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Get in the Game!

Injury prevention and treatment of the female athlete

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About Me...

- Northwestern Health Sciences University
 - Fall 2015 Graduate
 - NWHSU Human Performance Center
 - Second year Fellow
- Sporting Experience
 - Team Clinician for Minnesota Vixen
 - Chief Medical Officer for the Two Largest Judo Tournaments
 - Provider at National Rugby 7s' Tournament
 - Medical Tent Captain at World Championship of Rowing



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Northwestern Health Sciences University | Northwestern Health Human Performance Center | Outline

- 4 Types of Female Athletes
- Sex Differences between Males and Females
- Female Athlete Access to Sports
- Effects of Menarche on Sport Performance
- Relative energy deficiency in Sport and the affect on the Female Athlete
- 3 Most Common Types of injuries
- Injury Prevention
- Nutrition Recommendation

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- What are the difference between male and female athletes?
- What is Relative Energy Deficiency in Sport?
- What are the three most common injuries for female athletes?
- What are the best pre-participation exercises to reduce injuries in sport for Females?
- What are the effects of hormones on sport participation?
- Are there specific Nutritional needs for the female athlete?

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Lifespan Stage	Sex Issue	Gender Issue
Pre-Puberty (Girlhood)	Increased risk of Osgood-Schlatter - Onset early then boys due to growth pattern	Restricted access to playing fields due to Municipal policies
Adolescence	Increased risk of hormone related injuries	Body Image issues that may lead to barriers in sport participation
Adult Woman	Increase risk of stress fracture, patellofemoral problems, and ACL rupture	Increased risk of MSK injuries from domestic abuse & violence
Post-Menopausal	Increased incidence of OA of the knees	Access due to lack of role models and access to personal exercise opportunities

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Sex Differences in Sport

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Sex Differences

Female	Male
<ul style="list-style-type: none"> Peak Heights Velocity <ul style="list-style-type: none"> 10.5 – 13.0 y/o Max Height <ul style="list-style-type: none"> 17 – 19 y/o Skeletal Maturity <ul style="list-style-type: none"> 18-19 y/o Metabolic activity of muscles <ul style="list-style-type: none"> 35%-38% Shorter, weigh less and have shorter limbs and smaller articular surfaces <ul style="list-style-type: none"> 20% - 27% body fat 	<ul style="list-style-type: none"> Peak Heights Velocity <ul style="list-style-type: none"> 12.5 – 15.0 y/o Max Height <ul style="list-style-type: none"> 20 – 22 y/o Skeletal Maturity <ul style="list-style-type: none"> 21 – 22 y/o Metabolic activity of muscles <ul style="list-style-type: none"> 40% - 45% Taller, weight more, and have longer limbs and larger articular surface <ul style="list-style-type: none"> 12% - 18% body fat

O'Connor, F. G., Cassi, D. J., Davis, B. A., St. Pierre, P., Saha, R. E., & Wilkoff, R. P. (2013). ACSM's Sports Medicine: A Comprehensive Review. American College of Sports Medicine.

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History of Female Athletics

800 BC: Princess Nausicaa playing ball with her handmaidens

1900: Modern Olympics had 22 Female Athletes compete

1922: Special Women's Olympics

1940: Sex Verification Testing to prevent cheating begins

1972: Title IX

Casey, E., Rho, M., & Pissis, J. (2016). Sex differences in sports medicine. New York, NY: Demos Medical Publishing, LLC.

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Educational Amendment act of 1972

"No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance."

- Applies to Schools as a whole
- Approves access for all athletes

Overview Of Title IX Of The Education Amendments Of 1972, 20 U.S.C. A § 1681 Et. Seq. (2015, August 07). Retrieved March 12, 2018, from <http://www.pdhs.gov/evidence/files/education-amendments-1972-20-jan-1681-et-seq> ©2015 Northwestern Health Sciences University

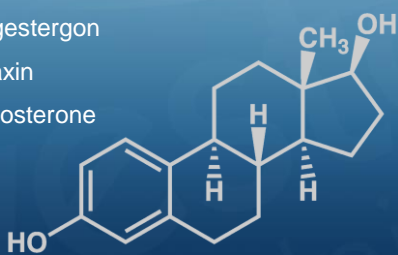
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Hormones of the Female Athlete

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- Estrogen
- Progesteron
- Relaxin
- Testosterone



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Estrogen

- Ligaments
 - Suppression of the Fibroblasts
 - Increase laxity and decreased load to failure
- Tendon
 - Increases collagen synthesis
 - Reduces stiffness
- Bone
 - Linear growth of bones
 - Growth plate closure
 - Decreases osteoclast activity
- Acicular Cartilage
 - Suppression of matrix metalloproteinases in articular chondrocytes
- Muscle
 - No relation to Muscle fibers
- Nervous Systems
 - Excitatory effect

Casey, E., Rho, M., & Press, J. (2016). Sex differences in sports medicine. New York, NY: Demos Medical Publishing, LLC. ©2015 Northwestern Health Sciences University

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Progesterone

- Ligaments
 - Negates the effect of estrogen on fibroblasts
- Tendon
 - Increases degradation of collagen
- Bone
 - Bone resorption increases with Follicular phase
- Acicular Cartilage
 - Negates the effects of estrogen on the matrix metalloproteinases in articular chondrocytes
- Muscle
 - Postmenopausal woman may have enhanced muscle growth
- Nervous Systems
 - Inhibitory effect of neurons

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Relaxin

- Ligaments
 - Increases joint and ligament laxity
 - Promotes collagen degradation
- Tendon
 - Decreases patellar tendon stiffness
- Bone
 - Unclear effects
- Acicular Cartilage
 - Cartilage degradation in combination with estrogen
- Muscle
 - With a supraphysiologic dose can heal muscles
- Nervous Systems
 - Affects spatial memory, stress response, energy balance, and reproductive signaling

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- Ligaments
 - Increases and enhances fibroblasts
- Tendon
 - Increases collagen maturation
- Bone
 - Increase calcium resorption and retention in the boen
- Acicular Cartilage
 - Males only effected
- Muscle
 - Increases muscle mass and protein synthesis
- Nervous Systems
 - Increases excitability of the motor system

Casey E., Rho, M., & Press, J. (2016). Sex differences in sports medicine. New York, NY: Demos Medical Publishing, LLC. ©2015 Northwestern Health Sciences University

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Follicular Phase
- 0 – 14 day
- Estrogen

Luteal Phase
- 14 – 28 days
- Progesterone

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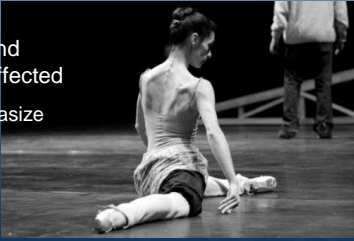
- Eumenorrhea
 - Normal Menstruation
- Oligomenorrhea
 - Abnormal Menstruation with cycles lasting longer then 35 days
 - Average of 3 – 6 cycles per year
- Amenorrhea
 - Absence of menstruation
 - Fewer then 3 cycles per year

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Oligomenorrhea & Amenorrhea

- Effects 10% - 20% of the athletic population
- 50% of runners and dancers can be effected
 - Sports that emphasize leanness



Brukner, Khan et al. (2012). Clinical Sports Medicine (4th ed.). New York: McGraw-Hill Medical. ©2015 Northwestern Health Sciences University

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Causes of Abnormal Hormones

- Primary Ovarian Insufficiency
- Eating Disorders
 - Anorexia Nervosa
 - Bulimia
- Excessive Exercise
- Thyroid Dysfunction
- Luteal Phase Defects
- Adolescence
- Polycystic Ovary Syndrome
- Uterine Fibroids
- Endometriosis
- Hormone Birth Control
- Medications
- Reduced Energy Deficiency in Sport

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Luteal Phase Defects


- Common among women in sports
- Abnormal Luteal phase is less then 10 days
- Lower levels of Progesterone
- Hard to recognize because the length of cycle may be normal
- Effects
 - Spinal Bone loss ~ 2-4%/year
 - Infertility
 - Spontaneous habitual Miscarriage

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PCOS & Hyperandrogenism

- More common disorder in elite female athletes
 - 37% compared to 20% of the General Population
- Signs & Symptoms
 - Absence of Ovulation with irregular menstruation
 - High Levels of Testosterone
 - Hirsutism
 - Cysts on the Ovaries



2017 World Championships of Ester Semenya

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Birth Control

- 70 % of Collegiate Athletes use hormonal contraceptive
- Administration
 - Oral, Transdermal, Vaginal
- Effect
 - Decreased Bone Mineral Density during peak years
- Injury, Performance, Pain
 - Unknown typically excluded from studies

Casey, E., Rho, M., & Press, J. (2016). Sex differences in sports medicine. New York, NY: Demos Medical Publishing, LLC. ©2015 Northwestern Health Sciences University

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Female Athlete Triad

- 2005 the IOC published its first census statement
- The Triad consisted of:
 - Disorder Eating
 - Low Bone Mineral Density
 - Irregular menstrual cycles
- Current Research has changed

Murray, M., Sundgot-Boergsen, L., Burke, L., Carter, S., Constantini, N., Anders, C., ... (2014). The IOC consensus statement: Beyond the Female Athlete Triad—Relative Energy Deficiency in Sport (RED-S). *British Journal of Sports Medicine*, 48(7), 491-497. doi:10.1136/bjsports-2014-093022

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Relative Energy Deficiency in Sport (RED-S)

- No longer a female only condition
- Centers around inadequate energy
 - Disorder Eating
 - Over Training
- Most common Sports effected
 - Weight Sensitive
 - Appearance requirements

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- Prevalence
 - Adult Athletes
 - Female – 20%
 - Male – 8%
 - Adolescent athletes
 - Female 13%
 - Male - 3%
- Muscle Protein Synthesis
 - 30 kcal/kg FFM/day
- Inadequate nutrients for activity level
- Distorted Body Image
- Decreased performance
- Clinical Eating Disorders
 - Anorexia Nervosa
 - Bulimia

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HEALTH EFFECTS

PERFORMANCE EFFECTS

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****Early Detection is Crucial****

High Risk	Moderate Risk	Low Risk
Serious Eating Disorder	Prolonged low body fat %	Healthy Eating
Serious Psychological or Physiological condition	Substantial weight loss	Normal Hormone Function
Extreme Weight Loss	Reduction of expected growth and development	Healthy BMD
	Abnormal Hormones	Health Musculoskeletal system
	• Abnormal menstrual cycle	
	• Menarche after 16	
	• Abnormal Hormone profile men	
	Reduced BMD	
	History of Stress Fracture	
	Psychological or Physiological complications	
	Prolonged energy deficiency	
	Disordered Eating	
	Lack of compliance or progress with treatment	

Mountjoy, M., Sundgot-Borgen, J., Burke, L., Carter, S., Conzelmann, N., Labura, C., ... Ungewickell, A. (2014). The IOC consensus statement: Beyond the Female Athlete Triad—Relative Energy Deficiency in Sport (RED-S). *British Journal of Sports Medicine*, 48(7), 491–497. doi:10.1136/bjsports-2014-093022

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- Strategies for Low Energy Availability
 - Increase Energy Intake and/or Decrease Exercise
 - Addition of an energy rich liquid supplement
 - Increase intake 300-600 kcal/day
- Strategies for Menstrual Dysfunction
 - Strongest predictor of recovery is weight gain
 - Oral Contraceptives may be considered but can perpetuate bone loss
 - Adequate Protein and Carbohydrate intake for Liver glycogen stores

Mountjoy, M., Sundgot-Borgen, J., Burke, L., Carter, S., Conzelmann, N., Labura, C., ... Ungewickell, A. (2014). The IOC consensus statement: Beyond the Female Athlete Triad—Relative Energy Deficiency in Sport (RED-S). *British Journal of Sports Medicine*, 48(7), 491–497. doi:10.1136/bjsports-2014-093022

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- Strategies for Low Bone Health
 - Restore the energy and estrogen-dependent mechanism for mineralization
 - High-impact loading or resistance training implemented
 - Supplementation Recommendations
 - 1,500 mg/day of calcium
 - Vitamin D 1500-2000 IU/day

Mountjoy, M., Sundgot-Borgen, J., Burke, L., Carter, S., Conzelmann, N., Labura, C., ... Ungewickell, A. (2014). The IOC consensus statement: Beyond the Female Athlete Triad—Relative Energy Deficiency in Sport (RED-S). *British Journal of Sports Medicine*, 48(7), 491–497. doi:10.1136/bjsports-2014-093022

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- Strategies for Psychological Sequela
 - Athletes not Compliant to Diet recommendation or behavioral changes
 - Athletes who are refusing or resistance to treatment

Managed by a Mental Health professional

Mountjoy, M., Sundgot-Borgen, J., Burke, L., Carter, S., Conzelmann, N., Labura, C., ... Lundqvist, A. (2014). The IOC consensus statement: Beyond the Female Athlete Triad—Relative Energy Deficiency in Sport (RED-S). *British Journal of Sports Medicine*, 48(7), 491–497. doi:10.1136/bjsports-2014-093002

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High Risk	Moderate Risk	Low Risk
No Competition	Competition only under medical supervision	Full participation
Training only under supervision	May train as long as following treatment plan	
Written Athlete Agreement		

Mountjoy, M., Sundgot-Borgen, J., Burke, L., Carter, S., Conzelmann, N., Labura, C., ... Lundqvist, A. (2014). The IOC consensus statement: Beyond the Female Athlete Triad—Relative Energy Deficiency in Sport (RED-S). *British Journal of Sports Medicine*, 48(7), 491–497. doi:10.1136/bjsports-2014-093002

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- Emphasis on Nutrition not Weight
- Realistic Goals
- Use of an Integrative Care team
 - Sports Physician
 - Nutritionist
 - Psychologist
 - Physiotherapist
 - Physiologist

Mountjoy, M., Sundgot-Borgen, J., Burke, L., Carter, S., Conzelmann, N., Labura, C., ... Lundqvist, A. (2014). The IOC consensus statement: Beyond the Female Athlete Triad—Relative Energy Deficiency in Sport (RED-S). *British Journal of Sports Medicine*, 48(7), 491–497. doi:10.1136/bjsports-2014-093002

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Most Common Injuries

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Three Most Common Injuries in Females

- Stress Fractures
- Anterior Cruciate Ligament Ruptures
 - 2x to 9x higher injury rate
- Patellofemoral Pain

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Stress Fractures

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Diagnosis

- Imaging
 - Plain Radiography – Poor Sensitivity
 - MRI – Highly Sensitive
 - Bone Scan – High Sensitivity but low specificity
 - CT – Less sensitive for early detection; more sensitive for fractures
- BONE SCAN PICTURE

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Chiropractic Supportive Care

- Co-management with Orthopedist
- Reduce Risk factors
- Initial Management
 - Modify Activity to maintain conditioning
 - Nutrition
- Return to Activity
 - Graduated return

Brinkner, Khan et al. (2016). Clinical Sports Medicine (5th ed.). New York: McGraw-Hill Medical. ©2015 Northwestern Health Sciences University

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Return to Play

- 0
 - **Pre-Entry**
 - Pain during Walking and Normal ADLs
- 1
 - **Initial Loading**
 - 50% normal pace
 - Slow increases in duration
- 2
 - **Increased Intensity**
 - Increased length of run
- 3
 - **Running on Consecutive dates**
 - Full Pace
- 4
 - **Return to Full Participation**
 - No restrictions

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Patellofemoral Pain

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Patellofemoral pain

Umbrella Term for all peripatellar or retropatellar pain in absence of other pathologies

Remote Factors	Local Factors
<p>Increased Hip Internal Rotation</p> <ul style="list-style-type: none"> Seen with medially facing patella Increased load causes apparent knee valgus 	<p>Patella Position</p> <ul style="list-style-type: none"> Lateral Displacement Lateral Tilt Posterior Tilt Patella Alta
<p>Increased Hip Adduction</p> <ul style="list-style-type: none"> Single Leg squat causing adduction of the thigh causing pelvic drop of non weight bearing leg 	<p>Soft Tissue Contributions</p> <ul style="list-style-type: none"> Tight Lateral Structures Compliant Medial Structures General Hypermobility
<p>Increased Apparent Knee Valgus/External Tibial Rotation</p> <p>Poor Trunk and Pelvis Control</p> <ul style="list-style-type: none"> Largest proportion of the body mass and can influence loads PFPP associated with greater anterior and ipsilateral trunk lean 	<p>Quadriceps (vasti) Dysfunction</p> <ul style="list-style-type: none"> Reduced activity of Quadriceps Delayed onset or reduced magnitude of vastus medialis oblique
<p>Dynamic Foot Functions</p> <ul style="list-style-type: none"> Associated with increased pronation with navicular drop and arch height mobility 	

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Patellofemoral Pain Findings

- History
 - Pain during running, on steps/stairs, any weight bearing with knee flexion
 - Nonspecific or vague pain
- Exam
 - Observation
 - May have small swelling suprapatellar or infrapatellar
 - Palpation
 - Can be tender on the medial or lateral facets or not tender at all
 - General Knee Orthopedics Negative
 - Functional Movements
 - Squat and stairs cause pain but LM taping of knee improved pain

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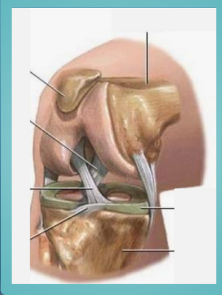
Anterior Cruciate Ligament

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ACL & Female

90% stability of anterior translation



- Q – Angle
 - Increased
- Posterior Inferior Tibial Slope
 - Increased
- Intercondylar Notch width
 - Decreased
- ACL Size
 - Decreased
- Hormonal Effects

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Relaxin Levels & ACL Rupture

- Average Concentration
 - 3.08 pg/mL
- **Non hormonal**
 - **5.30 pg/mL**
- Hormonal Contraceptives
 - 2.12 pg/mL
- Amenorrheic
 - 1.02 pg/mL
- **Oligomenorrheic**
 - **6.67 pg/mL**
- Eumenorrheic
 - 4.32 pg/mL

Dargatzis, J., Castiblanco, T., Kondrachineva, T., Kim, H., Stewart, D., & Kennedy, A. (2011). Trends in serum relaxin concentration among elite collegiate female athletes. *International Journal of Womens Health*, 3, 19-24. doi:10.2147/IJWH.S14188

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Mechanism of Injury Anterior Cruciate Ligament



- Highest incidence in Sports with pivoting and sudden decelerations
 - Football
 - Basketball
 - Netball
 - Soccer
 - Handball
 - Gymnastics
 - Downhill Skiing
- Knee Position
 - External Rotation with 10-30° of Flexion in Valgus
- Upper Torso
 - Internal Rotation

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Clinical Exam

****FIRST 24-48 HOURS HARD TO EXAMINE DUE TO****
****SWELLING****


- Historically
 - Patient describes Audible 'pop', 'crack', or 'something going out and going back'
 - Most acutely painful, especial right after injury
 - State feeling of instability
- Visual Inspection & Palpation
 - Acutely Swollen
 - Lateral joint line pain from bone marrow lesion
 - Medial joint line pain from meniscus injury

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Orthopedic Test

- Lever Sign (Lelli's Test)
 - Sensitivity – 68%
 - Specificity – 96%
- Lachman's Test
 - Sensitivity – 81%
 - Specificity – 78%
- Prone Lachman's Test
 - Sensitivity – 70%
 - Specificity – 80%
- Anterior Drawer
 - Sensitivity – 63%
 - Specificity – 91%



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Injury Prevention

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Female Nutrition

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General Findings

- Females have greater nutrition-related awareness and knowledge compared to males
- Females report consuming more fruits, vegetables, whole grains, and dairy products
- Female Athletes more likely to restrict energy
- Females have lower resting metabolic rate
- Females oxidize more lipids and fewer carbohydrates
- Female food intake decreases during the follicular phase of the cycle

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