

Sports Medicine Unique to the Female Athlete



Health Care That Works Conference 2016
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Objectives

- Identify conditions which are more common/prevalent in female athletes
- Recognize anatomical and sport differences that lead to higher injury rate
- Describe and understand differences in treatment and recovery

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Disclosures

None

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Case 1

- 18 yo female ice hockey player presents to your clinic with headache after sustaining a concussion. She has a brother who also plays ice hockey and was diagnosed with a concussion last year. She would like to know how the course of her concussion will compare to his.

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Concussion Frequency in Females

- Higher overall concussion injury rate (1.4x NCAA)
- Higher rate of concussion within a given sport
 - Soccer (2.1x), Baseball/Softball (3.2x), Basketball (1.7x)
 - College women's ice hockey = highest rate of all sports

Higher rate of concussion recurrence

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Heston B. "Do Female Athletes Concuss Differently From Males?" NCAA. n.p., n.d. Web. 24 September 2016.

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Identifying Risk Factors for Concussion

- Migraines are 4x more likely in females of childbearing years (linked to hormonal spike)
 - Females who suffer from migraines are more susceptible to concussion and have more severe concussions
- Eumenorrheic females not on oral contraceptives tend to have more and worse concussive symptoms than females who take OCPs

Heston B. "Do Female Athletes Concuss Differently From Males?" NCAA. n.p., n.d. Web. 24 September 2016.

Green DR, Cholewicki J, Miller AJ, Reed LC, Reinsel J. Differences in Symptom Reporting, Duration, Status and Patterns of Recurrence and Post-Concussion Concussion. In Sports Concussion: A Scientific Review and Management. 2013. Nov. 01, 2013. 24.

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Identifying Risk Factors for Concussion

- Screening for risk factors, such as migraine or lack of oral contraceptive use, may have some benefit
- May be able to identify and treat these females earlier

Concussion Symptoms in Females

- Higher number of symptoms
- More severe symptoms
- Higher total symptom score at baseline and post-concussion

Females More Likely to Report...

- Any symptom
 - Report more than males in general
- More symptoms at baseline
 - Females can have headache, emotional symptoms, difficulty concentrating, etc. as a result of fluctuations in hormone levels due to menstrual

Post-Concussive Females Noted to Have More...

- Drowsiness/Fatigue
- Sensitivity to Noise/Light
- Nausea
- Difficulty Concentrating
- Lightheadedness

Post-Concussive Females Noted to Have...

- Increased neurocognitive impairments in reaction time and visual memory
- Poorer balance (BESS)

Some Debate

- Some studies show no difference in concussion symptoms or post-concussion neurocognition between males and females
- Further studies needed that compare male and female athletes in the same sport

Recovery

- Greater amount of time lost:
 - From participation in sport
 - Before total symptom score returns to baseline
 - Before asymptomatic state is achieved

Recovery

- Some studies suggest a similar rate of recovery in males and females (even though females have a longer recovery overall):
 - Females are starting with higher # of symptoms and more severe symptoms
 - Takes a longer time to become asymptomatic

Why do these differences exist between males and females?

Why the difference? 🤔

- Reporting
 - Females report more than males, meaning:
 - More concussion #s
 - More concussion symptoms
 - More concussion severity
- But more organic etiologies exist

Why the difference? 🤔

- Females tend to have lower BMI, smaller neck girth, and less neck strength than males
 - Weaker isometric cervical flexion/extension (50% less)
 - Less protection of the head from acceleration/deceleration and rotational forces
 - Up to 44% greater head acceleration than

contact.

Heston B. "Do Female Athletes Concuss Differently from Males?" NCAA. n.d. Web. 24 September 2015.

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Why the difference? 🤔

- Hormones
 - In premenarchal and postmenopausal females, there are NO significant differences in mild TBI symptoms compared to males
 - Suggests that the onset of puberty and the menstrual cycle play a role in concussion incidence and severity

Green DM, Cholewicki J, Mihalik AJ, Head LT, Reinsel JC. "Differences in Symptom Reporting Between Males and Females in Prepubertal and Postmenopausal Concussions." J Sports Sci. 2015; 33(10): 1027-34.

Hormones

- Not proven that a female will have increased symptoms or poorer outcome associated with menses
- However, some studies do suggest that women could have poorer outcomes when concussed during Luteal Phase

Luteal Phase

- Last 2 weeks of cycle just prior to menstruation
- Abrupt change in hormone levels
- Theory that women concussed during this phase will do worse than those concussed during the Follicular Phase (first 2 weeks of cycle)

Menstrual Cycle Symptoms or Concussion Symptoms?

- Menstrual symptoms and concussion symptoms can overlap
 - Emotional symptoms, difficulty concentrating, headache, fatigue
- Females report more “concussion” symptoms than males when they are evaluated during baseline concussion testing. Menses may play a

Menstrual Cycle Symptoms or Concussion Symptoms?

- After being concussed, a menstruating female may report symptoms that are due to her menses, and not necessarily due to her concussion
- Achieving an asymptomatic state in a menstruating female may be unreasonable prior to return to play

Menstrual Cycle Symptoms or Concussion Symptoms?

- In the future, practitioners may need to:
 - Report if female is menstruating at time of evaluation or
 - Perform baseline concussion testing in females both during *Premenstrual* and *Follicular Phases* (2 separate baselines)
- Post-concussion, this may help to differentiate symptoms related to concussion versus related to menstruation. May allow for quicker return to play.

PINK CONCUSSIONS

FEMALE CONCUSSIONS VIA SPORTS, ABUSE,
ACCIDENTS OR MILITARY SERVICE

PINK CONCUSSIONS is the FIRST EVER non-profit organization with a highly personal and urgent mission to improve the pre-injury education and post-injury medical care for women and girls challenged by concussions and traumatic brain injuries (TBI) incurred from sport, violence, accidents or military service. **We are #pinkTBI.**

THE CHALLENGE is, despite the facts of #pinkTBI, the sport, academic, military, and medical communities do not have any female-specific medical guidelines, return to school/play/work/duty protocols or education resources.

www.pinkconcussions.com

Case 2

- 15 yo female soccer player presents to your clinic concerned because two of her teammates recently tore their ACLs. She is wondering if she is at risk for an ACL tear and if there is anything she can do to prevent it.

Risk of ACL Tear in Females

- 4-6x more likely to sustain an ACL injury
- 2.3-9.7x higher risk of ACL rupture
- Implications for decrease in physical activity, loss of athletic scholarship, and post-traumatic knee osteoarthritis within 10-20 years of injury

Why are females more at risk?

Anatomy



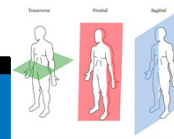
- Smaller femoral intercondylar notch width
 - Can lead to stenosis and impingement of the ACL
- 40-50% smaller ACL cross sectional area

Hormones

- Not proven that a female has increased risk for ACL injury due to hormonal influence or phase of the menstrual cycle
- However, some studies demonstrate increased incidence of ACL injury during Follicular Phase and also during ovulation

Biomechanics and Neuromuscular Control

- Most ACL injuries occur in non-contact situations during deceleration in cutting or landing
- Loading the frontal or transverse plane of the knee (versus sagittal) occurs in at risk females



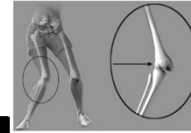
Biomechanics and Neuromuscular Control

- Females at risk for ACL injury exhibit less knee flexion when landing and during cutting tasks



Biomechanics and Neuromuscular Control

- Ligament Dominance theory: At risk females move with disproportionate knee valgus, hip adduction, hip internal rotation.



Biomechanics and Neuromuscular Control

- Trunk Dominance Theory: At risk females move with disproportionate lateral trunk displacement or poor trunk control.

Biomechanics and Neuromuscular Control

- Quadriceps Dominance Theory: At risk females have disproportionate quadriceps force relative to hamstrings.

Biomechanics and Neuromuscular Control

- Leg Dominance Theory: At risk females have asymmetries between lower extremities.

Biomechanics and Neuromuscular Control

- Combinations of the biomechanical predispositions have been found in female athletes at risk for ACL injury
 - Disproportionate quad strength with leg asymmetry
 - Lack of trunk control with leg asymmetry

Prevention of ACL Injury in Female Athletes

- Neuromuscular training programs
 - Prevention of ACL injury through correction of the neuromuscular and biomechanical imbalances that predispose an athlete to ACL injury
 - 24-82% reduction of ACL injury
 - 50% reduction in ACL injury risk

Neuromuscular Training Programs

- Many programs exist which may include warm-up, plyometrics, strengthening of lower extremities/core, and sport specific drills

Neuromuscular Training Programs

- Plyometric Training (Jump Training)
 - Instructed on positioning/control



Neuromuscular Training Programs

- Core Position and Control Movement Strategy (Core-PAC)
 - 6 weeks of 20 min warm-up 4x/week
 - Focus on moving center of mass (pelvis) in the intended direction of the base of support (planted foot) during side cutting and side hops
 - Increased knee flexion angles demonstrated after 6 weeks

FIFA 11+ f-marc.com/11plus/11plus/

The "FIFA 11+" is a complete warm-up programme to reduce injuries among male and female football players aged 14 years and older. The programme was developed by an international group of experts, and its effectiveness has been proven in a scientific study. Teams that performed the "FIFA 11+" at least twice a week had 30-50% fewer injured players. The programme should be performed, as a standard warm-up, at the start of each training session at least twice a week, and it takes around 20 minutes to complete. Prior to matches, only the running exercises (parts 1 and 3) should be performed. For all exercises, correct performance is of great importance. Therefore, the coach should supervise the programme and correct the players if necessary.



Case 3

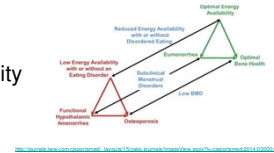
- 17 yo runner presents to your clinic with a new tibial stress fracture. This is her third stress fracture in the past few years and she wants to know what you can "fix" so that this won't keep happening.

Female Athlete Triad

- Presentation of multiple stress fractures should raise concern for the existence of pathology related to the Female Athlete Triad
- Stress fractures are more common in female athletes with low bone mineral density and menstrual dysfunction

Female Athlete Triad

- Spectrum of 3 interrelated conditions:
 - Low Energy Availability (inadvertently or through disordered eating)
 - Menstrual Dysfunction
 - Low Bone Mineral Density



Low Energy Availability

- Energy Availability (EA) is the amount of energy available for daily physiological functions (growth, thermoregulation, etc) that remains after exercise
- $EA = \frac{[\text{Energy Intake (kcal)} - \text{exercise energy expenditure (kcal)}]}{\text{Lean Body Mass}}$
- <30 kcal/kg/lean body mass is associated with low energy availability
- Measurements usually imperfect. Sports Dietician or Exercise Physiologist may be more accurate.

Body Weight in lbs	110	lbs
Body Weight in kg	49.89522007920375	kg
Body Fat Percentage	15	%
Exercise Energy Expenditure	1000	kcal
Exercise Duration	60.00	min
Daily Caloric Intake	2000	kcal
Energy Availability	25.57882322641754	kcal/kgFFM/day

Low Energy Availability

- Deficit may be unintentional (increasing exercise without increasing kcal) or due to disordered eating (Anorexia, Bulimia, etc)

Low Energy Availability

- Low EA can:
 - Decrease muscle strength
 - Limit anaerobic activity
 - Limit endurance
 - Increase risk for musculoskeletal injury
 - Cause amenorrhea
 - Lead to low bone mineral density

Menstrual Dysfunction

- Low energy availability -> pulsatile release of GnRH from hypothalamus fails to occur-> decreased LH from the anterior pituitary -> low levels of estrogen-> failure of endometrium to develop
- Amenorrhea as a component of the Female Athlete Triad is a diagnosis of exclusion (must rule out other causes such as pregnancy, thyroid disease, etc. first)

Low Bone Mineral Density

- Duration of amenorrhea correlates with the amount of decrease in bone mineral density
 - Low estrogen leads to low bone formation and increased resorption
 - Greater fragility and less repair
 - Increased risk of stress fractures, fractures, and irreplaceable bone loss both now and throughout a lifetime

Low Bone Mineral Density

- No longer use the terms "osteoporosis" or "osteopenia" in premenopausal females unless secondary cause present (ie malnutrition)
 - Z-score < -2 "BMD below expected range for age"
 - Z-score > -2 "BMD within the expected range for age"

Low Bone Mineral Density

- *Exception is in weight bearing athletes*
 - Low BMD is **Z-score < -1**
- Weight bearing athletes *should* have a higher BMD than the general population due to repetitive mechanical loading
- Z-score < -1 in these athletes may be enough to predispose to fracture

How can we treat pathology related to the Female Athlete Triad?

Early Detection is Critical

- *The Triad Coalition Consensus Panel recommends asking females these screening questions during high school and college preparticipation physicals*
 - Have you ever had a menstrual period?
 - How old were you when you had your first menstrual period?
 - When was your most recent menstrual period?
 - How many periods have you had in the last 12 months?
 - Are you presently taking any female hormones (estrogen, progesterone, birth control pills)?
 - Do you worry about your weight?
 - Are you trying to or has anyone recommended that you gain or lose weight?
 - Are you on a special diet or do you avoid certain types of foods or food groups?
 - Have you ever had an eating disorder?
 - Have you ever had a stress fracture?
 - Have you ever been told you have low bone density (osteopenia or osteoporosis)?

Screening

- Screening should occur annually
- Positive screen should prompt more thorough evaluation by a healthcare team (physician, sports dietician, athletic trainer, mental health professional, etc.) for formal diagnosis

Treatment

- Management should always focus on correcting low energy availability
- Goal is to achieve normal body weight in order to facilitate restoration of menses and proper bone mineral density
 - Increase caloric intake, decrease energy expenditure, or both
- Treatment plans should be tailored to the patient



Additional Treatment

- Recommend calcium intake of 1000-1300 mg/day & Vitamin D intake of 600 IU/day
 - Vitamin D levels should range between 32-50 ng/mL
- Cognitive Behavior Therapy shown to be effective for females with disordered eating
- Unclear if resistance training will improve BMD in females with amenorrhea



Treatment

- Pharmacological management not recommended until failure of treatment x1 year with new fractures present
 - Oral contraceptives
 - Do NOT restore spontaneous menses
 - May inhibit IGF-1 (needed for bone growth)
 - Bisphosphonates
 - Use caution as it is a known teratogen
 - Long term associated with atypical femur fracture and osteonecrosis



Clearance and Return to Play

The Triad Coalition Consensus Panel Risk Stratification

Risk Factors	Magnitude of Risk		
	Low Risk - 0 points each	Medium Risk - 2 point each	High Risk - 3 point each
Age of onset of initial AEDP	<input type="checkbox"/> No history of AEDP	<input type="checkbox"/> Low stress recurrent amenorrhea < 6 mo	<input type="checkbox"/> High stress recurrent amenorrhea > 6 mo
Low BMD	<input type="checkbox"/> T-Score > -1.0	<input type="checkbox"/> T-Score -1.0 to -1.5	<input type="checkbox"/> T-Score < -1.5
Physical Menstrual	<input type="checkbox"/> Menstrual 1-2 days	<input type="checkbox"/> Menstrual 3-5 days	<input type="checkbox"/> Menstrual > 5 days
Algebraic and/or Menstrual	<input type="checkbox"/> < 1 fracture in 12 months	<input type="checkbox"/> 1-2 fractures in 12 months	<input type="checkbox"/> > 2 fractures in 12 months
Low BMI	<input type="checkbox"/> > 18.5	<input type="checkbox"/> 18.0 - 18.5	<input type="checkbox"/> < 18.0
Stress Fracture/Protein	<input type="checkbox"/> None	<input type="checkbox"/> 1	<input type="checkbox"/> > 1
Concomitant Medical Conditions	<input type="checkbox"/> None	<input type="checkbox"/> 1	<input type="checkbox"/> > 1
Concomitant Medication	<input type="checkbox"/> None	<input type="checkbox"/> 1	<input type="checkbox"/> > 1

	Essential Risk Score	Low Risk	Medium Risk	High Risk
Full Clearance	0 - 1 point	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Provisional/Limited Clearance	2 - 3 points	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Restricted from Training and Competition	3 - 4 points	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Provisional Clearance: Full clearance, but athlete will be compliant with recommendations
 Limited Clearance: Cleared, but with limitations to training/competition



www.femaleathletetriad.org



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