The Female Athlete: Sport-specialized intensive training and injury risk for the adolescent female athlete

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Female sports with high specialization rates < age 12
Pasulka 2017, NCAA 2016 survey

• Gymnastics
• Figure Skating
• Dance
• Tennis
• Diving
• Soccer
• Swimming
• Cheerleading
What do they have in common?

- Individual sports
- Aesthetic
- Objective/subjective judging

➢ Early specialization is highly necessary for skill acquisition to occur prior to puberty

- Expensive $$$
# US National Team Members 2016

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laurie Hernandez</td>
<td>5 years old</td>
</tr>
<tr>
<td>Simone Biles</td>
<td>6 years old</td>
</tr>
<tr>
<td>Madison Kocian</td>
<td>6 years old</td>
</tr>
<tr>
<td>Aly Raisman</td>
<td>2 years old</td>
</tr>
<tr>
<td>Gabrielle Douglas</td>
<td>6 years old</td>
</tr>
<tr>
<td>Brenna Dowell</td>
<td>1 year old</td>
</tr>
<tr>
<td>Nia Dennis</td>
<td>7 years old</td>
</tr>
<tr>
<td>Bailie Key</td>
<td>3 years old</td>
</tr>
<tr>
<td>Alyssa Baumann</td>
<td>3 years old</td>
</tr>
<tr>
<td>Maggie Nichols</td>
<td>2 years old</td>
</tr>
<tr>
<td>Kyla Ross</td>
<td>2 years old</td>
</tr>
<tr>
<td>MyKayla Skinner</td>
<td>3 years old</td>
</tr>
<tr>
<td>Jordan Chiles</td>
<td>6 years old</td>
</tr>
<tr>
<td>Christina Desiderio</td>
<td>6 years old</td>
</tr>
<tr>
<td>Jazmyn Foberg</td>
<td>4 years old</td>
</tr>
<tr>
<td>Sydney Johnson</td>
<td>3 years old</td>
</tr>
<tr>
<td>Ragan Smith</td>
<td>3 years old</td>
</tr>
</tbody>
</table>

Average start age: **3.778**
Average age of achieving elite: **12.56**
Age Controversy Follows the Chinese Gymnasts
Sydney 2000 Olympics to Beijing 2008 Olympics
Alysa Liu becomes the youngest Women’s National Figure Skating Champion 2019 @ age 13
Developmental Framework for the Female Athlete

Critical “windows of opportunity” when female adolescents are more sensitive to specific training-induced adaptations

| CHRONOLOGICAL AGE (YEARS) | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21+ |
|---------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|
| AGE PERIODS               |   |   |   |   |   |   |   |   |   | EARLY CHILDHOOD | MIDDLE CHILDHOOD | ADOLESCENCE | ADULTHOOD |
| GROWTH RATE               |   |   |   |   |   |   |   |   |   | RAPID GROWTH ↔ STEADY GROWTH ↔ ADOLESCENT SPURT ↔ DECLINE IN GROWTH RATE |
| MATURATIONAL STATUS       |   |   |   |   |   |   |   |   |   | YEARS PRE-PHV ↔ PHV ↔ YEARS POST-PHV |
| TRAINING ADAPTATION       |   |   |   |   |   |   |   |   |   | PREDOMINANTLY NEURAL (AGE-RELATED) ↔ COMBINATION OF NEURAL AND HORMONAL (MATURITY-RELATED) |
| PHYSICAL QUALITIES        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Mobility                  | FMS | FMS | FMS |   |   |   |   |   |   | Mobility |
| Agility                   | SSS | SSS | SSS |   |   |   |   |   |   | Agility |
| Speed                     | Mobility | Mobility | Mobility |   |   |   |   |   |   | Mobility |
| Power                     | Agility | Agility | Agility |   |   |   |   |   |   | Agility |
| Strength                  | Speed | Speed | Speed |   |   |   |   |   |   | Speed |
| Hypertrophy               | Strength | Strength | Strength |   |   |   |   |   |   | Strength |
| Endurance & MC            | Hypertrophy | Hypertrophy | Hypertrophy |   |   |   |   |   |   | Hypertrophy |
| TRAINING STRUCTURE        | UNSTRUCTURED | LOW STRUCTURE | MODERATE STRUCTURE | HIGH STRUCTURE | VERY HIGH STRUCTURE |

Light pink: pre adolescent phase of adaptation

Dark pink: adolescent phase of adaptation

FMS = fundamental movement skills

MC = metabolic conditioning

PHV = peak height velocity

SSS = sport-specific skills

YPD = youth physical development
Actual Training Volume

• Gymnasts
  • Elite: 36-40 hours/week
  • Level 8-10: 20-34 hours/week

• Figure Skating
  • Junior/Elite: 20-30 hours week

• Dance
  • Pre professional, performing arts schools & competition studios: 15-20 hours
“If you want to prevent young athletes from overuse injuries, keep the weekly hours of training for a sport under their chronological ages.”

AAP, Sugimoto 2018, Post 2017, Jayanthi 2011
Does intensive exercise affect growth and maturation?

J Pediatrics 1993: **YES** ....Slower growth, delayed puberty, no distinct growth spurt and poor growth potential

J Pediatrics 2017: **NO** effect on growth and development rate of final height. It appears that genetics and natural selection to the sport have greater determination on the final height.

*Elite level or heavily involved female gymnasts may experience attenuated growth during their years of training followed by catch-up growth during reduced training schedules or the months following retirement.*
AGE of Menarche in Athletes
Vadocz 2016, Kapczuk 2017

- Non-athletes 12.5
- Ball sports 13.0
- Swimming 13.8
- Ballet/Dance 14.5
- Figure Skating 15.0
- Gymnastics 15.6
Functional Hypothalamic Amenorrhea (FHA)
Loucks 1993

Types of FHA:
1. Eating- too little
2. Stress-too much
3. Exercising-too much

*The hypothalamus releases too little GnRH in the condition known as functional hypothalamic amenorrhea (FHA).
*LEA occurs when the body has insufficient energy available to meet the needs of training and normal physiological functioning.*
Female Athlete Triad vs RED-S

1992: American College of Sports Medicine (ACSM)
“Female Athlete Triad”
Disordered eating, amenorrhea and osteoporosis

2014: IOC, ACSM, FATC (Female Athlete Committee)
embraced the more inclusive concept of RED-S
“Relative Energy Deficit-in Sport”
Describes the wide range of adverse effects on various body systems beyond the Triad
Health Effects of RED-S
Performance Effects of RED-S
Risk Factors For RED-S
relative energy deficiency – in sport

- Participating in sports that emphasize body size or appearance
- Pressure to lose weight to improve performance
- Competitive personality traits
- Lack of nonsport social or recreational outlets
- Training when injured, sick or exhausted
- Experiencing a traumatic event, injury, poor performance, change in coaching staff or other life stressors
Screening for Energy Deficits
Melin 2014, Martinsen 2015

- Low Energy Availability in Females Questionnaire (LEAF-Q)
- Brief Eating Disorder in Athletes Questionnaire (BEDA-Q)
Overuse Injuries

- Athletes with high specialization were nearly 2X likely to sustain an overuse injury compared with athletes with low specialization.

- Very common among young female athletes.

- Often go unreported in young female athletes.
Classification of Injuries
Pasulka 2017

**Acute:** a diagnosis that can be related to a single traumatic event

**Overuse:** a diagnosis that can be attributed to a gradual onset without a specific sports-related traumatic event.

**Serious overuse:** if the physician recommended treatment that typically requires at least 1 month of rest from sports.
Staging Overuse Injuries

Brenner 2007, Launay 2017

Stage 1: Pain after physical activity

Stage 2: Pain during physical activity with no impact on function

Stage 3: Pain during physical activity has an impact on performance

Stage 4: Chronic pain at rest and during all physical activities

*Mechanical pain is the main sign of overuse injuries
Gymnastics Injuries
Campbell 2019, O’Kane 2011

Most common location: Lower extremity

Most common type: SERIOUS Overuse & Acute
  • Sprains, growth plate injuries, soft tissue & bony injuries
  • Highest prevalence of stress fractures (2nd to cross country running)
  • High recurrent injury rates

Gymnasts had the highest serious injury rate across all young female athletes
Figure Skating Injuries
Hans 2018

Location: LE injuries

Most common acute injury: Ankle sprain

Most common injury type OVERUSE

• Patellar tendonitis, stress fractures
• Fatigue is a factor, there is more credit for difficulty in second half of the program
Dance Injuries
Laenderson 2011, Stracciolini 2015, Bowerman 2015

Location: LE injuries

Most common acute injury: Ankle sprain

Most common Injury Type ➔ OVERUSE
• Stress fractures
• Achilles, peroneal, FHL & posterior tibialis tendinopathy
Injury Prevention, Screening & Education
Beese 2015

Injury Prevention Programs
• The single most protective factor to prevent injury is **STRENGTH**
• Neuromuscular training may help to improve motor skills and performance while decreasing risk for injury among athletes specializing in a single sport

Screening high risk athletes
• Disordered eating
• RED-s
• Overuse injuries
• Stress

Community Outreach & Education
• Workshops for teachers, coaches & parents
• Master classes for the young athletes
Multidisciplinary Approach

- Pediatric Orthopedic
- Physical Therapist
- Athletic Trainer
- Nutritionist/dietician
- Sports Psychologist
- Adolescent Medicine
- Integrative Medicine
- Massage Therapist
- Primary Care Provider
• Young female athletes training at high volumes should be closely monitored and/or screened for health and performance deficits WHEN, not if, they show up to your office with an overuse injury.

• Meaningful healing can happen if we take the time to assess more than their lower extremity injury.
References


References


Kapczuk K, Elite athletes and pubertal delay. Minerva Pediatraca 2017 October;69(5):415-26


References


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References


