL impinges on the anterior intercondylar notch.[2] A smaller, narrower, posterior notch might predispose a person to ACL injury.

Shelbourne, Davis, and Klootwyk, found that the intercondylar notch width was narrower in women than in men.[9] The ACL is located within the intercondylar notch. The study population for this research consisted of 714 patients who underwent ACL construction. These patients' intercondylar notch widths were measured by taking a weightbearing posteroanterior radiograph. To prevent any differences or discrepancies, the same radiology technician took all of the measurements using the same radiographic technique and the same equipment for each patient. This study found that the patients who suffered ACL injuries had narrower intercondylar notch widths than the control subjects. These same researchers also proposed a different explanation for the increase in female ACL injuries due to smaller anthropometric measurements. They believed that the narrower notch was indicative of a smaller ACL within the intercondylar notch. The smaller the ACL, the weaker it is, therefore making it easier to damage.

In a study by LaPrade and Burnett, it was found that a statistically significant relationship exists between femoral notch stenosis and ACL injuries.[10] Anderson, Lipscomb, and Liudahl, supported the results found by the LaPrade and Burnett study. They found that in patients with ACL injuries, there was a significant amount of notch stenosis, particularly to the anterior outlet.[11]

The shape of the notch may be different depending on gender and could be a possible contributor to injuries to the ACL. A decreased notch to width ratio and an A-shaped notch may contribute to non-contact ACL injuries in females.[12] Another group of researchers took measurements of the notch width, total condylar width, notch width at two-thirds the notch height, and lateral condylar width. They found that lateral condylar width, notch width, total condylar width, notch width at two-thirds of the notch height, axial width, and ACL area were all much larger in men than in women.[13]

Muscular and Mechanical Differences

Men and women also differ in several muscle characteristics that may also influence risk of ACL injury. Muscle strength and coordination and the ability to recruit muscles are all important to knee stability. Women do not have as much muscle as men in the quadriceps and hamstring area, even after muscle strength has been normalized for body weight. Because knee stability depends on the strength of the surrounding muscles (primarily hamstrings and quadriceps), women are more prone to ACL injuries. In females, contraction of the quadriceps is the first response to anterior tibial translation (quadriceps dominant). Anterior tibial translation occurs when the tibia moves anteriorly while the femur remains in place. Anterior tibial translation is a leading cause of ACL injuries. Male subjects, however, contracted their

hamstrings first in reaction to anterior tibial translation (hamstring dominant). Enough strength in the muscles that surround and protect the knee (hamstrings and quadriceps in particular) is crucial to knee stability. Also, the shorter the reaction time to recruit and use these muscles to stabilize the knee is important in reducing the risk of ACL injury. Women are not only weaker than their male counterparts, they are also quadriceps dominant. The hamstring muscles are important in stopping anterior tibial translation, thus protecting the knee. Being "quadriceps dominant" means that women use their quadriceps muscles to stop anterior tibial translation first, which is not as effective at stopping this motion as using the hamstring muscles first. This places a considerable amount of strain on the ACL when compared to men who are hamstring dominant.[2] In fact, the quadriceps muscle is so powerful that it has the ability to create forces that are great enough to tear the ACL.[13]

The ability to recruit the hamstring muscles when the knee is under stress and during anterior tibial translation is vital to protecting the ACL. Women have been shown to be slower at generating this protective contraction of the hamstring muscles, allowing for less stability in the knee and an increased rate of ACL injuries.[13] Researchers believe that these deficits in females are due to fewer fast twitch motor units and the fact that females might not be able to quickly recruit available motor units.[14]

The mechanism that women use during cutting and pivoting maneuvers also contributes to higher risk of injury. Women tend to perform cutting maneuvers in a very erect manner, using more quadriceps than hamstring muscles than their male counterparts.[13] When cutting and making sharp turns, women stand with their back straighter and their legs less bent than men. This position causes women to use more quadriceps than hamstring muscles and leaves women more susceptible to ACL injury. Musculature clearly plays an important role in the higher occurrence of ACL injuries among women. The fact that women are quadriceps dominant, weak in the hamstring muscles, and in general weaker in the main muscles surrounding the knee, leads to the instability of the knee. This instability makes women more susceptible to ACL injury. More research should be done to determine if there are possible preventive measures that women can take to strengthen these knee stabilizing muscles and thus decrease the chance of ACL injury.

Prevention Overview

Many reasons are apparent for the increased incidence of ACL tears in women versus men. Not every factor responsible for ACL injuries in women can be completely changed or prevented. However, the musculature discrepancies and the way that certain high-risk maneuvers such as pivoting and landing after a jump can be changed. Training can and should be focused on decreasing the risk factors that are implicated in ACL injuries in women.

Hormonal Prevention

The female hormones of estrogen, relaxin, and progesterone have all been implicated to affect the ACL. Moller-Nielsen and Hammar studied 86 women soccer players over a 12 month period. [2] They found that women taking oral contraceptives had a significantly lower rate of ACL injury than the women who were not on oral contraceptives. Putting women on oral contraceptives might decrease a woman's risk of ACL injury, but this is not a truly feasible way of preventing these injuries. Preventing injury by putting a young female athlete on hormones to control estrogen, progesterone, and relaxin is not advisable due to adverse side effects and associated risks. There are outside factors and other risks that come with oral contraceptives and the decision to use them is individualized and personal.

Anthropometric Measurement Prevention

Everyone is born with the body structure that they will have forever. When reconstructing the ACL, many surgeons may perform notchplasty to increase the width of the femoral notch. This helps to prevent another ACL injury in the future. This procedure, while very good at preventing re-injury of a newly constructed ACL, is not considered for prophylaxis.[2] Increasing the femoral notch width is invasive, costly, and should be used only for an already damaged ACL where surgery for reconstruction is already indicated. Suggesting that anthropometric measurements such as Q angle, femoral notch morphology, posterior notch morphology, and shape and size of the intercondylar notch can be changed to decrease ACL injury in women is not feasible.

Neuromuscular and Proprioceptive Training Programs

A recent study suggested that a neuromuscular and proprioceptive training program helps prevent ACL injuries among women. The Prevent Injury and Enhance Performance (PEP) cohort study involved 1,041 female soccer players between 14 and 18 years of age.[15] The control group in this study consisted of 1,905 female soccer players. The active participants viewed a videotape that consisted of 3 warm-up activities, 5 special techniques for stretching for the lower extremities and trunk, 3 soccer-specific agility drills, 5 plyometric activities, and 3 strengthening exercises. The emphasis of this program was on proper technique in activities such as "soft landing" with deep hip and knee flexion. Each of the participants followed the exercises throughout the season. The PEP was a nonrandomized 2 year prospective study. An athletic exposure was defined as any practice or game in which the athlete was participating and consequently had the potential of ACL injury.

Another similar study was conducted by a different group of researchers. This research focused on the effect of neuromuscular training on the knee injury incidence in female athletes. Forty-three sports teams from 12 high schools in the area where the study took place participated in this research. They observed two groups of female athletes, one group that was trained before participation and a control group that did not have any intervention. They also looked at a group of untrained male athletes as a comparison. Unlike the PEP program, this research looked at different sports. The sports that were looked at were high school soccer, volleyball, and basketball. These sports were specifically selected because they all require a high level of pivoting, cutting, and jumping which are all high-risk behaviors for ACL injury. Each of the girls that were enrolled in the program followed a 6-week preseason neuromuscular training program. This program specifically incorporated flexibility, plyo-metrics, and a weight training regimen to increase muscle strength and to also decrease landing forces.[16]

Results from the previous studies were encouraging. In the first year of the PEP program (2000), the trained group had a total of 37,476 exposures and the control group had 68,580 exposures. The control group incurred a total of 32 ACL tears which is an incidence rate of 0.47 injuries/athlete/1000 exposures. The trained group, however, had only 2 ACL tears making an incidence rate of 0.05 ACL injuries/athlete/1000 exposures. These results showed a total decrease of 88 percent in the trained group. These results, when analyzed using the player as a unit of analysis, showed that the injury incidence for the trained group was 1.9/1000 players. The injury incidence for the control group was 16.8/1000 players. These statistics led to a rate ratio of 0.11, which is statistically significant at P= 0.0001. When using the teams as a unit of analysis, the injury incidences were 0.04/100 teams for the intervention group and 0.37/100 teams for the control group leaving a rate ratio of 0.11. This rate ratio was also statistically significant at a P= 0.0003.[15]

The second year of the PEP study (2001) had similar results. The trained group had a total of 30,384 athlete exposures while the control group had 68,868 exposures. Only four ACL tears were found in the trained group while the untrained group had a total of 35 ACL tears. These numbers led to an incidence rate of 0.13 injuries/athlete/1000 exposures in the intervention group as compared to an incidence rate of 0.51 injuries/athlete/1000 exposures in the control group. When the players were used as a unit of analysis, the injury incidence rate in the intervention group was 4.74/1000 players while the rate was 18.3/1000 players in the control group. This information led to a resultant rate ratio of 0.26 that is statistically significant at P=0.005. When using the team as the unit of analysis, the intervention group had an injury incidence rate of 0.08. The control group, in comparison, had an injury incident rate of 0.31. As a result, the rate ratio was 0.28, which is considered significant at a P level of 0.02.[15]

A study by Hewett., Lindenfeld, and Riccobene had different but encouraging numbers.[16] Throughout the sports seasons, the untrained female group had 23,138 athlete exposures. The trained female group had a total of 17,222 exposures and the male control group had 21,390 athlete exposures. The researchers used one-way chi-square tests and set the level of significance at $P \leq 0.05$. The overall incidence of all knee injuries in the trained group was 0.12, 0.43 in the untrained female group, and 0.09 in the male control group. These statistics led to the untrained female group having an injury rate that was 4.8 times higher than the male group and 3.6 times higher than the trained female group. The trained female group only had a 1.3 times higher rate of knee injury than the male control group. When comparing the two female groups using the chi-square analysis, a significant effect of training was found (P= 0.05). When comparing the untrained female group to the untrained male group, the untrained women were found to have a higher rate of ACL injury than the men (P= 0.03).[16]

Results

Women have an increased rate of ACL injury when compared to their male counterparts. In a study conducted by the National Collegiate Athletic Association (NCAA) during a five year period, the ACL injury rate for female soccer players was more than double that of male.[17] This trend is due to a number of factors. First of all, hormonal differences between men and women make women more susceptible to ACL injuries than men. Hormonal surges of estrogen, progesterone, and relaxin may weaken ligaments and increase the risk of ACL injuries. In addition to hormonal differences, notch width and anthropometric differences are also reasons for increased risk of ACL injury in women. Women have a smaller intercondylar notch width, lateral condylar width, notch width, axial width, and ACL area.[13] Also, musculature differences between men and women lead to an increase in ACL injury among women. Women are not as strong as men and are not able to recruit their hamstring muscles as quickly as men further contributing to knee instability. Finally, women tend to perform high-risk maneuvers incorrectly. This increases the chance of ACL injury. All of these characteristics: hormonal surges, notch and anthropometric measurements, less strength, and mechanical differences all add up to the increased rate of ACL injury among women. With this knowledge, research has been done to possibly prevent these injuries in women.

Encouraging results have been found through proprioceptive and neuromuscular training regimens.

Strengthening the muscles around the knee, learning how to quickly recruit those muscles for stability, and teaching women the correct body mechanisms for certain high risk maneuvers have all proven to be effective ways to decrease the likelihood of ACL injury in women.

Discussion

The PEP study strongly supports the idea that neuromuscular and proprioceptive training will decrease the likelihood of ACL injury in women. However, this study did have a limitation. The PEP cohort study only looked at female soccer players. No other sports or activities were looked at or researched.

While the study by Hewett, Lindenfeld, Riccobene, and Noyes supported the theory that a neuromuscular training program is beneficial to decreasing the risk of ACL injury in women, there were limitations to this study as well.[16] Each sport was not represented with equal numbers of participants, both control and trained. Also, the coaches chose if they wanted their team to participate in the prevention program, so the assignment of trained and untrained subjects was not randomized or blinded. This is important because it has been proven that a randomized, blinded study is more reliable. Overall, the study had promising results and similar research should be done to improve upon the previous study.

Major differences in the rates of ACL injury in women as compared to men exist. ACL injuries are expensive as well as emotionally and physically debilitating injuries. Some of the causes of these injuries in women cannot be changed or improved upon. The areas of research that can be focused on and improved are the muscular, proprioceptive, and mechanism of injury differences. Most ACL tears are noncontact injuries. This means that the athlete is actually doing something to themselves that leads to this injury. Women tend to have stronger quadriceps than hamstrings, leading to a pulling force on the knee. This discrepancy in power in the leg often leads to an injury to the ACL. Coactivation of the hamstrings with the quadriceps helps with joint stability, regulates the joint's "mechanical impedence", and equalizes the pressure distribution at the articular surfaces.[2] By strengthening the hamstrings and making the ratio of quadriceps to hamstring strength closer to one, the incidence of ACL injury may be reduced in women.

Not only do the quadriceps and hamstrings strength have to be improved, but all of the muscles around the knee must also be strengthened. Women tend to rely on the ligaments in the knee for knee stabilization. At times, the forces on the knee are too great for the ligaments alone to control. This discrepancy leads to more ligament damage and ACL injury. By combining strengthening exercises of all of the muscles in the knee as well as teaching a female to rely on those muscles for knee stabilization instead of the ligaments would greatly improve the ACL injury rate among women.

Women also tend to perform cutting and pivoting maneuvers in an erect manner. This body positioning leaves the ACL very susceptible to injury. Teaching females participating in activities that encourage cutting and pivoting to do these maneuvers with the correct body mechanics and positioning would decrease the incidence of ACL injury among these women. Jumping is a high-risk maneuver as well. By strengthening all of the muscles surrounding the knee and teaching the proper body mechanics, the likelihood of a woman incurring an ACL injury would be decreased. Promoting hip and knee flexion instead of straight legged landing and having the athlete perform the jumping and landing sequence correctly over and over until it is second nature would prove to be beneficial to the female athlete.

With regards to the PEP program, the training that those researchers used was to improve the "feed-forward" mechanism in female athletes. They tried to enhance the participant's ability to anticipate external forces and in turn be prepared to stabilize the knee. This would lead to the knee being better protected from the various loads and forces that may cause injury to the joint. They focused on proprioception and neuromuscular control to achieve their goal.

Proprioception, as they defined, is being able to take the stimuli from the environment by peripheral receptors and convert this neural signal to an efferent motor signal in the sensorimotor system. Neuromuscular control is considered to be the ability of taking the signal and responding correctly with regards to keeping the joint stable.[15] The results of the study were positive. Neuromuscular and proprioceptive training programs appear to decrease the chances of a woman injuring her ACL.

The study that included high school soccer, volleyball, and basketball players added to the evidence that the PEP program confirmed. A neuromuscular and proprioceptive designed program will decrease the likelihood of a female athlete incurring an ACL injury. The study focused on the research that the imbalance between hamstring and quadriceps muscle strength is a leading cause of ACL injury. Through the training program the researchers made that imbalance less of a factor thus protecting and making the knee more stable.[16] Training the correct muscles and the correct mechanisms of movement helps to decrease ACL injuries among the female population.

Conclusions

Many differences exist between men and women that leave women more susceptible to ACL injury. Hormonal,

structural, muscular, and mechanical differences all contribute to the increased incidence of ACL injury in women over men. While ACL injury is indeed multifactorial, the rate of injury in women can be reduced by focusing on the factors that can be improved. Research has been done in the effectiveness of neuromuscular and proprioceptive training programs for women and results from both types of training programs and studies have shown promising results in decreasing the rate of ACL injury among women.

Further research needs to be devoted to finding additional causes for the increased incidence of ACL injury in women versus men. As health professionals, it is important to fully analyze and thoroughly comprehend all of the reasons for this discrepancy. Current research may not be entirely conclusive and there may be other factors that have been overlooked. Future studies should be aimed at trying to treat and prevent the factors already known to cause ACL injury in women along with any newly identified factors. Decreasing and preventing these injuries is important as they not only cause a financial burden, but also a huge physical and emotional burden on the women that incur them. Research focused on decreasing the incidence of ACL injury among women is promising, and by increasing efforts in this focus, the rate of injury can hopefully be lessened.

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