If you are viewing this course as a recorded course after the live webinar, you can use the scroll bar at the bottom of the player window to pause and navigate the course.

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Learning Objectives

• Describe at least three recommended means of preventing pediatric overuse injuries.
• Describe the rationale for pitch counts in youth baseball.
• Identify at least three merits of early specialization and sports sampling.
• List at least three of the best ways for managing common overuse injuries, as proven by the available evidence.
Overview

• Pediatric sports participation and overuse injuries
• Role of sports medicine professionals
• Position/Consensus Papers
• Recommendations
• Conclusions

Sports Participation

• ~30 million children and adolescents participating in organized sports in the US (Hergenroder, 1998; NIH, 1992)
  – 4,519,312 males and 3,287,735 females
  – Over half of all enrolled students are competing in high school activities
<table>
<thead>
<tr>
<th>Enhanced physical and psychosocial development</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Cardio-respiratory fitness + Blood lipids + Selected psychological measures + Body comp + Bone mineral density</td>
</tr>
<tr>
<td>Establish good health habits at an early age</td>
</tr>
</tbody>
</table>

Bigger, faster, stronger: The rising cost of youth sports

Costs for youth sports set to spiral ... again

YOUR MONEY

The Rising Costs of Youth Sports, in Money and Emotion

JAN. 16, 2015
Wealth Matters

By PAUL SULLIVAN
Long-Term Athletic Development

Long-term athletic development pathways should accommodate for the highly individualized and non-linear nature of the growth and development of youth.

Youth of all ages, abilities and aspirations should engage in long-term athletic development programs that promote both physical fitness and psychosocial wellbeing.

All youth should be encouraged to enhance physical fitness from early childhood, with a primary focus on motor skill and muscular strength development.

Long-term athletic development pathways should encourage an early sampling approach for youth that promotes and enhances a broad range of motor skills.

Health and wellbeing of the child should always be the central tenet of long-term athletic development programs.
### Long-Term Athletic Development

Youth should participate in physical conditioning that helps reduce the risk of injury to ensure their on-going participation in long-term athletic development programs.

Long-term athletic development programs should provide all youth with a range of training modes to enhance both health- and skill-related components of fitness.

Practitioners should use relevant monitoring and assessment tools as part of a long-term physical development strategy.

Practitioners working with youth should systematically progress and individualize training programs for successful long-term athletic development.

Qualified professionals and sound pedagogical approaches are fundamental to the success of long-term athletic development programs.

---

### Pediatric Sport-Related Injury

- >3 million injuries annually that cause time lost from organized sport (Hergenroeder, 1998)
  - More than 35% of all medical visits in 5-17 year olds and
  - More than 20% of all emergency department visits in 5-24 year olds
  - Estimated cost (1996) of these visits was over $1.3 billion annually

- 12 million student athletes between the ages of 5-22 will suffer a sports related injury this year (Janda, 2004)
  - Resulting in 20 million lost days of school
Overuse Injuries

- 52% of injuries presenting to a sports medicine center were overuse injuries
  - Tennis, swimming, soccer, dance, track, runner, gymnastics, and cheerleading
- Females higher rate (63% vs. 40%)
- Males on team sports 5.3x higher rate of overuse than non-team sports
- High-overuse sport = 10x male and 3.6x female risk for overuse

Stracciolini, CJSM, 2015

<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

- Children (5-12) vs. Adolescents (13-17)
  - Children more traumatic (UE)
  - Adolescents more overuse (54.5% vs. 49.2%)

Stracciolini, AJSM, 2013
Overuse Injuries

- Overuse/chronic accounted for
  - 27.5% of boys and 36.2% of girls track and field injuries
  - Most often to lower extremity
- 1.5 per 10,000 AE
  - Girls greater risk than boys
  - Girls track/field and field hockey
  - 7.7% of all injuries (55.7% in boys swimming)
  - 7.6% resulted in time loss greater than 3 weeks

Schroeder, 2016; Pierpont, 2016
The Downside of Injuries

50% present for chronic injuries

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

Growth and Development

- Children and adolescents' physiologic status is defined by growth
  - Onset of puberty occurs at ~ 10.5 years for girls and ~ 12.5 years for boys
- Injuries in this age group occur in patterns distinct from adults
- Due to growth, may be susceptible to overuse injuries
Physeal Injuries

12 studies
- Baseball pitchers

12 studies
- Stress-related changes

10 studies
- 8 = Physeal widening
- 2 = osteochondritis & radiographic widening
- Caine, BJSM, 2006

Dropping Out

- 8% annual drop out rate from sports due to injuries in Australia (Grimmer, 2000)
- Elbow OCD in elite female gymnasts (Jackson, 1989)
  - Only one still participating after 3 yr follow-up
- Gymnasts with spine injury (Katz, 2003)
  - All ceased or reduced participation due to back pain
- Athletes with ACL injury retire from active participation at a higher rate than athletes without this injury (Thelin, 2006)
Overtraining - Burnout

**TABLE 6. Symptoms of Overtraining Syndrome/Burnout**

<table>
<thead>
<tr>
<th>Overtraining Syndrome/Burnout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatigue</td>
</tr>
<tr>
<td>Depression</td>
</tr>
<tr>
<td>Bradycardia or tachycardia</td>
</tr>
<tr>
<td>Loss of motivation or interest</td>
</tr>
<tr>
<td>Hypertension</td>
</tr>
<tr>
<td>Sleep disturbances</td>
</tr>
<tr>
<td>Insomnia</td>
</tr>
<tr>
<td>Irritability</td>
</tr>
<tr>
<td>Agitation</td>
</tr>
<tr>
<td>Decreased self-confidence</td>
</tr>
<tr>
<td>Anxiety</td>
</tr>
<tr>
<td>Nausea</td>
</tr>
<tr>
<td>Loss of appetite</td>
</tr>
<tr>
<td>Weight loss</td>
</tr>
<tr>
<td>Lack of mental concentration</td>
</tr>
<tr>
<td>Heavy, sore, stiff muscles</td>
</tr>
<tr>
<td>Restlessness</td>
</tr>
<tr>
<td>Frequent illness</td>
</tr>
</tbody>
</table>

(DiFiori, CJSM, 2014) 21

**TABLE 7. Diagnosis of Overtraining Syndrome/Burnout**

History
Decreased performance persisting despite weeks to months of recovery
Disturbances in mood
Lack of signs/symptoms or diagnosis of other possible causes of underperformance
Lack of enjoyment participating in sport
Inadequate nutritional and hydration intake
Presence of potential triggers: (a) increased training load with adequate recovery, (b) monotony of training, (c) excessive number of competitions, (d) sleep disturbance, (e) stressors in family life (parental pressure), (f) stressors in sporting life (coaching pressure and travel demands), (g) previous illness.

Testing (if indicated by history)
Consider laboratory studies: complete blood count, comprehensive metabolic panel, erythrocyte sedimentation rate, C-reactive protein, iron studies, creatine kinase, thyroid studies, cytomegalovirus and Epstein-Barr virus titers.
Profile of Mood States (POMS): A psychometric tool for a global measure of mood, tension, depression, anger, vigor, fatigue, and confusion.

(DiFiori, CJSM, 2014) 22
How Does Recent Sport-Related Injury Affect HRQOL?

• Adolescents with a self-reported recent injury demonstrated lower HRQOL compared to their uninjured peers
  – Physical functioning
  – Pain
  – Social functioning
  – Global HRQOL

• Indicate injuries affect areas outside the expected physical component of health

(Valovich McLeod, J Athl Train. 2009)
National Athletic Trainers’ Association Position Statement: Prevention of Pediatric Overuse Injuries

Tamara C. Valovich McLeod, PhD, ATC; Laura C. Decoster, ATC; Keith J. Loud, MD, CM, MSc; Lyle J. Micheli, MD; J. Terry Parker, PhD, ATC; Michelle A. Sandrey, PhD, ATC; Christopher White, MS, ATC

POSITION STATEMENT

Overuse Injuries and Burnout in Youth Sports: A Position Statement from the American Medical Society for Sports Medicine

John P. DiFiori, MD;† Holly J. Benjamin, MD;‡ Joel Brenner, MD, MPH;‡ Andrew Gregory, MD;‡ Neeru Jayanthi, MD;† Greg L. Landry, MD, and Anthony Luke, MD, MPH

(Clin J Sport Med 2014;24:3-20)
Overuse Injuries

• Growth-related
  – Apophyseal injuries

• Repeated microtrauma
  – Chronic submaximal loading of tissue
  – Stress fractures
  – Tendinopathies

• Combined mechanisms

  • Repetitive submaximal loading when rest is not adequate for adaptation to take place
  • Muscle-tendon unit, bone, bursa, NV, physis
  • Apophyseal and physeal stress injuries unique to youth athlete

Valovich McLeod, JAT, 2011
DiFiori, CJSM, 2013

High Vs. Low Risk

• High Risk
  – Can result in significant time loss
  – Stress fx
  – Physeal stress injuries
  – OCD
  – Apophyseal injuries
  – Effort thrombosis (TOC)

DiFiori, CJSM, 2013

<table>
<thead>
<tr>
<th>Location</th>
<th>High Risk</th>
<th>Low Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip/Pelvis</td>
<td>Femoral neck (tension-sided)</td>
<td>Femoral shaft stress fracture</td>
</tr>
<tr>
<td>Back (lumbar spine)</td>
<td>Patellaris stress fracture</td>
<td>Congenital spondylolisthesis, pelvic stress fracture</td>
</tr>
<tr>
<td>Leg</td>
<td>Anterior cortical tibial stress fracture</td>
<td>Medial tibial stress fracture, tibial shaft stress fracture</td>
</tr>
<tr>
<td>Ankle</td>
<td>Neovascular stress fracture, talus dorsum osseous defect, talus stress fracture</td>
<td>Dorsal tibial stress fracture</td>
</tr>
<tr>
<td>Foot</td>
<td>Talus navicular stress fracture, fifth metatarsal proximal diaphyseal stress fracture, sesamoid stress fracture</td>
<td>Sesamoid, third, fourth metatarsal stress fractures, cuboid</td>
</tr>
<tr>
<td>Knee</td>
<td>Patellar stress fracture, osteochondral dislocations of femoral condyle or patella</td>
<td>Tibial tubercle and inferior patellar pole apophysis</td>
</tr>
<tr>
<td>Shoulder</td>
<td>Effort thrombosis</td>
<td>Proximal humeral physical stress fracture</td>
</tr>
<tr>
<td>Elbow</td>
<td>Osteochondral fracture, apophyseal necrosis of metapodial epiphysis</td>
<td>Medial epicondylic apophysis</td>
</tr>
<tr>
<td>Wrist</td>
<td>Dorsal radial physeal stress injury</td>
<td></td>
</tr>
</tbody>
</table>
Preventative Approach

- Advocated by several prominent sports and healthcare organizations
  - International Olympic Committee (2008)
- 50% of overuse injuries in active children and adolescents are preventable (Smith et al, 1993)

*Prevention*

- Improved injury surveillance
- Identification of risk factors
- Thorough PPE
- Improved training and conditioning
- Proper supervision and education
- Sport alterations
- Delayed specialization

Valovich McLeod, JAT, 2011
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

EC = C
(Mountjoy, 2008; FIMS, 1998; Almquist, 2008; DiFiori, 2013)

Preparticipation Physical Examination

• Screening process
  – Injury history
  – Risk factors
  – Stature/maturity
  – Joint stability
  – Strength
  – Flexibility

Identification of Risk Factors

EC = C
(ACSM, 1993; Dalton, 1992; Hergenroeder, 1998; Caine, 2006; PPE Working Group, 2005)
Risk Factors for Overuse Injuries

Growth-Related Risk Factors

- Growth plate cartilage
- Growth spurt
- Age
- Height
- Tanner stage
Intrinsic Risk Factors

- History of previous injury
- Anatomical alignment
- Muscle imbalances
- Inflexibility
- Muscle weakness
- Instability / laxity

Extrinsic Risk Factors

- Training and recovery
- Equipment
- Poor technique
- Environment
Overuse-Prone Profiles

<table>
<thead>
<tr>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall stature</td>
<td>Tall stature</td>
</tr>
<tr>
<td>Endomorph body structure</td>
<td>Decreased upper extremity strength</td>
</tr>
<tr>
<td>Less static strength</td>
<td>Less static strength</td>
</tr>
<tr>
<td>More explosive strength</td>
<td>More explosive strength</td>
</tr>
<tr>
<td>Decreased muscle flexibility</td>
<td>High limb speed</td>
</tr>
<tr>
<td>High degree of ligamentous laxity</td>
<td>Increased muscle tightness</td>
</tr>
<tr>
<td>Large Q-angle</td>
<td>Increased ligamentous laxity</td>
</tr>
<tr>
<td></td>
<td>Greater leg length discrepancy</td>
</tr>
<tr>
<td></td>
<td>Pronation</td>
</tr>
<tr>
<td></td>
<td>Large Q-angle</td>
</tr>
</tbody>
</table>

(Lysens, 1989)

Risk Factor Identification

- Arm pain and fatigue \( EC=A \) (Lyman 2001, Olsen, 2006)
- Decreased throwing performance \( EC=A \) (Lyman, 2001)
- Volume of pitches \( EC=A \) (Lyman 2001, 2002; Olsen, 2006)
  - 9-14 year olds: 75 pitches in a game, 600 pitches in a season, and 2000-3000 pitches in a year
  - 15-18 year olds: 90 pitches per game; no more than 2 games per week
- Anatomical factors \( EC=C \) (DiFiori, 2002; Lysens, 1989)
Risk Factors for Lower Extremity Injury

- Multi-directional balance
  - Predictive of overall injury risk
  - OR 3.0 (95% CI: 1.5-6.1)
- Physical maturation
  - Boys <14 y/o more likely to sustain LE overuse injury

Suggested Assessment for Runners

<table>
<thead>
<tr>
<th>Intrinsic</th>
<th>Extrinsic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Standing Q angle</td>
<td>• Preseason activity level</td>
</tr>
<tr>
<td>• BMI</td>
<td>• Modify training volumes</td>
</tr>
<tr>
<td>• Navicular Drop</td>
<td>• Early and continued participation in ball</td>
</tr>
<tr>
<td>• Hip abduction, extension and ER strength</td>
<td>sports with 360° playing field</td>
</tr>
<tr>
<td>• Menstrual cycle</td>
<td></td>
</tr>
</tbody>
</table>

Onate, CJSN, 2015 39

Paterno, 2013 40
Education and Supervision

• Athletes for S&S of overuse \( EC=A \) (Lyman 2001, Olsen, 2006)

• Coach certifications \( EC=B \) (FIMS, 1998; Caine, 2006; Ransone, 1999; Valovich McLeod, 2008)
  – Sport safety, techniques, psychosocial, health/medical concerns

• Adequate supervision \( EC=C \) (FIMS, 1998; ACSM, 1993)

• General knowledge of S&S of overuse \( EC=C \) (Hodson, 1999)

Coaching Education Programs

<table>
<thead>
<tr>
<th>Organization</th>
<th>Web Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Youth Sports Coaches Association</td>
<td><a href="http://www.nays.org">www.nays.org</a></td>
</tr>
<tr>
<td>American Sports Education Program</td>
<td><a href="http://www.asep.com">www.asep.com</a></td>
</tr>
<tr>
<td>National Center for Sports Safety</td>
<td><a href="http://www.sportssafety.org/prepare">www.sportssafety.org/prepare</a></td>
</tr>
<tr>
<td>American Red Cross</td>
<td><a href="http://www.redcross.org">www.redcross.org</a></td>
</tr>
<tr>
<td>National Federation of State High School Associations</td>
<td><a href="http://www.nfhslearn.com">www.nfhslearn.com</a></td>
</tr>
</tbody>
</table>

(Valovich McLeod, JAT 2011)
Sport Alterations

• Limit total volume of physical activity \(EC=A\) (Lyman, 2001, 2002; Olsen 2006; Loud, 2005)
• Young pitchers avoid curves & sliders \(EC=A\) (Lyman, 2002)
• Pitching limits \(EC=A\)
  – 9-14 y/o = 75/game and 600/season (Olsen, 2006)
  – HS = 90/game (Andrews, 1996)

Sport Alterations

• 16-20 hours/week of vigorous physical activity \(EC=A\) (Loud, 2005)
• Only play one overhead throwing sport at a time \(EC=C\) (Cassas, 2006; Benjamin 2005; Carson, 1998)
• Avoid playing the same sport year round \(EC=C\) (Cassas, 2006; Benjamin 2005; Carson, 1998)
Throwing

- Avoid pitching with arm fatigue
- Avoid pitching with arm pain
- Avoid pitching too much – future research needed, but the following general limits are:
  - Avoid pitching more than 80 pitches per game
  - Avoid competitive pitching more than 8 months of the year
  - Avoid pitching more than 2500 pitches in competition per year

Olsen et al, 2006

Throwing

- Monitor pitchers with the following characteristics closely for injury
  - Those who regularly use anti-inflammatories to “prevent” injuries
  - Regularly starting pitchers
  - Pitchers who throw >85mph
  - Taller and heavier pitchers
  - Pitchers who warm up excessively
  - Pitchers who participate in showcases

Olsen et al, 2006
Throwing

• 10-year prospective study
  – 9-14 years of age
  – Interviewed annually
• 5% cumulative injury rate
• Pitch >100 innings per year were 3.5x more likely to be injured
• Pitchers who also played catcher had a trend towards increased risk of injury

Fleisig, AJSM, 2011

Throwing

• High school baseball players account for 13% of patients undergoing UCL reconstruction (Petty, 2004)
• Survey of healthy youth baseball players (Makhni, 2014)
  – 26.6% report prior injury to arm
  – 11% reported playing with pain
  – 44% had arm fatigue sometimes, often or always
  – 53% felt arm pain limited how hard they could throw sometimes, often or always
## MLB Pitch Smart

<table>
<thead>
<tr>
<th>AGE</th>
<th>DAILY MAX (PITCHES IN GAME)</th>
<th>REQUIRED REST (PITCHES)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 Days</td>
</tr>
<tr>
<td>7-8</td>
<td>50</td>
<td>1-20</td>
</tr>
<tr>
<td>9-10</td>
<td>75</td>
<td>1-20</td>
</tr>
<tr>
<td>11-12</td>
<td>85</td>
<td>1-20</td>
</tr>
<tr>
<td>13-14</td>
<td>95</td>
<td>1-20</td>
</tr>
<tr>
<td>15-16</td>
<td>95</td>
<td>1-30</td>
</tr>
<tr>
<td>17-18</td>
<td>105</td>
<td>1-30</td>
</tr>
<tr>
<td>19-22</td>
<td>120</td>
<td>1-30</td>
</tr>
</tbody>
</table>

## Swimming

<table>
<thead>
<tr>
<th>Level</th>
<th>Category</th>
<th>Skill Objective</th>
<th>Training Objective</th>
<th>Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sport Preparation (6-9 yrs)</td>
<td>Stroke Technique, All four strokes</td>
<td>Aerobic development, Joy of participation</td>
<td>2-3 sessions per week, 30-60 minutes</td>
</tr>
<tr>
<td>2</td>
<td>Basic Skill Development (6-11 yrs)</td>
<td>Teaching fundamentals, Technique, Balance and coordination in the water, All strokes, all events, Develop athleticism</td>
<td>Continued progressive aerobic development, Emphasis on kicking, Swim practice skills, Self-management and independence</td>
<td>2-4 sessions per week, 30-60 minutes, Encourage other activities/sports, Intra-squad competition or low-pressure competition</td>
</tr>
<tr>
<td>3</td>
<td>Basic Training Development (11-14 yrs)</td>
<td>Strong foundation in all four strokes, No specialization, Stretching, calisthenics, own body weight exercise, Develop athleticism</td>
<td>Aerobic endurance, Maintain good technique on low intensity interval work, Focus preparation on 200 IM and 200/500 free, Kicking emphasis, Learn to compete</td>
<td>4-6 sessions per week, 60-90 minutes, Year round participation, Encourage other activities/sports while understanding need to meet attendance expectations</td>
</tr>
</tbody>
</table>

---

## Swimming

<table>
<thead>
<tr>
<th>Level</th>
<th>Category</th>
<th>Skill Objective</th>
<th>Training Objective</th>
<th>Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Progressive Training (13-18 yrs)</td>
<td>Maintain and refine technique, Core body conditioning, Additional dryland such as medicine balls, free weights</td>
<td>Focus switches to training rather than fundamentals, Aerobic/Increased yardage, Introduction to anaerobic threshold work and speed development, Focus on 400 IM and mid-distance freestyle</td>
<td>6-10 sessions per week, 90-120 minutes, Year round including LC competition, Consent to swimming, Shorter breaks to minimize deterioration of aerobic base</td>
</tr>
<tr>
<td>5</td>
<td>Advanced Training (14 and over)</td>
<td>Attention to detail, Efficiency, Technical precision, Strength training</td>
<td>Distance based physiological training, All energy systems with heavy aerobic emphasis, Specificity of training for stroke and distance, Still train for and compete in wide variety of events</td>
<td>8-10 sessions per week, 90-120 minutes, Year round, High commitment level, Short breaks to minimize deterioration of aerobic base</td>
</tr>
</tbody>
</table>
Training and Conditioning

• Preventative program $EC=A$ (Emery, 2005; Junge, 2002; Olsen, 2005)
  – NM control, balance, coordination, flexibility, strengthening
  – Especially those with history of LE injury

• General fitness program $EC=C$ (ACSM, 1993; DiFiori, 2002; Flynn, 2002; Faignebaum, 2000)

• 1-2 days off per week $EC=C$ (Mountjoy, 2008; Brenner, 2007)

• 10% rule $EC=C$ (ACSM, 1993; Brenner, 2007)

Prevention Programs

• 19% of injuries were overuse injuries to the knee

• Significant ↓ in players injured in the intervention group compared to controls for overall injuries, lower limb injuries, as well as acute knee and ankle injuries

<table>
<thead>
<tr>
<th></th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior leg pain</td>
<td>5 (27.8%)</td>
<td>20 (51.3%)</td>
</tr>
<tr>
<td>Knee pain</td>
<td>5 (27.8%)</td>
<td>6 (15.4%)</td>
</tr>
<tr>
<td>Low back pain</td>
<td>3 (16.7%)</td>
<td>5 (13.8%)</td>
</tr>
</tbody>
</table>

(Continued)
Prevention Programs

• Soccer injuries in youth
  – 37% were overuse

• Total injuries (per player per year)
  – Intervention = 0.76 (±0.89) *sig lower than control (p<.01),
  – Control = 1.18 (±1.04)

• Overuse injuries –
  – Intervention = 0.26 (±0.48) *sig lower than control (p<.05),
  – Control = 0.44 (±0.65)

(Junge et al, 2002)

Early Specialization vs. Sports Sampling

10,000 hours of "deliberate practice" are needed to become world-class in any field
Early Specialization vs. Sports Sampling

Typical Aspects of Early Sports Specialization

- Highly structured, emphasis on physical development
- Minimal rest or time off
- May involve exclusion of other sports
- May be initiated by adults
- High volume, intensity, duration of training
- Goal of obtaining state or national status
- May involve exclusion of other sports
- Initiative by adults

Ohio State Recruits by Urban Meyer

Multi-sport in high school

Only play football?

#WinUs
Going Pro?

TABLE 2. Estimated percentages of athletes moving from high school to college, high school to professional, and college to professional in several sports in the United States.*

<table>
<thead>
<tr>
<th></th>
<th>Basketball</th>
<th>Football</th>
<th>Baseball</th>
<th>Ice Hockey</th>
<th>Soccer</th>
<th>Women's Basketball</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men's Sports</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school athletes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>549,500</td>
<td>983,600</td>
<td>495,300</td>
<td>29,900</td>
<td>321,400</td>
<td>456,900</td>
</tr>
<tr>
<td>Seniors</td>
<td>151,000</td>
<td>246,000</td>
<td>124,000</td>
<td>19,000</td>
<td>197,800</td>
<td>212,900</td>
</tr>
<tr>
<td>College freshman athletes</td>
<td>690</td>
<td>16,200</td>
<td>7,000</td>
<td>1,000</td>
<td>2,020</td>
<td>4,000</td>
</tr>
<tr>
<td>High school to college, %</td>
<td>9.8</td>
<td>5.6</td>
<td>12.8</td>
<td>5.7</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>College athletes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15,200</td>
<td>56,500</td>
<td>25,200</td>
<td>3,200</td>
<td>19,200</td>
<td>14,400</td>
</tr>
<tr>
<td>Seniors</td>
<td>3,500</td>
<td>12,600</td>
<td>5,300</td>
<td>800</td>
<td>4,100</td>
<td>3,200</td>
</tr>
<tr>
<td>Athletes divided</td>
<td>44</td>
<td>250</td>
<td>600</td>
<td>35</td>
<td>86</td>
<td>32</td>
</tr>
<tr>
<td>College to professional, %</td>
<td>1.4</td>
<td>2.0</td>
<td>10.5</td>
<td>4.1</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>High school to professional, %</td>
<td>0.03</td>
<td>0.09</td>
<td>0.46</td>
<td>0.39</td>
<td>0.08</td>
<td>0.02</td>
</tr>
</tbody>
</table>

*Adapted from the National Collegiate Athletic Association (NCAA), percentages are based on estimated data and thus are approximations. Estimates for the professional level are based on athletes divided; there is no guarantee that they qualified for the playing season.

TABLE 1. Evidence Regarding Early Sport Specialization to Achieve Elite Status*

<table>
<thead>
<tr>
<th>Study</th>
<th>Sport</th>
<th>Athletes</th>
<th>Study Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chornetova and</td>
<td>Swimming</td>
<td>Elite Russian</td>
<td>Swimmers who specialized before 13 years of age spent less time on a national team and retired earlier than late specializers.</td>
</tr>
<tr>
<td>Valiashkovski</td>
<td></td>
<td>swimmers</td>
<td></td>
</tr>
<tr>
<td>Carlsson</td>
<td>Tennis</td>
<td>10 elite, 18 near-elite</td>
<td>Elite players began intense training and specialized later than near-elites (after 13 years vs 11 years).</td>
</tr>
<tr>
<td>Lidor and Lavyan</td>
<td>Multiple sports</td>
<td>63 elite, 78 near-elite</td>
<td>Elite athletes were more likely than near-elites to begin intense training after age 12 and were more likely to have played more than 1 sport in their developmental years.</td>
</tr>
<tr>
<td>Meush et al</td>
<td>Multiple sports</td>
<td>146 elite, 95 near-elite</td>
<td>Elite athletes began intense training at a later age vs near-elites. Near-elites have more hours of training at a young age (0-15 years).</td>
</tr>
<tr>
<td>Gullich and Enrich</td>
<td>Olympic sports</td>
<td>1558 German athletes, elite and near-elite</td>
<td>Elite athletes began intense training and competition in their sport later than did near-elites. More elites participated in more than 1 sport from age 11 years than did near-elites.</td>
</tr>
</tbody>
</table>
Against Early Specialization

- Avoid overuse injury
- Allow proper rest
- Cross sport skill development
- Maintain interest in sport
- Prevent social isolation
- Prevent burnout
- Prevent overdependence

For Early Specialization

- Gain competitive edge
- Develop and hone skills faster
- Early talent recognition
- Increase opportunity for scholarships or professional contracts

Ferguson, 2014

Specialization

- Potential risks
  - Social isolation
  - Burnout
  - Overdependence
  - Manipulation
  - Injury
  - Compromised growth and maturation

Malina, CSMR, 2010
Specialization Among D1 Athletes

• Specialization increased throughout high school
  – No differences between sexes
  – Football tended to be more highly specialized

• Reasons for specialization
  – Enjoyed the one sport the most
  – Opportunity to earn scholarship
  – Being the best at that one sport

Specialization & Injury Theory

• Growing physeal cartilage has decreased strength
  – Demands of growth exceed blood supply to region

• Apophysis is structurally weakest part of joint before ossification
  – More prone to injury with excessive force
## Specialization & Injury Risk

### Table 1: Degree of sports specialization and risk of all-cause injuries

<table>
<thead>
<tr>
<th>Degree of Specialization</th>
<th>Risk of Injury</th>
<th>Risk of Serious Overuse Injury</th>
<th>Risk of Acute Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low specialization (0 or 1 of the following): Year-round training (&gt;8 months per year) Chooses a single main sport Quit all sports to focus on 1 sport</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Moderately specialized (2 of the following): Year-round training (&gt;8 months per year) Chooses a single main sport Quit all sports to focus on 1 sport</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Highly specialized (3/3 of the following): Year round training (&gt;8 months per year) Chooses a single main sport Quit all sports to focus on 1 sport</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

*Reproduced with permission from Jayanthi et al.*

### Specialization & Injury Risk

![Odds Ratio vs Exposure Hours Per Week Graph](image)

**Figure 1.** Relationship of injury to exposure hours in high school athletes.  

Meyer, 2015 65

Meyer, 2015 66
Specialization & Injury Risk

• **Single-sport athletes** (Hall, 2015)
  – 4x greater risk of Osgood Schlatter, SLJ, patellar tendinopathy
  – 1.5x greater risk of PFPS

• **Sports-specialized training** (Jayanthi, 2015)
  – Independent risk for injury (odds ratio [OR], 1.27; 95% CI, 1.07-1.52; P<.01)
  – Serious overuse injury (OR, 1.36; 95% CI, 1.08-1.72; P<.01)

---

Specialization & Injury Risk

• ↑ risk of injury and serious overuse injury among young athletes who specialize in 1 sport
  – Independent of training volume and age

• Risk of injury, overuse injury, and serious overuse injury
  – Increases as the degree of specialization increases
Table 1. Seven postulates associated with the Developmental Model of Sport Participation*

<table>
<thead>
<tr>
<th>Postulate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Early diversification (sampling) does not hinder elite sport participation in sports where peak performance is reached after maturation.</td>
</tr>
<tr>
<td>2</td>
<td>Early diversification (sampling) is linked to a longer sport career and has positive implications for long-term sport involvement.</td>
</tr>
<tr>
<td>3</td>
<td>Early diversification (sampling) allows participation in a range of contexts that most favorably affects positive youth development.</td>
</tr>
<tr>
<td>4</td>
<td>High amounts of deliberate play during the sampling years build a solid foundation of intrinsic motivation through involvement in activities that are enjoyable and promote intrinsic regulation.</td>
</tr>
<tr>
<td>5</td>
<td>A high amount of deliberate play during the sampling years establishes a range of motor and cognitive experiences that children can ultimately bring to their principal sport of interest.</td>
</tr>
<tr>
<td>6</td>
<td>Around the end of primary school (around age 13 years), children should have the opportunity to either choose to specialize in their favorite sport or to continue in sport at a recreational level.</td>
</tr>
<tr>
<td>7</td>
<td>Late adolescents (around age 16 years) have developed the physical, cognitive, social, emotional, and motor skills needed to invest their effort into highly specialized training in 1 sport.</td>
</tr>
</tbody>
</table>

*Reproduced with permission from O’Malley et al.²³

---

Table 2. Recommendations for stage of specialization and sport*

<table>
<thead>
<tr>
<th>Type of Sport</th>
<th>Recommended Stage of Specialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gymnastics, diving, figure skating</td>
<td>Early adolescence</td>
</tr>
<tr>
<td>Team sports, tennis, golf</td>
<td>Middle adolescence</td>
</tr>
<tr>
<td>Endurance sports, track, distance events</td>
<td>Late adolescence</td>
</tr>
</tbody>
</table>

*Adapted from Jayanthi et al.²⁷
Specialization and Injury

• SR of association between specialization and injury
• 3 studies included (Hall, 2015; Jayanthi, 2015; Jayanthi 2011)
  – 2 studies reported a statistical effect of early specialization on development of overuse injury
  – 1 study reported association of specialization in tennis with injury that resulted in withdrawal
• SOR=B that early specialization is associated with injury
  Fabricant, 2016

Delayed Specialization

• Encourage multiple sports and activities
  $EC=C$ (ACSM, 1993; FIMS, 1998)
• Discourage specialization <10 years old
  $EC=C$ (ACSM, 1993; FIMS, 1998)
• Time off $EC=C$ (Brenner, 2007)
Organizations Against Early Sports Specialization

- National Athletic Trainers’ Association
- American Medical Society for Sports Medicine
- American Academy of Pediatrics
- International Society for Sports Psychology
- World Health Organization
- International Federation of Sports Medicine
- National Association for Sports and Physical Education

Ferguson, 2014 73

Management of Common Overuse Injuries

74
Osgood Schlatter Disease

- Most often seen in 10-15 y/o males
- Repetitive microtrauma resulting in a traction apophysitis of the tibia tuberosity
  - May have associated distal patellar tendonitis
- Sports with jumping, squatting, kicking
- Conservative treatment
  - Ice, analgesic, NSAID, avoidance of exacerbating activities

Chang, 2013
Sinding-Larsen-Johansson

- Secondary to microtrauma from chronic repetitive traction of the proximal attachment of the inferior pole of the patella
- Conservative treatment
  - Rest, knee extensor mechanism training

Chang, 2013

Patellofemoral Pain

- Frequent complaint among adolescent females
- Insidious onset of anterior knee pain exacerbated by activity, including, jumping, stairs, and prolonged sitting
- Conservative treatment
  - Rehabilitation, hip strengthening,
Medial Tibial Stress Syndrome

- Focal tenderness in the middle to distal tibia
- Most often in distance runners
- More prevalent in females
- Non-operative treatment
  - Reduction in running and other activity restrictions
  - Gait / movement evaluation and correction

Little League Shoulder

- Overuse injury to the proximal humeral physis of the throwing arm of skeletally immature youth
- Chronic repetitive microtraumatic shear, torque or traction on the unossified cartilage
- Occurring with increasing frequency (Heyworth, 2016)
  - Greater number of youths participating and starting at a younger age
  - Most common age affected = 13
  - Treatment of rest (average 4.2 months), activity modification and physical therapy
**Little League Elbow**

- Apophysitis of medial epicondyle
- Can present with fracture or avulsion in same area
- Highest incidence among 9-10 years
- In absence of fracture, often treated non-operatively with cessation of throwing for 4-6 weeks
- RTP with supervised gradual throwing programs average 12 weeks after non-op and 7-8 months after operative

---

**Lateral Elbow Conditions**

- **Panner’s Disease**
  - Most common cause of lateral elbow pain in patents younger than 10
  - Benign, self-limiting condition
  - Vague, generalized pain
- **OCD**
  - More common in adolescents
  - Compression injury associated with throwing
  - Associated with pain, decreased ROM, and mechanical symptoms
## Differential for Panner’s and OCD

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Panner’s disease</th>
<th>OCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral elbow pain</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Throwing activity</td>
<td>Nearly always</td>
<td>Usually</td>
</tr>
<tr>
<td>Age (y)</td>
<td>7-12</td>
<td>13-16</td>
</tr>
<tr>
<td>Locking, catching</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Loss of extension</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>X-ray appearance</td>
<td>Entire capitellum fragment, lytic, irregular</td>
<td>Island of bone demarcated from capitellum</td>
</tr>
<tr>
<td>Treatment</td>
<td>Non-operative</td>
<td>May require surgery</td>
</tr>
<tr>
<td>Prognosis</td>
<td>Good</td>
<td>Guarded – may have loss of function</td>
</tr>
</tbody>
</table>

### Case Scenario
Case Presentation

- 16 year old elite baseball pitcher
- Grew up in Dominican Republic
- Began baseball at age 5
- Played year round baseball
- 2-3 times per week, mainly structured practice
- Significant pitching role
  - No pitch counts or limits

Ferguson & Stern, 2014

Case Presentation

- Moved to Canada at age 10
- Summer league only
  - Reduced volume of pitching
- Noticed intermittent pain
  - Low back and left hip
- Played through pain

Ferguson & Stern, 2014
Case Presentation

- Joined travel team at age 14
- High intensity throwing programs in off season
- Baseball 10+ months / year
- Noticed medial elbow pain
  - Continued with training
- In playoffs medial elbow pain increased to where he could not throw
- Sought medical care and rested several months

Case Presentation

- Beginning of next season pain had decreased
- Noted not feeling up to full potential
- Began to feel onset of gradual shoulder pain
- Continued to pitch but reported throwing his shoulder out during a tournament
- Diagnosed with Type II SLAP lesion
Case Presentation

- Current Complaints
  - Right shoulder pain
  - Right elbow pain
  - Left hip pain
  - Low back pain

Summary of the State of Evidence Regarding Overuse Injuries

Ferguson & Stern, 2014
Evidence for Prevention

EC=A
- Sport alterations
- LE prevention programs

EC=B
- Risk factor identification
- Education/Supervision

EC=C
- Delayed specialization (now B)
- Injury surveillance
- PPE

Valovich McLeod, JAT 2011

Evidence for Prevention

EC=B
- Limiting participation time
- Monitoring of training workload
- Pre-season conditioning programs
- Neuromuscular training programs

EC=C
- Proper sizing of equipment
- Emphasis on skill development rather than competition
- Individual modifications to participation time

DiFiori, CJSJM, 2013
Summary Findings

EC=A
- All overuse injuries are not benign
- History of injury is risk factor

EC=B
- Underreported in the literature
- Adolescent females should be assessed for menstrual dysfunction

EC=C
- PPE
- Parent and coach education for sport readiness
- Sport specialization (Now B)
- Address underlying causes of overuse injuries

DiFiori, CJSM, 2013
Thank You

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Athletic Training Practice-Based Research Network
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@TamaraCVMcLeod

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| TABLE 3. Adjusted Odds Ratios, 95% CIs, and P-values from Logistic Regressions Predicting Injury Type (Reference = Traumatic) by Sex |
|---|---|---|---|---|---|---|---|
| | Males | | | Females | | | |
| | Odds Ratio | 95% CI | P | Odds Ratio | 95% CI | P |
| Background characteristics | | | | | | | |
| Age, y | 1.098 | 1.022-1.180 | 0.011 | 1.037 | 0.973-1.107 | 0.261 |
| BMI at onset | 0.856 | 0.727-1.009 | 0.063 | 0.818 | 0.776-1.004 | 0.315 |
| History of chronic injury | 1.119 | 0.751-1.665 | 0.581 | 1.408 | 1.039-1.926 | 0.032 |
| Activity characteristics | | | | | | | |
| Participates in at least 1 | | | | | | | |
| Team sport | 5.329 | 3.026-9.303 | 0.000 | 1.277 | 0.624-2.215 | 0.226 |
| Contact/collision sport | 0.458 | 0.335-0.741 | 0.001 | 1.001 | 0.639-1.567 | 0.999 |
| Total no. sports | 1.069 | 0.945-1.206 | 0.280 | 1.132 | 1.005-1.274 | 0.040 |
| High-impact sport | 10.310 | 4.429-24.090 | 0.000 | 3.041 | 2.303-5.738 | 0.000 |
| Constant | 0.0560 | 0.017-0.194 | 0.000 | 0.0374 | 0.013-0.107 | 0.000 |
| N | 741 | 871 |
| Log likelihood | 75.81 | 72.28 |
| Pseudo R2 | 0.076 | 0.063 |

CI, confidence interval.

Stracciolini, CJSM, 2015
in that sport are key. An excellent resource from Canada Sport for Life highlights the appropriate training habits of Canadian youth. It is called the Long Term Athlete Development (LTAD) model. This model is based off six stages of athletic development:

1. FUNdamental stage
2. Learning to train
3. Training to train
4. Training to compete
5. Training to win
6. Retirement/retainment

The focus of the early stages of the model is encouraging activity in many sports in a fun and engaging manner. While the later stages focus on sport specific skills, intense training and high level competition. The stages

Russell 2013