Disclosures

• I have no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services discussed in this CME activity
Objectives

- Children and adolescents are participating in competitive sports at young ages and increase intensity.
- Understand and identify risk factors for injuries in the young athlete
  - Background on youth sports injuries
  - Understand how growth and maturation plays different roles in injuries
- Review some common risk factors for injuries
- Discuss prevention of injuries
The Pediatric Athlete Challenges

• Unique Challenges and Risk Factors
  • Age
  • Sex
  • Growth and Maturation Differences
  • Sports Selection
  • Early Sports Specialization
  • Biomechanics
Youth Sports Injuries

• 46.5 million children participate in sports each year
  – 1 in 3 will be injured
  – Lost participation time
  – Increase in number of physician visits
• Lengthy and recurring rehab
• If significant enough may stop participating in activities → increase risk of obesity
• CDC - more than ½ of all sports injuries are preventable
The Downside of Injuries

- HRQOL
- Lost participation time
- Physician visits
- Concerns with growth
- Lengthy rehabilitation
- Stopping participation

50% present for chronic injuries
Youth Sports Injuries

- Acute traumatic injuries
- Overuse injuries - Account for nearly ½ of all injuries
  - Growth Related (apophyseal injuries)
  - Repetitive micro-trauma (stress fractures and tendinopathy)
  - Risk factors include
    - Training errors
    - Improper technique
    - Excessive training, inadequate rest
    - Muscle weakness and imbalances
    - Early specialization
    - Puberty and skeletal maturity
Growth and Maturation

• Occurrence of puberty and skeletal maturity is a far more important marker than chronological age when managing pediatric injuries
  – Onset of puberty ~ 10.5 years for girls and ~12.5 years boys
  – Tanner Stages
• Growth process is a risk factor for sports injury
  – Increased risk of injury because of biomechanical imbalances
    • Neuromuscular control, strength, and flexibility
Growth and Maturation - Middle to Late Childhood (6-12 years)

- Growth is steady, but at the end girls may be taller and heavier than boys of the same age due to earlier onset of puberty
- Highest proportion of hyper-laxity
- Strength and speed are equal
- Girls have better balance
- Boys have slightly better explosive power
- Continue mastery of motor skills
• Post pubertal changes
  – Muscle mass and strength
  – Increase in limb mass is double the increase in limb length
    • Imbalance of forces resulting in decreased lower extremity control and function
• Boys will have huge increase in jumping, throwing, sprinting. Girls increase but plateau
• Peak muscle tightness in hamstrings and calves at 12 in girls and 14 in boys
• Widening of pelvis in girls
Growth and Maturation - Late Adolescence (16-20 years)

- Gains in speed, size, and strength but not nearly as quickly in puberty
- Girls continue to accumulate fat mass which may have negative effect on performance
- Girls also have hormonal influences

### Overuse Injuries

<table>
<thead>
<tr>
<th></th>
<th>Overuse</th>
<th>Traumatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>62.5%</td>
<td>37.5%</td>
</tr>
<tr>
<td>Males</td>
<td>41.9%</td>
<td>58.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Upper Extremity</th>
<th>Spine</th>
<th>Lower Extremity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>15.1%</td>
<td>11.3%</td>
<td>65.5%</td>
</tr>
<tr>
<td>Males</td>
<td>29.8%</td>
<td>8.2%</td>
<td>53.7%</td>
</tr>
</tbody>
</table>

Stracciolini, AJSM, 2014
Peak Height Velocity and Injury Risk

• During peak height velocity biochemical properties of bone change
  – Bones increase in size more rapidly than fill in with mineral
  – BMD decreases before and rebounds after
• Relative skeletal weakness during peri-pubertal growth (increased risk of fracture)
• Increase tibia and femur length, increase overall body mass, and increase height of the center of mass lead to decreased core stability
Pre-Pubertal boys and girls are similar.

Puberty
- Higher rates of sprains immediately after peak height velocity and into maturity
  - Girls: peak incidence 10-14 y/o
  - Boys: peak incidence 15-19 y/o
Peak Height Velocity and ACL Injury Risk

GLM Slope Test:
Wald = 10.37, $P < 0.001$
Joint Hyper-laxity

Beighton Score

Give yourself 1 point for each of the manoeuvres you can do, up to a maximum of 9 points.

- Can you bend your thumb back onto the front of your forearm?
- Can you bend your knee backwards?
- Can you put your hands flat on the floor with your knees straight?
- Can you bend your elbow backwards?
- Can you bend your little finger up at 90° (right angles) to the back of your hand?

www.ehlers-danlos.org
T: 020 8736 5604
When To Be Concerned

- Frequent injuries
- Year round athlete and/or lack of multisport or free play
- Weak muscles, poor flexibility
- Hypermobility
  - Those with hypermobile joints usually have more complaints of joint pain
- Gradual onset of pain, pain presenting as ache, no direct injury, stiffness or ache after/during training, missed training, point tenderness
Shoulder Injuries

• Overhead athlete
  – Throwers, Volleyball, Swimming, Gymnastic, Tennis
• Common Pediatric Injuries
  – Multidirectional Instability
  – Little league Shoulder and Elbow
• Common pediatric shoulder findings
  – Laxity
  – Rotator cuff weakness
  – Scapular dyskinesia
  – Poor posture
Multidirectional Instability

• https://www.youtube.com/watch?v=XtVUZRZVn7Y
• https://www.youtube.com/watch?v=6oZXzJ1qRVM
Scapula Dyskinesia

- [https://www.youtube.com/watch?v=JbOMAwlaVcM](https://www.youtube.com/watch?v=JbOMAwlaVcM)
Back/Hip/Knee/Ankle/Foot Injuries

• All or any athlete
  – Runners, Dancers, Gymnasts, Hockey, Football
• Common Pediatric Injuries
  – Back: Spondylolysis
  – Hip:
    • Apophysitis and Avulsion fractures
    • Tendinitis/Bursitis, Labral, FAI
  – Knee:
    • Apophysitis: Osgood Schlatter, Sinding Larsen Johannsson
    • PFPS, OCD
  – Ankle/Foot: Salter Harris Fractures vs Ankle Sprains
Common Pediatric Lower Extremity Findings:
- Hip/Hamstring/Achilles Tightness
- Hip Abduction/Gluteus Medius weakness
- Pes Planus
- Genu Valgum
Hip Injuries

- 5-12 years old predominately male
- During adolescence greater proportion in females
  - More overuse and soft tissue
- Hip injuries steadily increase in females as they become older
  - Biomechanical changes, weak lumbo-pelvic-hip complex
  - Differences in movement patterns
    - Weak hip abductors and external rotators
Hip Injuries

Distribution of female hip injuries.

Distribution of male hip injuries.
Cam Femoroacetabular Impingement

- FAI common cause of hip pain/disorders in athletes
- Cam deformities are a risk for OA
- Cam deformities are present in 10-15% of ALL males BUT only a fraction are problematic
- High level male athletes 1.9-8x more likely to develop cam deformity
  - Adolescent males ice-hockey, basketball, soccer - training at least 3x/wk at greater risk
  - Youth ice hockey players 4.5x more likely
- Genetic vs repetitive micro-trauma/high shear force across physis or both?
- Potential window during skeletal maturation where bony morphology can be influence
  - ? Chosen sport
  - ? Prevention and avoidance of future hip pathology
Prevention

Improved injury surveillance

Identification of risk factors

Thorough PPE

Proper supervision and education

Sport alterations

Improved training and conditioning

Delayed specialization

Valovich McLeod, JAT, 2011
Prevention- Injury Surveillance

- Improved understanding of prevalence, incidence and economic cost
- Increased funding and support
- Participation in surveillance efforts by all athletic healthcare providers
- Development of resources and training improved surveillance
Pre-Participation Physical Exam

- Screen each athlete for potential risk factors
- Unfortunately mandated for high school athletes but not all club based or youth sports

- Injury history, stature, maturity (Tanner stage), joint stability, strength and flexibility
- Diet, menstrual history
- Cardiovascular- Pulmonary symptoms
- Concussion history
Prevention - PPE

- 2 minute Ortho Exam
Prevention - PPE

- Biomechanical assessment or functional screening test
  - Evaluate posture, gait mechanics, core stability and functional strength
- Focused exam on those with previous injury or risk factors
- Predisposing anatomical risk factors
  - Leg length discrepancy
  - Genu Valgus/varus
  - Pelvic rotation
  - Generalized joint hypermobility
Prevention - PPE
Prevention - PPE

Desirable knee angle:

5° - 15° degrees off straight
PPE- Functional Testing
Prevention- Sports Specialization

- Sport Specialization
  - Avoid playing single sport year round
  - Pediatrics should play only 1 overhead throwing sport at a time
- Pre-season and in-season prevention
- AAP recommendations for organized sports participation
Prevention - Early Diversification

- Early diversification includes
  - Involvement in multiple sports
  - Participation in “deliberate play” (intentional and voluntary nature of informal sport games designed to maximize inherent enjoyment)

- Benefits
  - Children experience different physical, cognitive, & psycho-social environments
  - Less injuries experienced by diversified youth athletes vs early specialization
  - Greater potential of minimizing dropouts while maximizing sustained participation
  - Fosters positive peer relationships and leadership skills
  - Creating intrinsic motivation through participation in enjoyable activities
Integrated Neuromuscular Training

- ↑Strength & Power
- ↑Motor Skills
- ↑Sports Performance
- ↑Fat free mass
- ↑Metabolic Health
- ↑Health-related QOL
- ↑Injury Resistance
- ↑Long-term development
Volume or quantity of time participating is the most consistent predictor of overuse injury
- Some data suggests no more than 16-20 hours per week

AAP recommendations to prevent overuse injuries
- Have at least 1-2 days off per week
- 10% rule
- Take at least 2-3 months away from a specific sport each year
- Participate on only 1 team during a season
- If complaints of non specific joint/muscle pain, fatigue, poor academic performance be on alert for burnout
- Focus on proper hydration, nutrition, sleep
  - Sleep duration is an independent factor associated with injury
- Education of parents, coaches, athletes
Conclusion

- Prevention of pediatric overuse injuries requires a comprehensive multidimensional approach
  - Injury surveillance
    - Overuse injuries may be predictor for future injury
  - Identification of risk factors for injuries
  - Thorough PPEs
  - Proper supervision and education
    - Injuries but also concussion, heat illness, cardiac events
  - Sports alterations
  - Improved training and conditioning programs
    - Integrative Neuromuscular Training (INT) used during childhood can improve strength
    - Pre-season conditioning can reduce injury rates
  - Delayed specialization
    - Too much too early vs too little too late
    - Free play can improve performance and motor skills
Thank You