ACL Injuries in High School-Aged Female Athletes:

Mechanisms, Screening and Prevention

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Introduction

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  - Apex High alumni 2004
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  - Final year eDPT student: UNC-CH

Go Cougars!

Learner Objectives

- The audience will review and understand knee anatomy and ligament function
- The audience will understand mechanisms of ACL injury and risk factors specific to the female anterior cruciate ligament
- The audience will understand the benefits of preventing injury and impacts an ACL injury has on its victim

Objectives Continued…

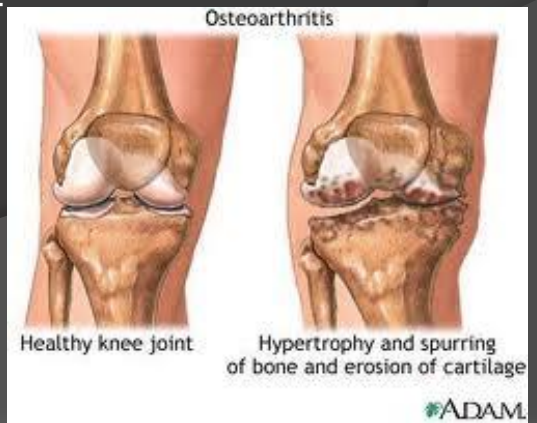
- The audience will understand how to generally screen for increased risk of ACL injury
- The audience will be presented with current research surrounding ACL injury prevention
- The audience will understand and be offered an ACL injury prevention intervention program
- Prove what you know! ☺

The Numbers

- Females are between **two and eight times more likely** to suffer an anterior cruciate ligament (ACL) injury compared to males[1]
- Female athletes in the US are estimated to suffer 38,000 ACL tears yearly[2]
- The cost of surgery and rehabilitation following injury is estimated to be between $17,000 – $25,000 US dollars per injury[3]

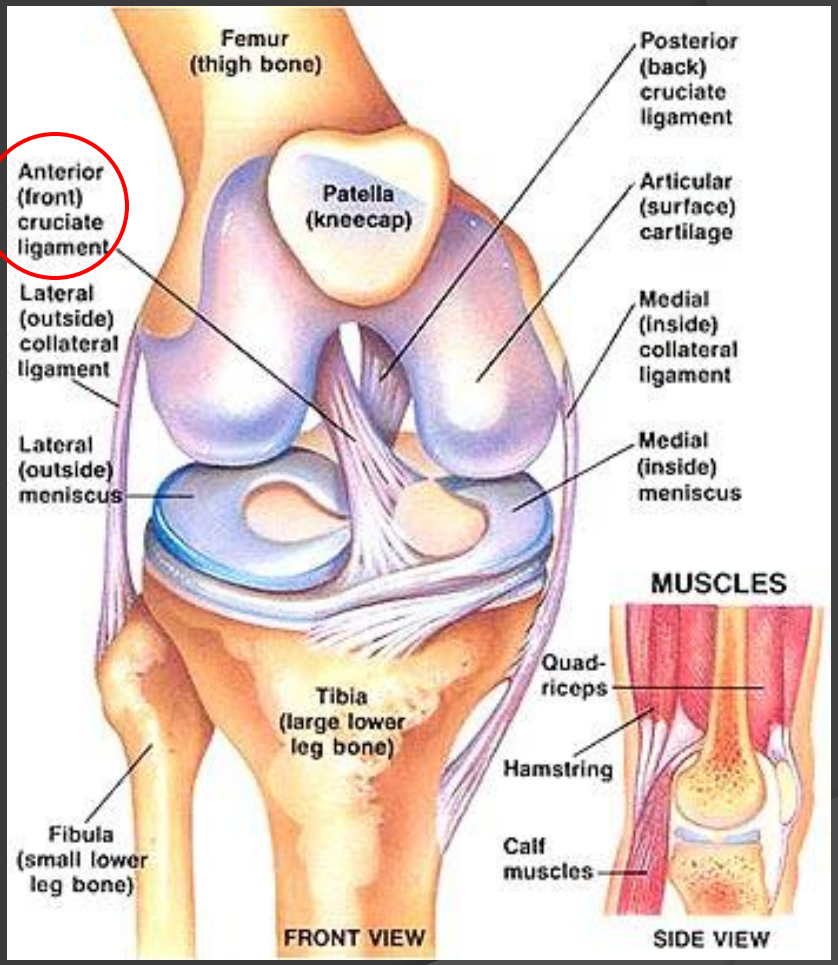
ACL injury consequences

- Increased risk of meniscal damage[5]
- Increased risk of osteoarthritis[7]
- Loss of participation in sport and redirection of future activities[5,6]
- Emotional and psychological costs
  - Decreased sport participation correlated with decreased academic achievement[4]
  - Negative effect on mood[4]



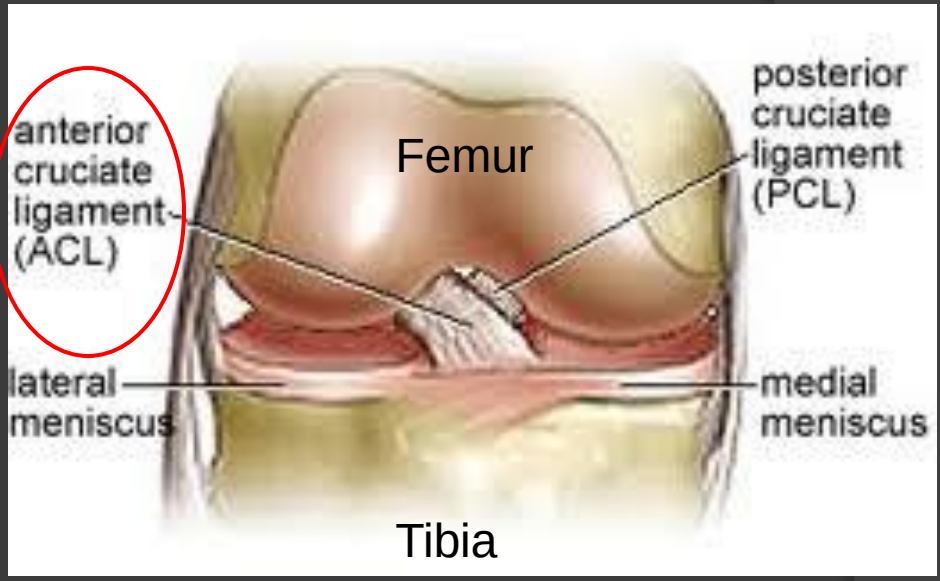
Knee Joint Anatomy

- Ligaments: Maintain joint stability
- MCL-Medial collateral ligament
- LCL- Lateral collateral ligament
- PCL- posterior cruciate ligament
- Meniscus
- **ACL**-Anterior cruciate ligament



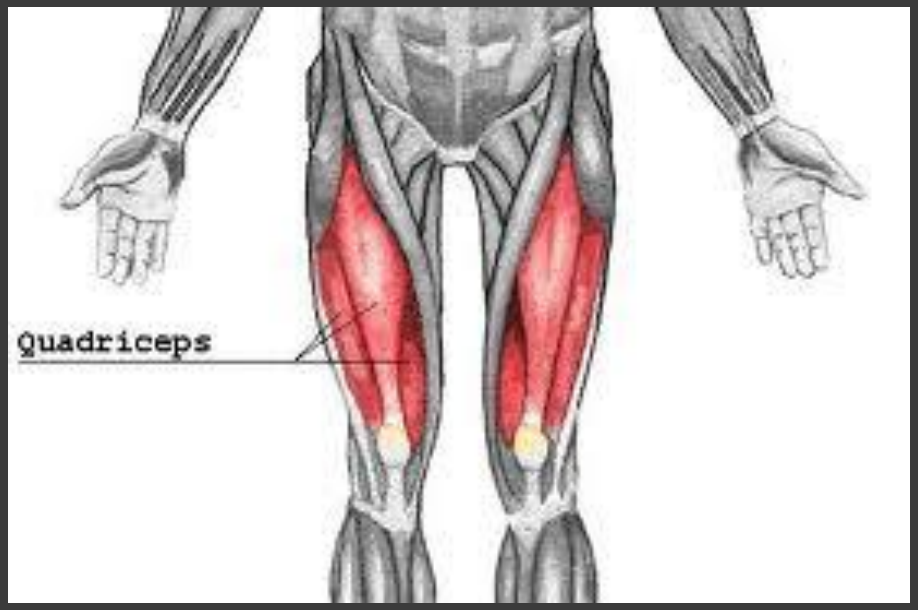
The ACL: What does it do?

- **Primary job**: Prevents forward sliding of the tibia (shin bone) on the femur(thigh bone)[8]
- Helps to prevent knee hyperextension and side to side sliding of the tibia and femur[8]
- Also helps to prevent internal rotation (twisting to the inside) of the tibia on the femur[8]



★ Very important to maintain knee joint stability in activities/sports that involve **cutting, changing speed and direction, jumping and decelerating**[9]

Surrounding Knee muscles



Quadriceps: Big front thigh muscles

Primary Job: Straighten the knee

Hamstrings: muscles on back of leg

Primary job: Bend the knee

How does the ACL get injured?

Contact injury

70% of ACL injuries are non-contact injuries[2]

Non-contact injury

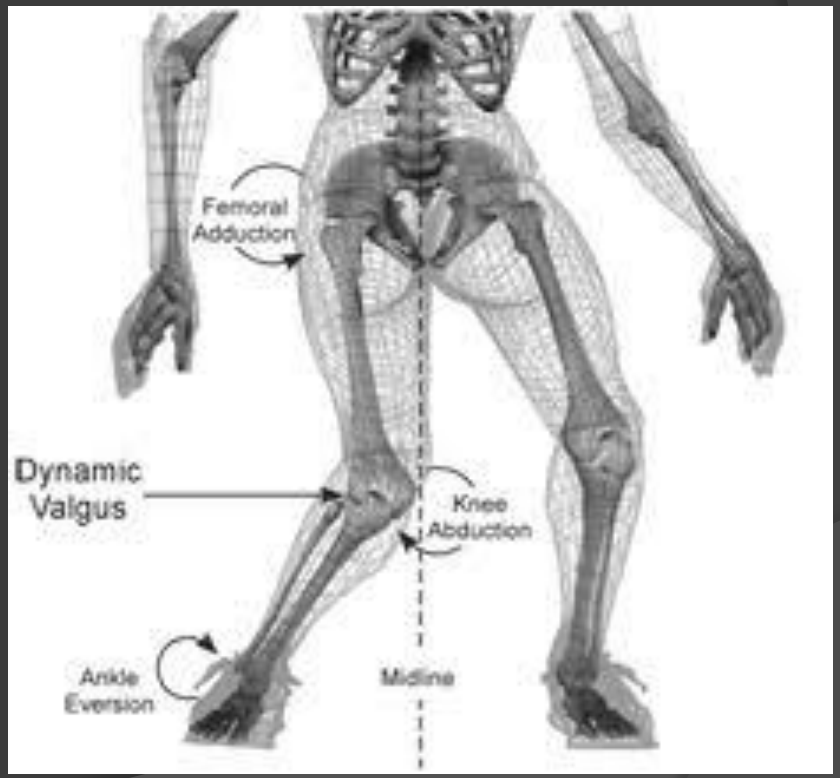
Non-Contact ACL injury

- Volleyball player tears her ACL, MCL and meniscus

Viewer discretion is advised…

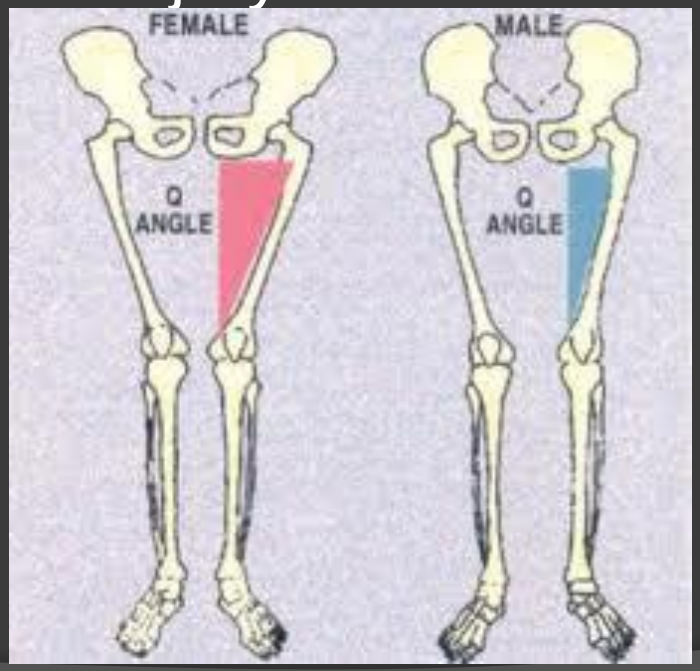
ACL injury results from a number of factors which can be:

- Modifiable
- Non-Modifiable



Non-Modifiable Risk Factors for Females

- Anatomical
  - Increased Q angle[1,10] : Increases valgus moment at the knee which leads to ACL injury[10,11,12]



Q Angle

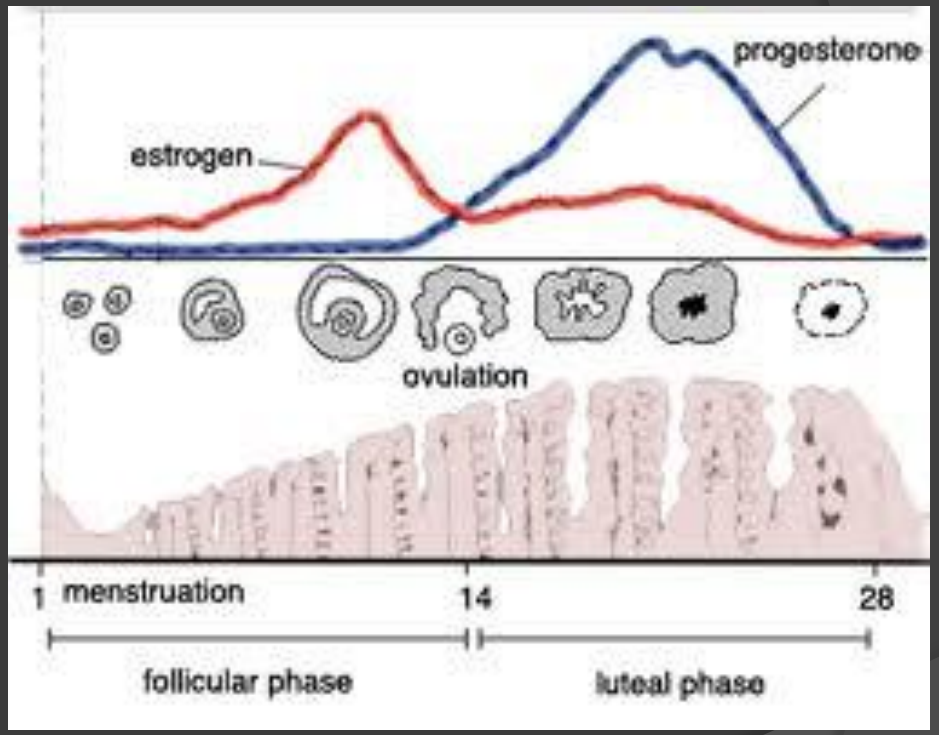
Knee Valgus

Non-modifiable Anatomical risk factors continued..

- **ACL Size**: Female ACLs are smaller than males even when normalized for weight and height[13]
- **Joint laxity:** Females have greater knee joint laxity versus males regardless of athletic participation[14]
- **Femoral notch width and shape:** differences between males and females in some studies that may predispose females for ACL tears[1,11]
- **Foot pronation (flat feet):** rotates the tibia inward and pulls it forward stressing the ACL and increasing the risk of injury[16]
  - Mixed evidence regarding females specifically having greater ankle pronation vs. males[15,16]

Non-modifiable: Hormonal risk factor

- Female menstrual cycle hormone changes ➡ increases ligament laxity during certain times
- The exact phase where females are at higher risk is still controversial
- Some report higher ACL risk during the Luteal phase (days 18-28)[18,19]
- Some report higher risk during follicular phase particularly days 1-2 of menses[17]

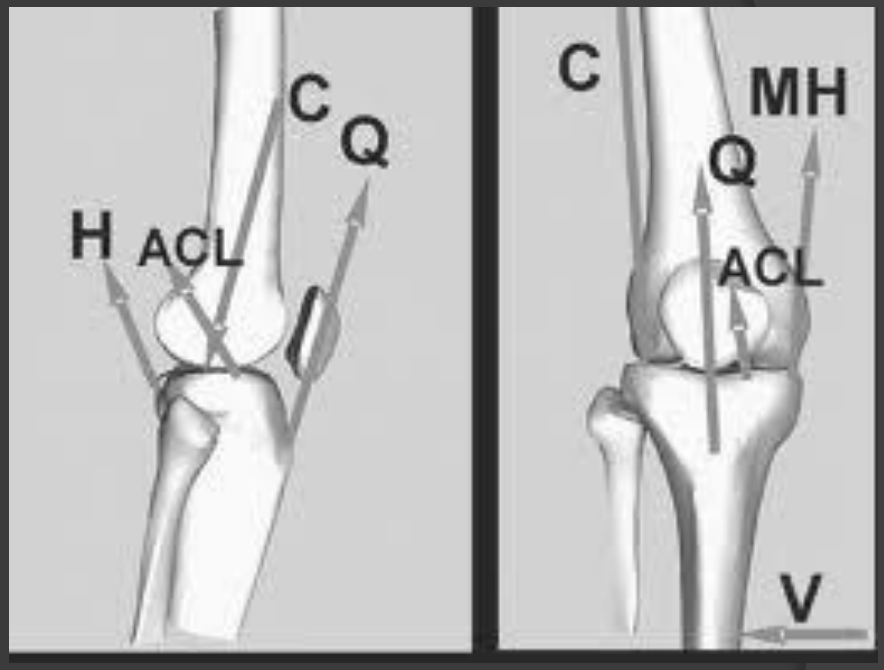


Modifiable Risk Factors!

"I alone cannot change the world, but I can cast a stone across the waters to create many ripples."
— Mother Teresa

Modifiable risk factors: Neuromuscular differences

- **Female athletes specifically** have a different muscle recruiting order[20]
  - Quads reach peak torque before the hamstrings which increases forward sliding of the tibia and stress on the ACL
- Females with ACL injury have weaker hamstrings paired with stronger quadriceps:[21]
  - Hamstring/Quad ratio
- Generally weaker hamstrings and quadriceps muscles vs. un-athletic males[20]
  - Ligaments take more of the landing "blow"
  - Hamstring has less ability to help the ACL



Modifiable risk factors: Biomechanics

- Females land from jumps/perform cutting maneuvers in a more erect:(knees and hips straight) posture
  - Increases force of the quadriceps pulling the tibia forward and limits the hamstrings ability to help the ACL pull the tibia back

Modifiable risk factors: Biomechanics

- Females land from jumps and perform cutting maneuvers in **more knee valgus** (knees buckled inward) vs. males which puts great **strain on the ACL** and again puts the muscles at a mechanical disadvantage

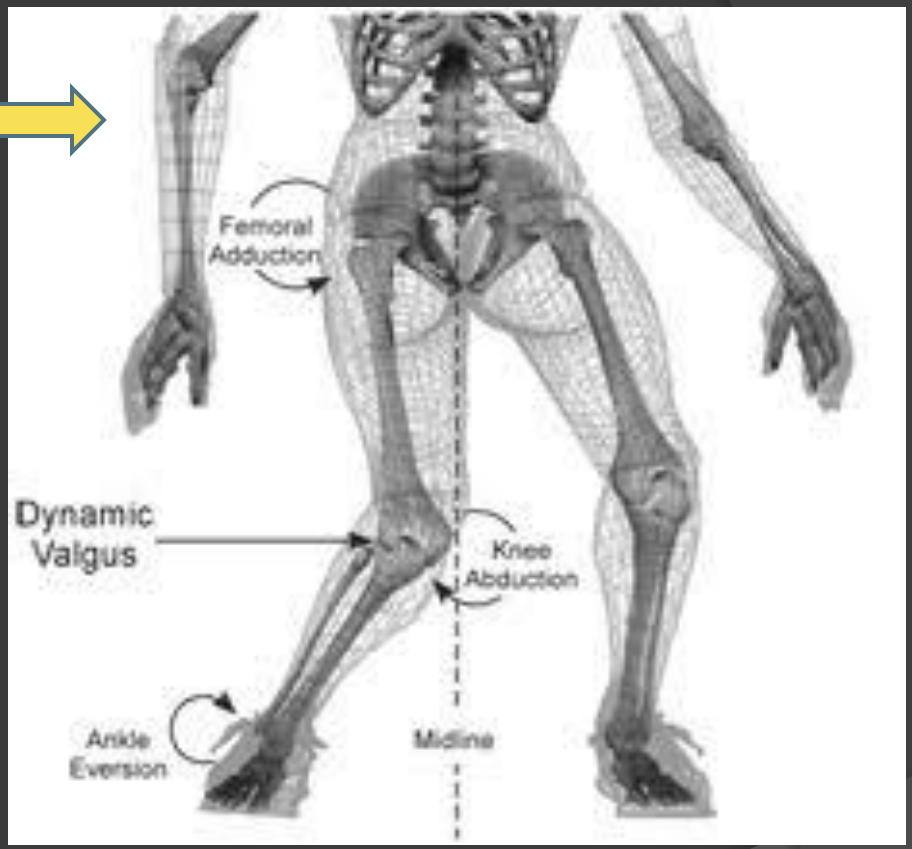
How to screen for increased ACL risk: The LESS Score

- The Landing Error Scoring System (LESS) has been used to identify potentially high-risk movement patterns that occur during a jump-landing task[24]
- Athletes are asked to jump off a 30cm box to a distance of 50% their height away from the box, land, then immediately perform a maximal vertical jump[24]
- Scores each of the factors below on a 1-3 scale with higher scores indicating more risk for injury[24]
  - Knee flexion at initial ground contact & throughout landing
  - Knee Valgus at initial ground contact & throughout landing
  - Forward and sideways trunk flexion at initial ground contact
  - Ankle plantar flexion (toes down) at initial ground contact
  - Foot position at initial contact
  - Stance width at initial contact
  - Foot symmetry
  - Softness of landing and overall impression

More practical observational screening for high school coaches. Observation during activity:

ACL injury WARNING!

Landing in knee valgus



The Position of no return:

Hip /thigh rotated inward, knee buckled inward (valgus), tibia rotated inward, foot rotated out and ankle rolled outward (ankle eversion)

Male vs. Female landing

So, what can we do?

- There have been many intervention programs designed to modify the neuromuscular and biomechanical mechanisms of ACL injury
  - Hewett et al. designed a progressive 6 week- three phase "jump program" which focused on stretching, plyometrics and strength[25]
    - Compared injury rates for the season between an intervention female group vs. untrained female group vs. untrained male control group
    - Results showed significant **decrease in landing force and knee valgus angles** when landing from a jump, in addition to an increase in hamstring strength.
    - An expansion of this study with the same intervention yielded 14 serious knee injuries in the "control" group versus 2 injuries in the intervention group[23]
      - Injury rate was significantly less in the intervention group vs. the untrained female group.[23]
      - At season end, the female trained group had only 1.3 times more ACL injury than the male group vs. 4.8 times higher injury rate in the untrained females versus the male group! This almost evens out the playing field!!

But....

- This program is to be performed 3x/week for 2 hrs per session…NOT really feasible for high school competition time restraints.

- A more feasible PEP (Prevent injury, Enhance Performance) program was created!

ACL injury prevention program: The PEP Program

- The PEP (Prevent injury, Enhance Performance) was developed by the Santa Monica Orthopedic and Sports Medicine Group in order to decrease the number of ACL injuries incurred by female soccer players. It is a highly specific 15-20 minute training session that can easily replace a traditional warm-up.[26,27]

- The program's main focus is teaching strategies to avoid injury and includes specific exercises targeting neuromuscular and biomechanical risk factors associated with female ACL injury[26,27]

- The program includes basic components of stretching, strengthening, plyometrics, agilities, and avoidance of high-risk positions to address deficits in neuromuscular coordination, biomechanics and strength.[26]

- Your copy of the PEP program is included in your handout packet!

PEP program specific goals[26,27]

- Avoid vulnerable positions for the ACL
- Increase lower extremity flexibility
- Increase strength
- Increase proprioception through agilities and plyometrics

PEP Program Research

- Gilchrist et al. examined the effectiveness of the PEP program on 61 Div. I women's soccer teams. After only 12 weeks, there were 7 ACL injuries in the intervention teams versus 18 with the control teams (41% decrease)[26].
  - In the last 6 weeks of the program there were 0 ACL injuries in the intervention group vs. 8 in the control group!

PEP Program Research

- Mandelbaum et al. studied 14 to 18 year old female club soccer players using the same PEP program for 2 years and had very promising results supporting the use of the PEP program for aid in preventing ACL injuries in female athletes[27].
  - Year 1: 1012 girls on 52 intervention teams demonstrated only 2 ACL injuries, whereas the 1905 girls on 95 control teams reported 32 ACL injuries (88% decrease)
  - Year 2: 4 ACL tears in the intervention group vs. 35 total ACL tears in the control group (74% decrease)

Pros of the PEP program

- Little equipment needed (only a cone/ something to jump over)
- Quick and Easy 15-20 minutes/ 3x week
- Effective
- Recommend use of partners after some team education to check for technique
- Let's take a look at the PEP program handouts

Conclusions:

- Females athletes are much more likely to injure their ACLs
- ACL injury has immediate and LONG TERM physical and emotional effects
- There are female specific risk factors that are either modifiable or non-modifiable
- Look for “The position of no return”
- There is something you can do!!

Questions??

Let’s find out!!

POP QUIZ ☺

Thank you so much for your time and attention!

Any additional questions?
Feel free to contact me!
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