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>
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

Onate, CJSM, 2015
## Suggested Assessment for Runners

### Intrinsic
- Standing Q angle
- BMI
- Navicular Drop
- Hip abduction, extension and ER strength
- Menstrual cycle

### Extrinsic
- Preseason activity level
- Modify training volumes
- Early and continued participation in ball sports with 360° playing field

Paterno, 2013
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.sportssafetly.org/prepare">www.sportssafetly.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
  \textit{EC=A} (Loud, 2005)

- Only play one overhead throwing sport at a time
  \textit{EC=C} (Cassas, 2006; Benjamin 2005; Carson, 1998)

- Avoid playing the same sport year round \textit{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>

http://m.mlb.com/pitchsmart/pitching-guidelines/
Throw Like a Pro: Throw Faster, Stronger, and Safer with Dr. James Andrews and Dr. Kevin Wilk

Abracadabra Health

$9.99 Buy

This app is designed for both iPhone and iPad

Rating: 4+

LINKS
Developer Website

© Abracadabra Health, LLC
### 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&lt;br&gt;• All four strokes</td>
<td>• Aerobic development&lt;br&gt;• Joy of participation</td>
<td>• 2-3 sessions per week&lt;br&gt;• 30-60 minutes</td>
</tr>
<tr>
<td>2</td>
<td>Basic Skill Development (8-11 yrs)</td>
<td>• Teaching fundamentals&lt;br&gt;• Technique&lt;br&gt;• Balance and coordination in the water&lt;br&gt;• All strokes, all events&lt;br&gt;• Develop athleticism</td>
<td>• Continued progressive aerobic development&lt;br&gt;• Emphasis on kicking&lt;br&gt;• Swim practice skills&lt;br&gt;• Self-management and independence</td>
<td>• 2-4 sessions per week&lt;br&gt;• 30-60 minutes&lt;br&gt;• Encourage other activities/sports&lt;br&gt;• 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&lt;br&gt;• No specialization&lt;br&gt;• Stretching, calisthenics, own body weight exercise&lt;br&gt;• Develop athleticism</td>
<td>• Aerobic endurance&lt;br&gt;• Maintain good technique on low intensity interval work&lt;br&gt;• Focus preparation on 200 IM and 200/500 free&lt;br&gt;• Kicking emphasis&lt;br&gt;• Learn to compete</td>
<td>• 4-6 sessions per week&lt;br&gt;• 60-90 minutes&lt;br&gt;• Year round participation&lt;br&gt;• 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>
</table>
| 4     | Progressive Training (13-18 yrs)| - Maintain and refine technique  
- Core body conditioning  
- Additional dryland such as medicine balls, free weights | - 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 | - 6-10 sessions per week  
- 90-120 minutes  
- Year round including LC competition  
- Commit to swimming  
- Shorter breaks to minimize deterioration of aerobic base |
| 5     | Advanced Training (14 and over) | - Attention to detail  
- Efficiency  
- Technical precision  
- Strength training | - 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 | - 8-10 sessions per week  
- 90-120 minutes  
- Year round  
- High commitment level  
- Short breaks to minimize deterioration of aerobic base |
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>Condition</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>
Prevention Programs

• Soccer injuries in youth
  – 37% were overuse

• Total injuries (per player per year)
  – Intervention = .76 (±.89) *sig lower than control (p<.01),
  – Control = 1.18 (±1.04)

• Overuse injuries –
  – Intervention = .26 (±.48) *sig lower than control (p<.05),
  – Control = 0.44 (±.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

Ohio State Recruits by Urban Meyer

- Multi-Sport in High School: 42
- Football Only in High School: 5

Only Play Football? #WWUS
Typical Aspects of Early Sports Specialization

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

<table>
<thead>
<tr>
<th>Men’s Sports</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>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>455,300</td>
<td>29,900</td>
<td>321,400</td>
<td>456,900</td>
</tr>
<tr>
<td>Seniors</td>
<td>157,000</td>
<td>281,000</td>
<td>130,100</td>
<td>8500</td>
<td>91,800</td>
<td>130,500</td>
</tr>
<tr>
<td>College freshman athletes</td>
<td>4500</td>
<td>16,200</td>
<td>7300</td>
<td>1100</td>
<td>5200</td>
<td>4100</td>
</tr>
<tr>
<td>High school to college, %</td>
<td>2.9</td>
<td>5.8</td>
<td>5.6</td>
<td>12.9</td>
<td>5.7</td>
<td>3.1</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>15,700</td>
<td>56,500</td>
<td>25,700</td>
<td>3700</td>
<td>18,200</td>
<td>14,400</td>
</tr>
<tr>
<td>Seniors</td>
<td>3500</td>
<td>12,600</td>
<td>5700</td>
<td>800</td>
<td>4100</td>
<td>3200</td>
</tr>
<tr>
<td>Athletes drafted</td>
<td>44</td>
<td>250</td>
<td>600</td>
<td>33</td>
<td>76</td>
<td>32</td>
</tr>
<tr>
<td>College to professional, %</td>
<td>1.3</td>
<td>2.0</td>
<td>10.5</td>
<td>4.1</td>
<td>1.9</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>

aAdapted from the National Collegiate Athletic Association (47), percentages are based on estimated data and thus are approximations. Estimates for the professional level are based on athletes drafted; there is no guarantee that they qualified for the playing roster.
<table>
<thead>
<tr>
<th>Study</th>
<th>Sport</th>
<th>Athletes</th>
<th>Study Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barynina and Vaitsekhovskiï⁵</td>
<td>Swimming</td>
<td>Elite Russian swimmers</td>
<td>Swimmers who specialized before 11 years of age spent less time on a national team and retired earlier than late specializers.</td>
</tr>
<tr>
<td>Carlson⁹</td>
<td>Tennis</td>
<td>10 elite, 10 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 Lavyan³⁰</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>Moesch et al³⁸</td>
<td>Multiple sports</td>
<td>148 elite, 95 near elite</td>
<td>Elite athletes began intense training at a later age vs near-elites. Near-elites has more hours of training at a young age (9-15 years).</td>
</tr>
<tr>
<td>Gullich and Emrich²⁰</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 & Injury Risk

Table 1. Degree of sports specialization and risk of all-cause injuries\textsuperscript{a}

<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):</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Year-round training (&gt;8 months per year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chooses a single main sport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quit all sports to focus on 1 sport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderately specialized (2 of the following):</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Year-round training (&gt;8 months per year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chooses a single main sport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quit all sports to focus on 1 sport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly specialized (3/3 of the following):</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Year round training (&gt;8 months per year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chooses a single main sport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quit all sports to focus on 1 sport</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a}Reproduced with permission from Jayanthi et al.\textsuperscript{40}
Specialization & Injury Risk

Figure 1. Relationship of injury to exposure hours in high school athletes.\textsuperscript{41}
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

Figure 2. Degree of sports specialization by injury type and sex.
| Postulate 1 | Early diversification (sampling) does not hinder elite sport participation in sports where peak performance is reached after maturation |
| Postulate 2 | Early diversification (sampling) is linked to a longer sport career and has positive implications for long-term sport involvement |
| Postulate 3 | Early diversification (sampling) allows participation in a range of contexts that most favorably affects positive youth development |
| Postulate 4 | 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 |
| Postulate 5 | 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 |
| Postulate 6 | 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 |
| Postulate 7 | 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 |

*Reproduced with permission from Côté et al.*
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*
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
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, CJSM, 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, CJS, 2013
“Number one is just to gain a passion for running. To love the morning, to love the trail, to love the pace on the track. And if some kid gets really good at it, that’s cool too.” – Pat Tyson, award-winning high school and college cross-country coach*

“Somewhere behind the athlete you’ve become and the hours of practice and the coaches who have pushed you is a little girl who fell in love with the game and never looked back... play for her.” – Mia Hamm, member of United States women’s national soccer team*

“Before kids can play like a pro, they must enjoy playing the game like a kid.” – Steve Locker, national and international soccer player, coach, and author**
Thank You

tmcleod@atsu.edu
@TamaraCVMcLeod

www.atpbrn.org