THE PEDIATRIC ATHLETE - ARE THEY JUST SMALL ADULTS?

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Objectives

- Define the pediatric athlete
- Pediatric females vs. males
- Common pediatric injuries
- Pediatric rehab strategies
- Pediatric athlete and resistance training

Why Is This Topic Important?

- Estimated 30 million kids (age 5-18) in US participate in organized sports programs
- Sports are the leading cause of injury in pediatrics and adolescents - 4 million Sports Related Injuries(SRI) in US per year
- Yearly cost of treating SRI estimated to be $1.8 billion
- Increased numbers, increased intensity, increased specialization, younger age

Franklin CC and Weiss JM, Curr Opin Pediatr, 2012

Average age of Sports Related injuries (SRI):
- boys: 13.0 yrs - girls: 12.4yrs

- Most common sports:
  - Football - Soccer
  - Basketball - Hockey
  - Baseball/ softball - Wrestling

Taylor et al., Acad Emerg Med, 2000

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Who Is The Pediatric Athlete?

- Children 5-12
- Adolescents 13-21

Adolescence: Orthopedic definition
- Begins: At the onset of puberty for the given individual regardless of age or gender
- Ends: At skeletal maturity. Closed growth plates

When Are Kids Ready For Sports?

- “At the time when a child has attained the necessary motor, physical, cognitive, social, and adaptive ability to meet the demands of a particular sport”

- Where is your patient along the development continuum?
  - Physically
  - Emotionally
  - Mentally

The Pediatric Athlete - Are They Just Small Adults?

Are They Just Small Adults… Physically?

- Neural development:
  - Brain’s most rapid and critical period of growth is from age 0 to 2
    - At age 2 the brain is 80% the size of the adult brain
  - Glial cell and myelination production continues until about age 10
    - Acquisition of motor skills
  - Growth spurts at 6-7 yrs, 10-12 yrs, ~ 18 yrs of age (changes in coordination/balance)
• Vision: young children have myopic acuity – primarily due to their less spherical eyeball shape
  – Visual Closure: 5 years
  – Tracking objects: 6-7 yrs
  – Judging velocity: 6-7 yrs
  – Figure-ground perception: 8yrs
  – Object size perception: 11 yrs
  – Adult depth perception: 12 yrs

• Hearing: basic auditory listening skills mastered by 3 years of age

  ➢ Stricker, Pediatr Clin N Am, 2002
  ➢ Cech and Martin, 1995

Thermo-regulation

• Heat illness is the leading cause of death and disability during HS and collegiate athletics
• Average 5,946 non-fatal ED visits per year for heat illness related to sports and recreation
• Incidence highest among males (72%) ages 10-14yo (18.2%) 15-19yo (35.6%)

  ➢ CDC: MMWR July 29, 2011

Thermo-regulation:

• Children have a poorly developed subcutaneous fat layer, allowing for hypothermia:
  – Higher body surface area and inability to shiver leads them to lose heat 4x faster

• Increased opportunity for hyperthermia:
  – Higher body surface area
  – Increased metabolic rate
  – Decreased number of sweat glands
  – Increased threshold to begin sweating

  ➢ Stricker, Pediatr Clin N Am, 2002

Bone development

– Bone vs. soft tissue lengthening
  • Long bones typically fuse by:
    – 17.5 yrs ± 2 in boys
    – 14.5 yrs ± 2 in girls
  • Skeletal growth continues until age 30 (3-5mm increase per year)
  • Peak bone density mostly achieved in adolescence
  • Tensile strength of ligaments and tendons greater than epiphyseal plates
  • Common areas of injury
Cartilage
- Activity is important in development
- Low resistance to repetitive loading
- Less resistance to shear forces

Balance and Postural Control
- Center of mass
  - Moves from T12 to L5-S1
- Three balance systems:
  - Vision, vestibular, proprioception
- Coordination – varies with somatic growth spurts

Are They Just Small Adults…Mentally?
- Selective attention and use of complex memory strategies mature around 10-12 yr
- Development of abstract thought – 13 yr
- Present oriented with an inability to perceive future benefits/problems
- Unable to reflect on actions

Are They Just Small Adults…Emotionally?
- Social pressures
  - Parents, coaches, friends/teammates, scholarships, media...
- What is pain?
  - Frequently kids don’t understand pain
  - Often can’t localize pain, can’t differentiate “stretch pain” from “real pain”
- Pain scales different
  - FLACC pain scale used from 2mo-7yr
  - Visual pain scales (faces, pictures)
When Are Kids Ready For Sports?

• Preschool (ages 3-5)
  – Develop gross motor activities between 3-6 yrs
  – Unable to compare their abilities to others before age 6
  – Egocentric
  – Difficulty tracking objects and determining velocity
  – Difficulty in processing multiple auditory stimuli
  – Memory is enhanced with the use of visual aids
  – Concrete-operational – they need clear and concise information
  – Learn from trial and error
  – Short attention spans (5-15 minutes)
  – Poor selective attention

  [Image: Committee on Sports Medicine and Fitness, Pediatrics, 1992]

• Middle childhood (ages 6-11)
  – “Fine tuning” gross motor skills
  – Continue to improve with practice
  – 60% can throw, kick, run, jump, catch, hop, and skip
  – Before age 9, unable to fully understand the competitive nature of sports
  – Developing their sense of right and wrong
  – Balance improves
  – Improved visual acuity, tracking ability, and integration of perceptual motor skills
  – Begin to form body image

  [Image: What Does The Research Say?

• Kids ages 8-10 yrs had higher injury rates than younger (5-7 yrs) or older (11-13 yrs) in football and baseball

  [Image: During this time the parameters of the game also changed

  [Image: Radelet et al, Pediatrics, 2002]
Are Pediatric Female Athletes Similar To Males?

- Boys and girls are similar before puberty in:
  - Height
  - Percent body fat
  - Weight
  - Motor skills
  - Strength

- Differences seen after puberty in:
  - Muscular strength
  - Neuromuscular control
  - Injury rates

Concerns for Female Athlete

- Increased injury rates - ACL, stress fractures
- Female Athlete Triad - disordered eating (energy deficit), amenorrhea (menstrual disturbances), osteoporosis (bone loss)
- Sex discrimination?
- Other?

Adolescent Specific Injuries

Skeletal, Muscular, Ligamentous, Cartilagenous

- Growth Plate Fractures:
  - Sprains are rare
  - Most sprains are really (type 1) growth plate fractures
  - Type 1 and 2 fractures non-operative generally
  - Type 3 and 4 fractures usually surgical

Adolescent Specific Injuries

Skeletal
Adolescent Specific Injuries

Growth Plate Fractures

- Non-displaced Type 1 fracture
- Crosses growth plate, often misdiagnosed as sprain

Adolescent Specific Injuries

Growth Plate Fractures

- Displaced Type 1 growth plate fracture
  - Apophyseal Avulsion
    - Deceleration / jumping injury
    - Severe pain and inability to bear weight
    - Crutches as needed with slow return to activity
    - Rarely Surgical

Adolescent Specific Injuries

Skeletal

- Long Bone Fractures
  - Similar to adult injuries
  - Cast treatment common to avoid growth plate injury from internal fixation
  - Healing is bone dependent ~ 6 - 8 weeks
  - Occasionally surgical
    - External fixation

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Adolescent Specific Injuries
Muscular

- Muscle Strain / Rupture
  - Common Site:
    - Rectus Femoris
    - Adductors (groin pull)
    - Hamstrings
    - Plantaris, Medial head of gastrocnemius
  - Treatment
    - Rest, Gentle stretch
    - Slow resumption of activity
    - Can be up to eight weeks for recovery
    - If palpable defect or very weak then MRI

Adolescent Specific Injuries
Muscular

- Muscle Contusion
  - Quadriceps common site
  - Often large hematoma
  - Ice and Immobilize in flexion
  - May lead to Myositis Ossificans

Adolescent Specific Injuries
Ligamentous

- Knee:
  - Anterior Cruciate Ligament (ACL)
    - Uncommon in this age group
    - Difficult to treat surgically due to growth plate
    - Surgery may be delayed until maturity
    - Look for concomitant cartilage injuries

Adolescent Specific Injuries
Ligamentous

- Knee:
  - Medial Collateral Ligament
    - More common (esp. hockey)
    - Treatment almost always conservative
    - Pain usually over femoral insertion (medial epicondyle)
    - Three grades of severity (1,2,3)
    - Hinged knee brace 6-12 weeks depending on severity

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Adolescent Specific Injuries

• Dislocations
  – Rare in the young adolescent
  – Elbow:
    • 2-3 weeks immobilization then start therapy
    • Stiffness is problem, rarely surgery
  – Shoulder:
    • Chance of repeat dislocation if occurs before age 20 is >90% without surgery
    • Therapy is still first line treatment

Adolescent Specific Injuries

• Traumatic Cartilage Loss
  – Patellar Sleeve Fracture
    • Occurs in younger adolescents and children
    • Appears as simple fracture of inferior pole of patella
    • Includes full thickness loss of cartilage from backside of patella
    • MRI
    • Surgery

Adolescent Specific Injuries

• Meniscus Tears
  – Uncommon in this age group
  – Catching, popping, locking symptoms
  – Joint line tenderness
  – MRI diagnosis
  – Arthroscopic repair if possible / debridement
  – Meniscal transplant
Avascular Insults
Osteochondritis Dissecans

- Osteochondritis Dissecans (OCD)
  - Occult trauma vs Avascular insult
  - Involves an area of sub-chondral bone and overlying cartilage
  - Occur in knee, elbow, ankle, rarely others
  - Best prognosis in patients with open growth plates
  - MRI evaluation necessary
  - Stable lesions can be observed, protected weight bearing, cessation of sport
  - Loose fragments are reattached or debrided

Avascular Insults
Osteochondritis Dissecans

- OCD of Knee
  - Most common on lateral aspect of medial femoral condyle
  - Xray is helpful: “tunnel” or “skiers” view
  - Catching, popping, ache, not always painful

Avascular Insults

- Legg-Calve-Perthes: AVN of ossific nucleus of the femoral head caused by loss of blood supply
  - Children 3-12 yo (m>f; 4:1)
  - Trendelenberg gait
  - Decr. ROM especially abduction and IR
  - Pain in groin, hip, knee (referred)
- SCFE: growth plate of proximal femoral physis weak and becomes displaced
  - Children 10-15yo (m>F; 3:1)
  - Trendelenberg gait
  - Pain in groin, anterior/medial thigh and knee
  - Decr. ROM especially flex, abd, IR
  - Leg moves into ER when attempt flexion

Overuse / Repetitive Injuries

- Tendonitis:
  - Can occur in any tendon due to repeated stress
  - Inflammation and microtrauma of tendon
  - Patellar tendon common (jumper’s knee)
  - Prolonged rest, anti-inflammatories to heal
  - May participate as pain allows
Overuse / Repetitive Injuries

- **Traction Apophysitis**
  - Occurs at growth plate below a tendon insertion into bone
  - Repetitive microtrauma at growth plate
  - Pain with activity, palpation
  - Rest is only cure
  - Ischium, patella, base of 5th metatarsal, etc.

Overuse/ Repetitive Injuries

- **Osgood Schlatter Disease:**
  - 10-15 year old, boys > girls
  - Overuse syndrome
  - Repeated stress on tibial tubercle
  - Rest, anti-inflammatories, sports as tolerated
  - Resolves with maturity

Overuse / Repetitive Injuries

- **Shoulder Pain**
  - Usually instability due to ligamentous laxity
  - Chronic irritation, fatigue, synovitis
  - Not rotator cuff pathology in this age group
  - Treatment is rest and rotator cuff strengthening
  - Swimmers, throwing athletes

Overuse / Repetitive Injuries

- **Stress Fractures**:
  - The “dreaded black line”
  - Not common in adolescents,
  - More common in the 18+ age group
  - X-Rays not always diagnostic
  - MRI conclusive diagnosis
  - Rest +/- Casting is usually appropriate
NATA Position Statement on Management of Overuse Injuries
1. Injury Surveillance
2. Pre-participation Physical Exam
3. Identify Risk Factors
4. Coach education and medical supervision
5. Sport Alterations
6. Training and Conditioning Progression
7. Delayed Specialization

Pediatric Rehab Strategies
- Case 1: common spine conditions
- Case 2: apophyseal avulsion
- Case 3: common UE conditions
- Case 4: common LE conditions

Case 1: 16 y/o male athlete with “poor posture”
Common Spine Conditions
- Postural Syndrome
- Spondylolysis, Spondylolisthesis
- Scoliosis
- Scheuermann’s Kyphosis Disease
- Disc herniation

Spine Rehab. Intervention Strategies
- Postural education - no slouching, neutral pelvis, abdominal bracing
- Core strengthening including scapulae, trunk, pelvis - endurance rather than power
- Progressive dynamic lumbar stabilization
- Muscle flexibility- hamstrings, upper traps, lats
- Bracing (Scoliosis, Scheuermann’s)
Case 2: 14 y/o male pulled up while running 40 yd dash in PE class and fell to ground w/ severe butt pain. Unable to walk on his leg

Pelvis - Apophyseal Avulsion Fractures

• Ischial tuberosity 54% - hamstrings
• ASIS 19% - sartorius
• AlIS 22% - rectus femoris
• Pubic symphysis 3% - adductors
• Iliac crest 1% - external oblique (traction), “hip pointer” with contusion
• Greater trochanter - (rare) hip abductors

Apophyseal Avulsion Fracture
Rehab Intervention Strategies

• Comfort and protect
• Ice progressing to heat
• Progress gentle strength, stretch, and activity as tolerated - 2-6 weeks?
• Education

Case 3: 12 y/o male pitcher with worsening R shoulder and elbow pain along with decreased throwing velocity

Common Upper Extremity Conditions

• Little league shoulder
• Little league elbow
• Multi-directional instability/ laxity

Upper Extremity Rehab Intervention Strategies

• Rest - LL shoulder (2-3 mo); LL elbow (2-4 wks)
• Progressive strengthening - including core, cuff program, Popeye program
• Throwing analysis
• Return to throwing program
• Education - appropriate pitch count (AAOS Guidelines for Young Baseball Player)
Case 4: 13 y/o male, R knee pain (3/10) for 2-3 mo. Pain and limping with walking, running, PE activities. Mildly overweight

Common Lower Extremity Conditions
- Slipped Capital Femoral Epiphysis (SCFE)
- ACL tears
- Traction Apophyseal injuries: Apophysitis:
  - Osgood-Schlatter’s Disease
  - Sinding-Larsen-Johansson
  - Sever’s Disease

Lower Extremity Rehab Intervention Strategies
- SCFE: post-op N/LWB 4-6 wks
  - Hip strengthening, core stability, balance, proprioception
- ACL: often conservative
  - Focus on neuromuscular control, LE mechanics, core strengthening, jump/landing training, balance/proprioception
  - ACL prevention programs
- Apophysitis: relative rest, flexibility, core strengthening

Can The Pediatric Body Handle Weight Training?

Myths About Resistance Training At A Young Age
- Will damage growth plates causing higher injury rates and stunting growth
- Will have negative effects on cardiovascular health
- Safer to participate in sports activities than resistance training
- Pre-pubertal kids cannot benefit from resistance training
Potential Benefits of Pediatric Resistance Training

- Increase muscle strength
- Increase muscle power
- Increase local muscle endurance
- Enhance motor skill performance
- Increase bone mineral density
- Improve body composition
- Improve insulin sensitivity
- Improve blood lipid profile
- Reduce risk of sports-related injuries
- Enhance sports performance
- Stimulate a more positive attitude toward lifetime physical activity

-Faugenbaum and Myer, Curr Sp Med Rep, 2010

Resistance Training Benefits

- **Strength training**
  - Neuromuscular gains vs. hypertrophy
  - Changes can be made in:
    - Increased recruitment
    - Increased frequency
    - Decreased inhibition
  - May improve sports performance

- **Aerobic training**
  - Pre-pubescent children can increase VO2 max but not to the extent that pubescent and post-pubescent children and adults are capable of
  - Maximum 10% VO2 max gain in pre-pubescent children compared to 15-20% in the other populations
  - "ceiling phenomenon" with gains in VO2 max

- Stricker, Pediatr Clin N Am, 2002

Resistance Training and Injury Prevention

- Minimal Studies in this age group
- Micheli- 15%-50% less overuse and acute injuries
- Hejna et al. 13-19 yo
  - Fewer injuries
  - Less time required to return to sports following injury
- Multifaceted program to reduce SRI
  - Increased muscle strength
  - Enhance movement mechanics
  - Improve functional abilities

- Stricker, Pediatr Clin N Am, 2002

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Resistance Training and Performance Enhancement

- No consistent correlation in this age group between strength training and improved athletic performance or body composition
  - Sport specific movements
  - Multiplanar, proprioception challenging
  - Require coordination of multiple joints
  - Require balance and stability

A Synopsis Of Recommendations For Resistance Training In The Pediatric Athlete:

- Provide qualified instruction and close supervision
- Ensure the exercise environment is safe and free of hazards
- Begin each session with a dynamic warm-up
- Focus on developing proper exercise technique and learning fundamental training principals
- Perform 1-2 sets of 6-15 repetitions on strength exercises
- Perform 1-3 sets of 6 or fewer repetitions on power exercises
- Perform exercises for the upper body, lower body, and midsection
- Include exercises that require balance and coordination
- Cool down with less intense activities and stretching

A Synopsis Of Recommendations For Resistance Training In The Pediatric Athlete:

- Resistance train 2-3 times each week on nonconsecutive days
- Keep the program fresh and challenging by systematically varying the training program
- Motivation to begin should be from the athlete
- Loads should be specific to each child, increase gradually
- Equipment should be appropriate for the size of the child
- Competition should be discouraged
- Dynamic concentric contractions over the entire range of motion should be a focus
- Strength training should be a fun activity!

Thank you!

Questions?
Bibliography