THE FEMALE ATHLETE
Shaylon Rettig, MD, MBA

OBJECTIVES

• Anatomic and physiologic gender differences and their impact on sport
• Nutritional concerns in females and its effect on menstruation and bone density
• Musculoskeletal injuries common to females

TITLE IX

• Title IX of the Educational Assistance Act of 1972 required institutions receiving federal money to offer equal opportunities to both males and females in all programs including athletics

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**TITLE IX**
NCAA DII

**BENEFITS OF EXERCISE AND ATHLETIC PARTICIPATION**
- Improves self-confidence, self-esteem and self-image
- Increases leadership skill and team-building skills
- Increases bone marrow density, cardiovascular fitness and muscle tone
- Decreases incidence of medical conditions
- Young women more likely to graduate and better able to deal with success and failure
- Less likely to smoke, drink alcohol, use drugs, become pregnant

**ANATOMIC AND PHYSIOLOGIC GENDER DIFFERENCES**

<table>
<thead>
<tr>
<th>Oxygen pulse (efficiency of cardiorespiratory system)</th>
<th>Boys have advantage in aerobic activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo2 max (reflects level of aerobic fitness)</td>
<td>Boys have great aerobic fitness</td>
</tr>
<tr>
<td>Estrogen (higher in females)</td>
<td>Unknown whether related to increase in ligament laxity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Body shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls have lower center of gravity-improved balance; increase knee valgus; Different running gait</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heart size and volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke volume is less; Increased HR for given submaximal cardiac output; Cardiac output is 30% less</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hemoglobin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen carrying capacity is greater in boys</td>
</tr>
</tbody>
</table>
ANATOMIC AND PHYSIOLOGIC GENDER DIFFERENCES

- Women move differently than men
- They jump, land and pivot in more upright position
- Land with femoral internal rotation, apparent knee valgus and foot pronation (ACL, patellofemoral)
- Conditioning drills need to address these differences

NUTRITION

- One of the primary nutritional concerns for the female athlete is inadequate dietary intake resulting in inadequate energy for sports as well as deficiencies in iron, calcium, Vitamin D and other nutritional needs

NUTRITION

- Athletes in esthetic sports (e.g. ballet, gymnastics, skating, long distance running) appear to be most at risk
- In one study, dancers dietary intake was less than 70% of the recommended daily intake
- Not uncommon for female athletes to either fast, skip meals or consume low-fat/caloric meals
- Some ultimately develop eating disorders

CALCIUM

<table>
<thead>
<tr>
<th>Age Group (yr)</th>
<th>Suggested intake (mg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>500</td>
</tr>
<tr>
<td>4-8</td>
<td>800</td>
</tr>
<tr>
<td><strong>9-18</strong></td>
<td><strong>1300</strong></td>
</tr>
<tr>
<td>19-50</td>
<td>1000</td>
</tr>
<tr>
<td>51-70</td>
<td>1200</td>
</tr>
<tr>
<td>&gt;70</td>
<td>1200</td>
</tr>
<tr>
<td>Amenorrheic athletes</td>
<td>1500</td>
</tr>
<tr>
<td>Pregnant and lactating</td>
<td>1500</td>
</tr>
</tbody>
</table>
### Calcium

<table>
<thead>
<tr>
<th>Food</th>
<th>Calcium Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mac and Cheese</td>
<td>360 mg/cup</td>
</tr>
<tr>
<td>Whole Milk</td>
<td>300 mg/cup</td>
</tr>
<tr>
<td>Yogurt</td>
<td>270-350 mg/cup</td>
</tr>
<tr>
<td>OJ w/ calcium</td>
<td>200-250 mg/cup</td>
</tr>
<tr>
<td>Dark green leafy veggies</td>
<td>200 mg/cup</td>
</tr>
<tr>
<td>American cheese</td>
<td>170 mg/cup</td>
</tr>
</tbody>
</table>

### Vitamin D

<table>
<thead>
<tr>
<th>Age Group (yr)</th>
<th>Suggested intake (IU/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-18</td>
<td>600</td>
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- Fortified milk (8 oz) - 100 IU
- Fortified orange juice (8 oz) – 100 IU
- Fortified cereal (1 serving) - 40-80 IU
- Pickled herring (100 g) - 680 IU
- Canned salmon with bones (100 g) - 624 IU
- Mackerel (100 g) - 360 IU
- Canned sardines (100 g) - 272 IU
- Codfish (100 g) - 44 IU
- Swiss cheese (100 g) - 44 IU
- Raw shiitake mushrooms (100 g) - 76 IU
- Most multivitamins (1 tab) - 400 IU
**VITAMIN D**

- <20 Deficiency
- 20-30 Insufficient
- >30 Normal; ideal range is 40-50

**VITAMIN D**

- Recommended treatment for vitamin D–deficient patients 1–18 years of age is as:
  - 2000 IU/day of vitamin D2 or D3 for at least 6 weeks or
  - 50,000 IU of Vitamin D2 once weekly for at least 6 weeks

**IRON**

<table>
<thead>
<tr>
<th>Age Group (yr)</th>
<th>Suggested intake (mg/day)</th>
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<tbody>
<tr>
<td>1-3</td>
<td>7</td>
</tr>
<tr>
<td>4-8</td>
<td>10</td>
</tr>
<tr>
<td>9-13</td>
<td>8</td>
</tr>
<tr>
<td>14-18</td>
<td>15</td>
</tr>
<tr>
<td>18-50</td>
<td>18</td>
</tr>
<tr>
<td>&gt;50</td>
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<tr>
<td>Lactation</td>
<td>9-10</td>
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<tr>
<td>Pregnancy</td>
<td>27</td>
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</table>

• The RDAs for vegetarians are 1.8 times higher than for people who eat meat. This is because heme iron from meat is more bioavailable than non-heme iron from plant-based foods, and meat, poultry, and seafood increase the absorption of non-heme iron.
IRON

<table>
<thead>
<tr>
<th>Food</th>
<th>mg/serving</th>
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<tbody>
<tr>
<td>Breakfast cereal</td>
<td>18</td>
</tr>
<tr>
<td>Oyster, eastern/White beans</td>
<td>8</td>
</tr>
<tr>
<td>Chocolate, dark</td>
<td>7</td>
</tr>
<tr>
<td>Beef liver</td>
<td>5</td>
</tr>
<tr>
<td>Lentils/Spinach/Tofu</td>
<td>3</td>
</tr>
<tr>
<td>Kidney bean, sardines,</td>
<td>2</td>
</tr>
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IRON DEFICIENCY

- Menstruation
- The normal absorption rate of 1 milligram is stepped up to 1.5–3 milligrams per day—the female body’s natural response to blood loss.
- Heavy periods
- Prolong heavy periods
- Diet

IRON DEFICIENCY

- According to the U.S. Centers for Disease Control and Prevention (CDC),
  - “Data . . . suggest that only one fourth of adolescent girls and women of childbearing age (twelve to forty-nine years) meet the recommended dietary allowance for iron through diet . . . .
  - 11 percent of nonpregnant women aged sixteen to forty-nine years had iron deficiency
  - 3 to 5 percent also had iron-deficiency anemia.”

IRON DEFICIENCY

- True anemia is not as common in the female athlete as is nonanemic iron deficiency
- Iron supplementation in anemic athletes can increase aerobic power and improve performance
- Unclear whether iron supplementation in athletes who are iron deficient and not anemic has the same benefits
IRON

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FEMALE ATHLETE TRIAD

- Disordered eating associated with reproductive dysfunction and osteopenia
- Metabolic fuel hypothesis-the athlete is challenged to balance energy intake with energy expenditure
- Negative fuel balance, the body will sustain essential physiological functions
FEMALE ATHLETE TRIAD

- Athletic amenorrhea, low-estrogen and amenorrhea state
- Traditionally we have attributed bone density loss to the loss of estrogen’s protective effect on bone
- Recent studies suggest negative energy balance may be the key factor leading to bone loss
- One study showed disordered eating was associated with low bone mineral density in athletes with/without menstrual irregularities

FEMALE ATHLETE TRIAD

- Osteopenia is defined as bone mineral density (BMD) that is 1.0 to 2.5 SD below the young adult reference mean as measured by dual-energy x-ray absorptiometry (DEXA)
- Osteoporosis is a BMD more than 2.5 SD below reference mean

FEMALE ATHLETE TRIAD

- Treatment is prevention through education
- Counseling on the benefits of ‘fueling’ one’s body for maximal sports performance
- ‘Enhancing performance through proper nutrition’

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STRESS FRACTURES

• Modest increased risk*
• Most common in track and field athletes (lower extremity)
• Athletes with menstrual irregularities have a higher incidence of stress fractures*
• Due to change in intensity or duration of activity

STRESS FRACTURES

• Treatment- 15 inch pneumatic leg brace (tibia) or tall pneumatic walker for tibia (ankle/midfoot), short walker for forefoot/toes
• Treatment- rest; remove from aggravating activity, usually 4-6 weeks
• Address causative factors: estrogen deficits, menstrual irregularities, nutritional concerns, shoe wear, training techniques (gait analysis)

ANTERIOR CRUCIATE LIGAMENT

• Disproportionate number of noncontact (NC) ACL injuries in females participating in sports involving pivoting, cutting, and changing directions of jumping
• 75 to 85% of NC ACL occur in this setting
• Soccer players 5x more likely to get ACL injuries (contact and NC)
• Basketball players 3x more likely (contact and NC)

ANTERIOR CRUCIATE LIGAMENT

• Multiple risk factors
• Environmental (shoe traction interface, bracing)
• Anatomic (Q angle, knee valgus, foot pronation)
• Hormonal (menstrual cycle)
ANTERIOR CRUCIATE LIGAMENT

• Multiple risk factors
  • Biomechanical
    • ACL has different mechanical properties in females (smaller)
    • Neuromuscular factors are different in sexes (quadriceps dominant)
    • Fatigue (male and female)
    • Imbalance in strength, flexibility and coordination

• Reconstruction does not prevent post-traumatic osteoarthritis
  • Reconstruction was significantly associated with less repeat surgery and less meniscal and chondral reinjury

ANTERIOR CRUCIATE LIGAMENT

• The goals of neuromuscular prevention programs are to decrease knee loading and to improve protective motions in the kinetic chain
  • Combine stretching, strengthening, aerobic exercise, agility drills, plyometrics and risk awareness
  • Sport specific drills to safely respond to unanticipated movements

PATELLOFEMORAL JOINT INJURIES

• Patellofemoral pain
  • Anatomic (malalignment, abnormal patellar height, shallow trochlear groove)
  • Dynamic (muscle imbalance or overuse)
  • Specific (chondral, plica, or neuroma)
PATELLOFEMORAL JOINT INJURIES

• Patellofemoral pain
• Evaluate flexibility (hamstrings, IT band, hips)
• Evaluate strength (VMO bulk, squat mechanics, single leg squat)
• Patella tracking (J sign, hypermobile)

THE FEMALE ATHLETE

• Shoulder instability
  • More laxity in shoulders but it does not translate to symptomatic multi-directional instability
  • Not related to hypermobile syndrome
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