[U18]
Sports Medicine
Joe DiMaggio Children's Hospital
PERFORMING ARTS & DANCE MEDICINE

The Female Athlete:

Sport-specialized intensive training and injury risk for the adolescent female athlete

Whitney Chambers PT, DPT, SCS, OCS
U18 Sports Medicine

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

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

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

THE COST OF AN OLYMPIC ATHLETE

FIGURE SKATING

COACHING

$40,000+

PER YEAR

Many top-level skaters move their residences to be closer to their desired coach and training rink, incurring extra moving and living costs on top of the coaching fees.

CHOREOGRAPHY

$10,000

PER PROGRAM

Each competition requires multiple routines. The Olympics require two. Skaters may, however, pull from previous years of choreography.

OFF-ICE TRAINING

$2,000

PER YEAR

This includes body training like weights and cardio, and technique development like ballet and yoga.

COSTUME

$5,000

EACH

High-end designers are now in the figure skating costume design game, which requires breathable, comfortable material that won't malfunction.

TRAVEL

$10,000

PER YEAR

Many skaters must also pay for their coaches' travel to and from competitions.

SKATES

$1,500

PER PAIR

Boots and blades are customized based on the style of skating and the skater's preferences. Multiple pairs are needed.

TOTAL

$68,500

*These are averages/estimates based on information from the following sources:

http://www.bostonglobe.com/lifestyle/style/2014/01/11/the-ice-rink-becomes-runway-for-female-figure-skaters/ZfSFpCEEKGGPrwzAcvnGRN/story.html

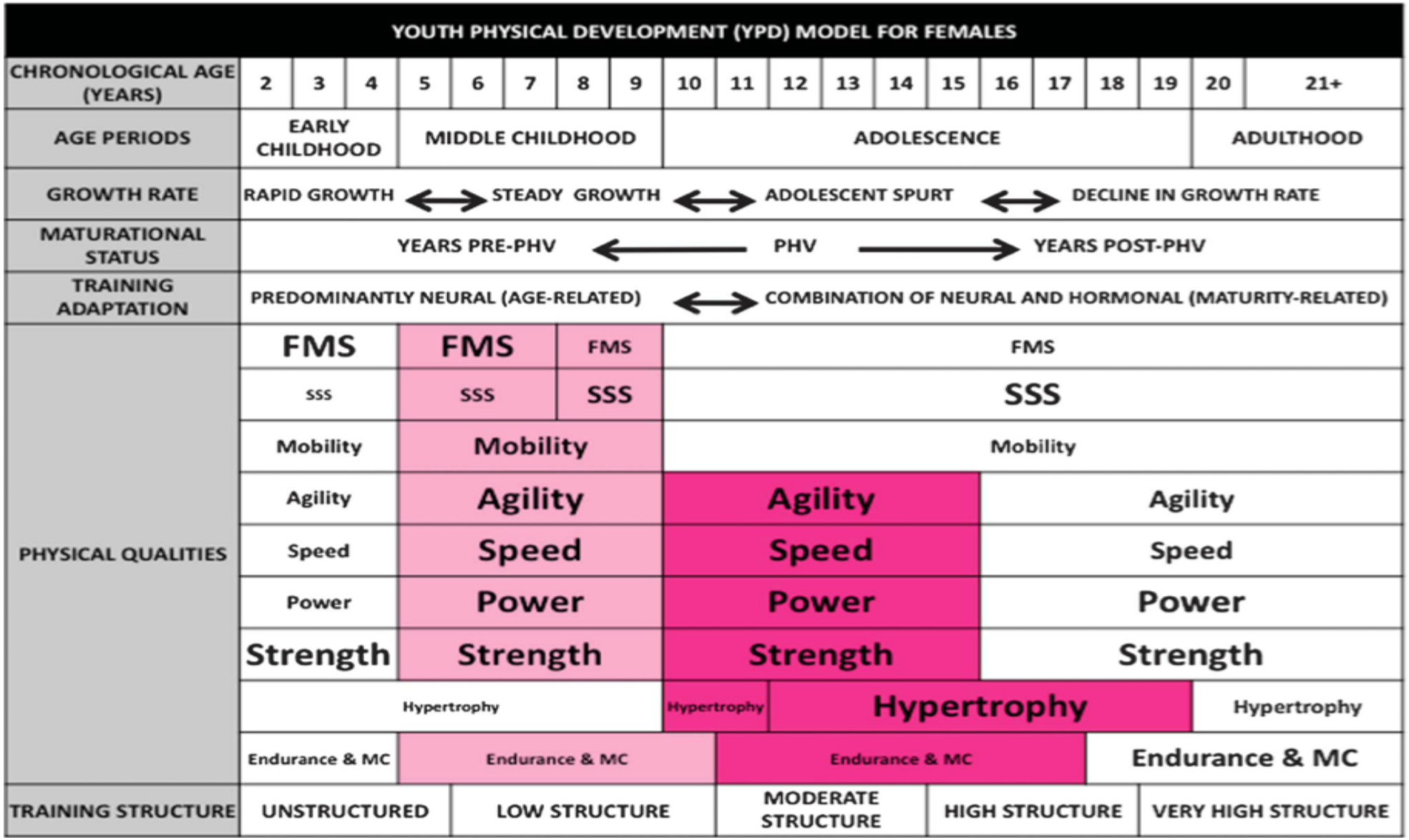
http://www.ice.riedellskates.com/CategoryList.aspx?CategoryName=Skates-and-Boots

http://www.huffingtonpost.com/2014/01/30/the-average-cost-of-train_n_4698161.html

http://www.usfsa.org/Content/parentsarticles/Parents_Oct04.pdf

Developmental Framework for the Female Athlete

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



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

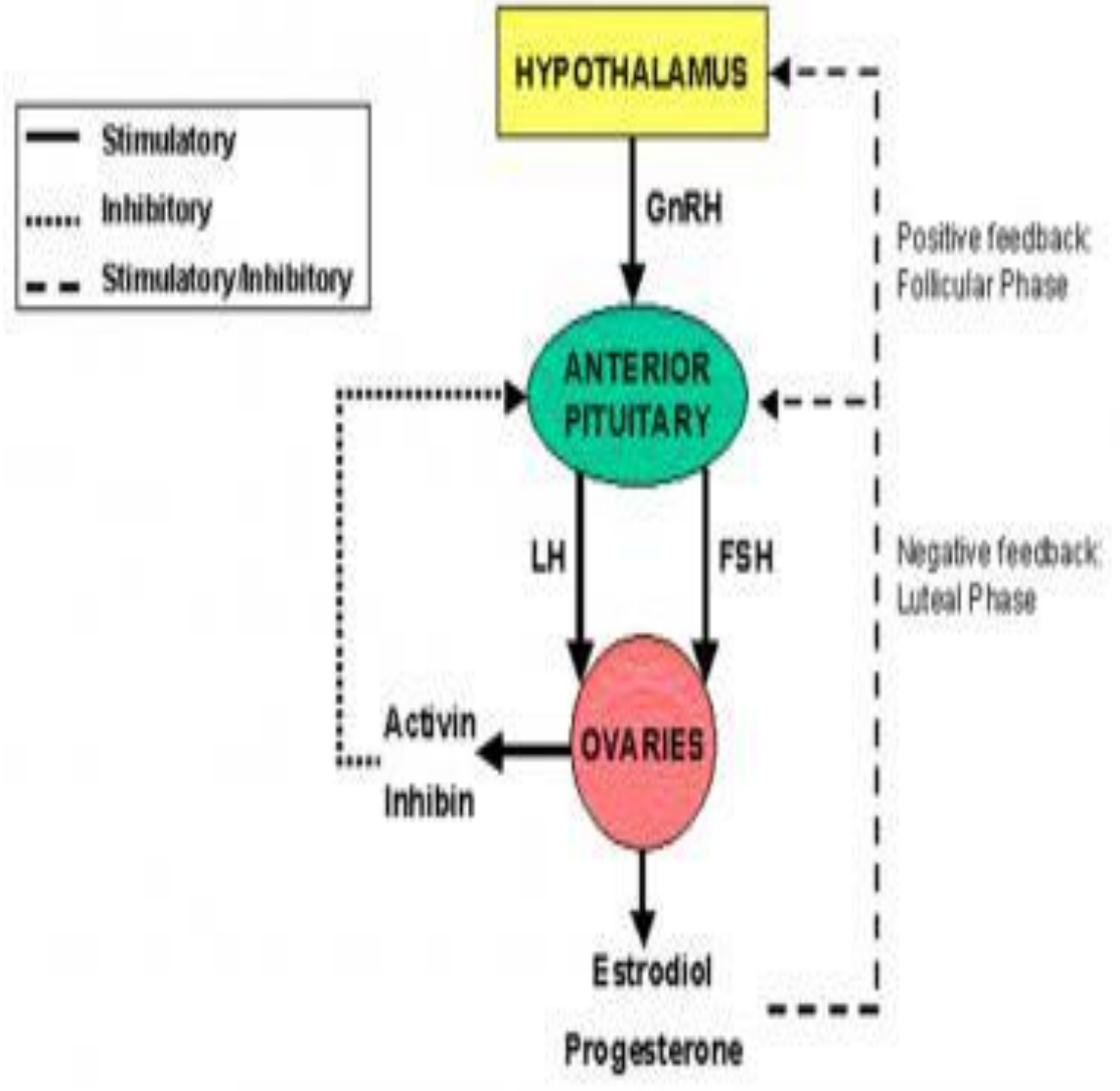
Functional Hypothalamic Amenorrhea (FHA)

Loucks 1993

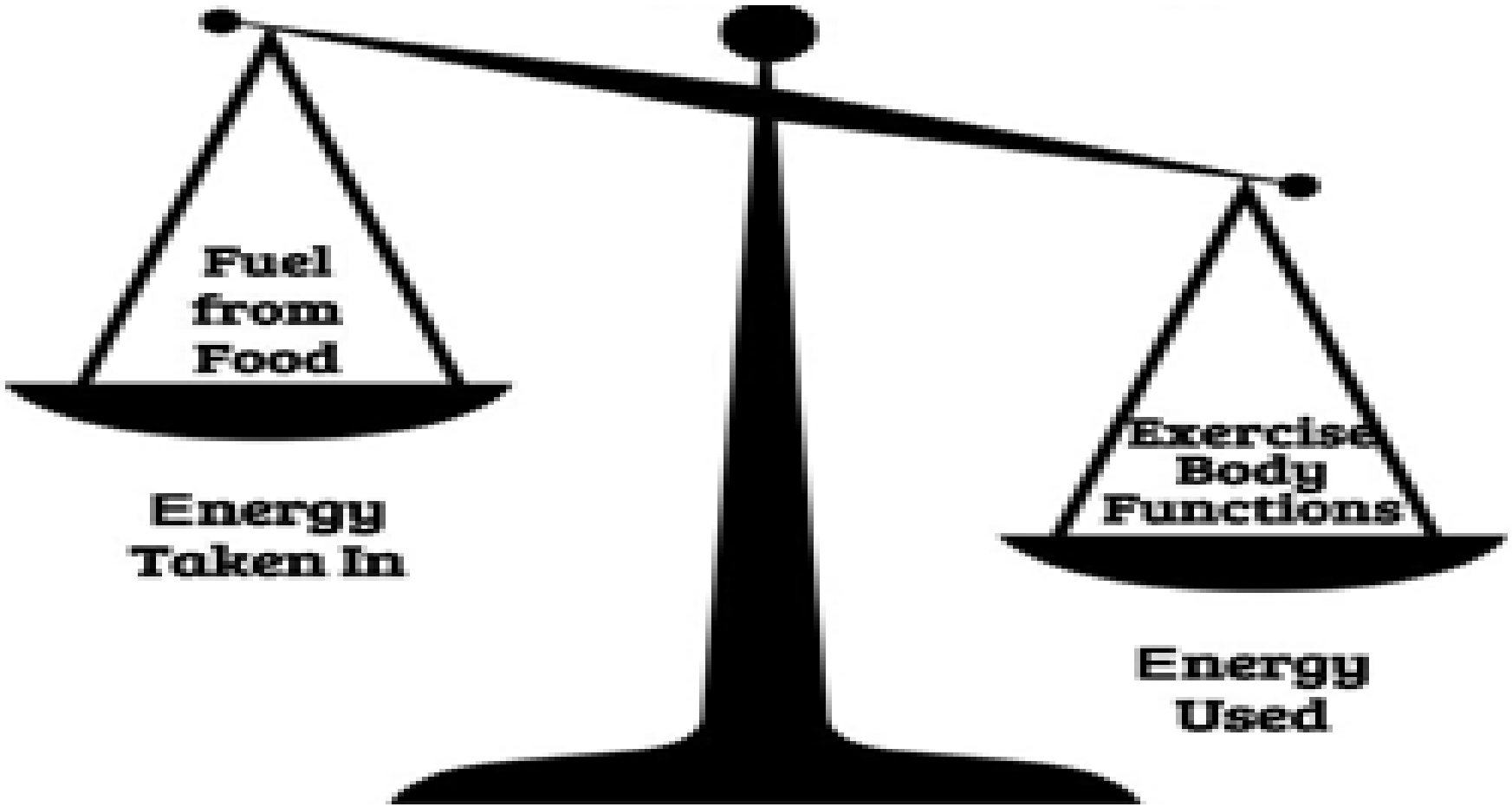
Types of FHA:

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).



Low Energy Availability (LEA) Melin 2019, Slater 2017



*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

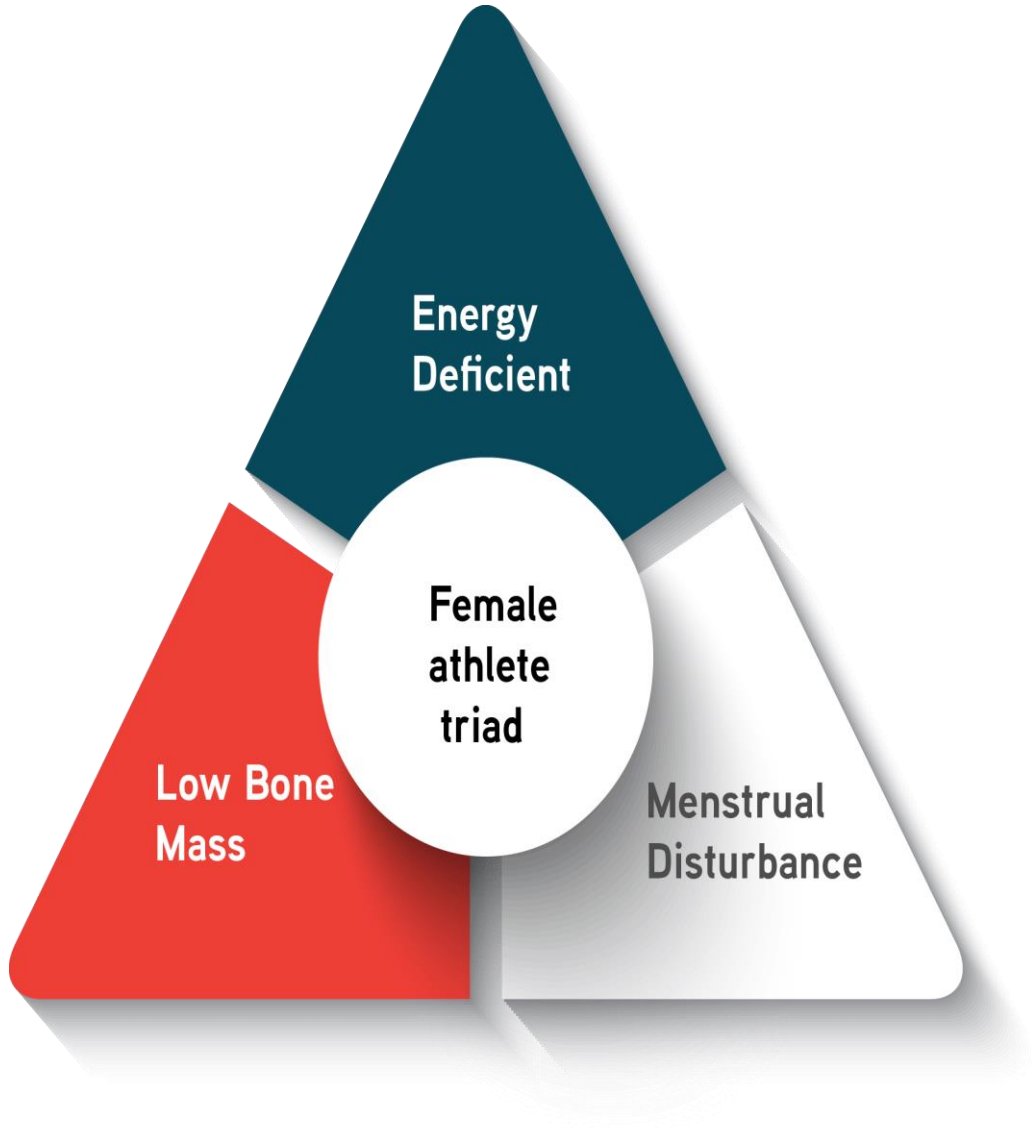
1992: American College of Sports Medicine (ACSM)
"Female Athlete Triad"

Disordered eating, amenorrhea and osteoporosis

2014: IOC, ACSM, FATC (Female Athlete Committee) embraced the more inclusive concept of RED-S

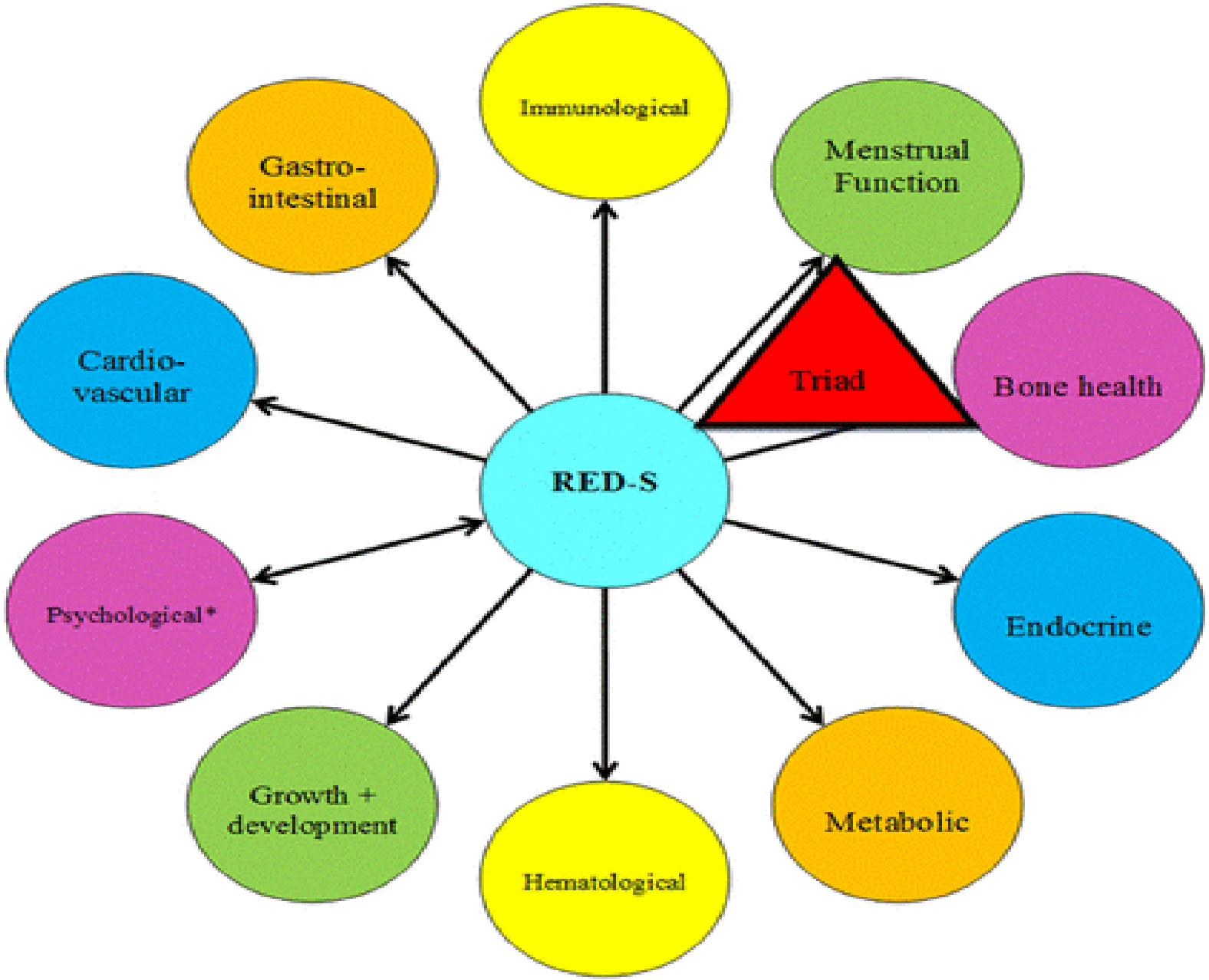
"Relative Energy Deficit-in Sport"

Describes the wide range of adverse effects on various body systems beyond the Triad



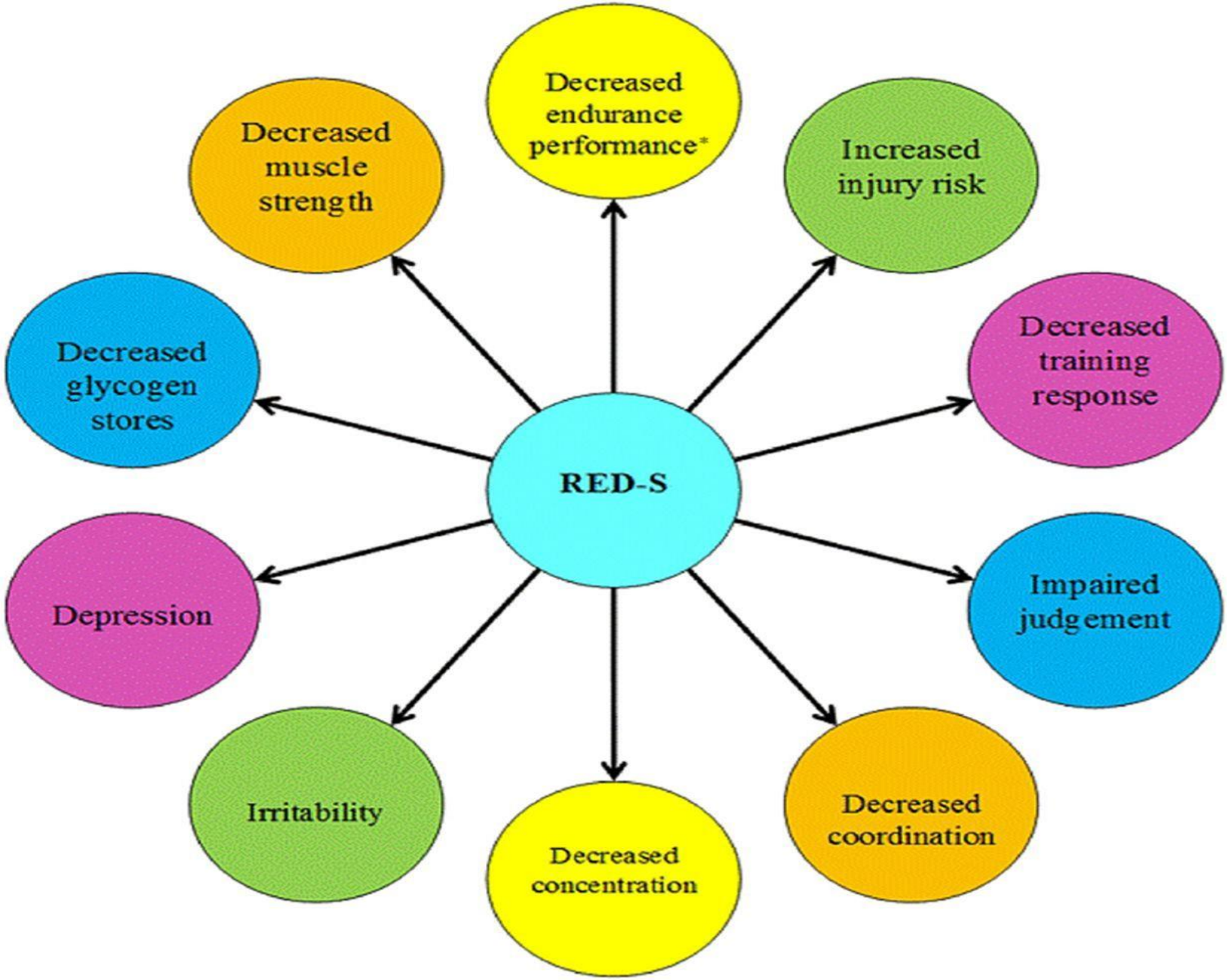
Health Effects of RED-S

Mountjoy, et al, Br J Sports Med 2014



Performance Effects of RED-S

Mountjoy, et al, Br J Sports Med 2014



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

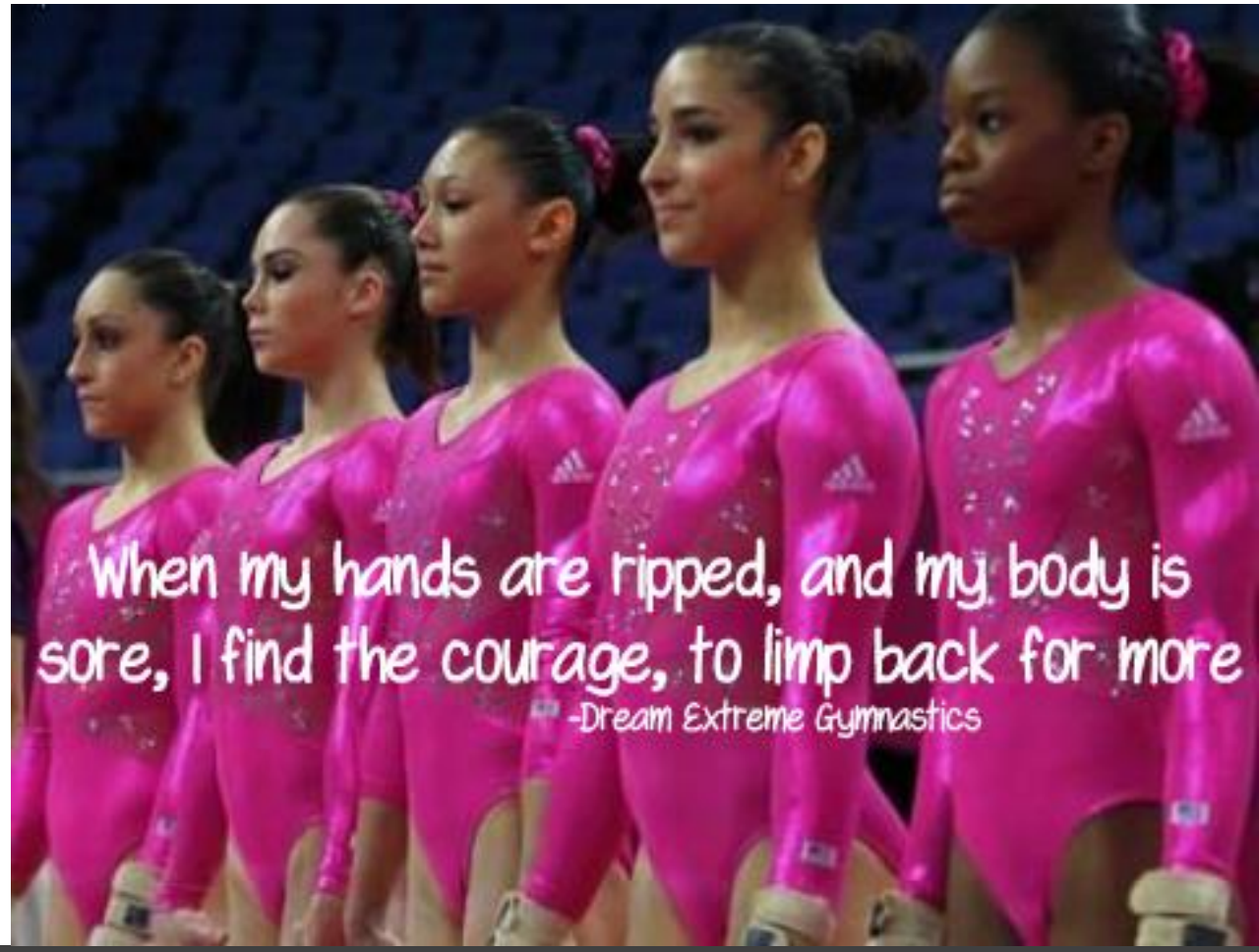
Melin 2014, Martinsen 2015

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

Overuse Injuries

Bell 2018, Stracciolini 2015, Wu 2016

- 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

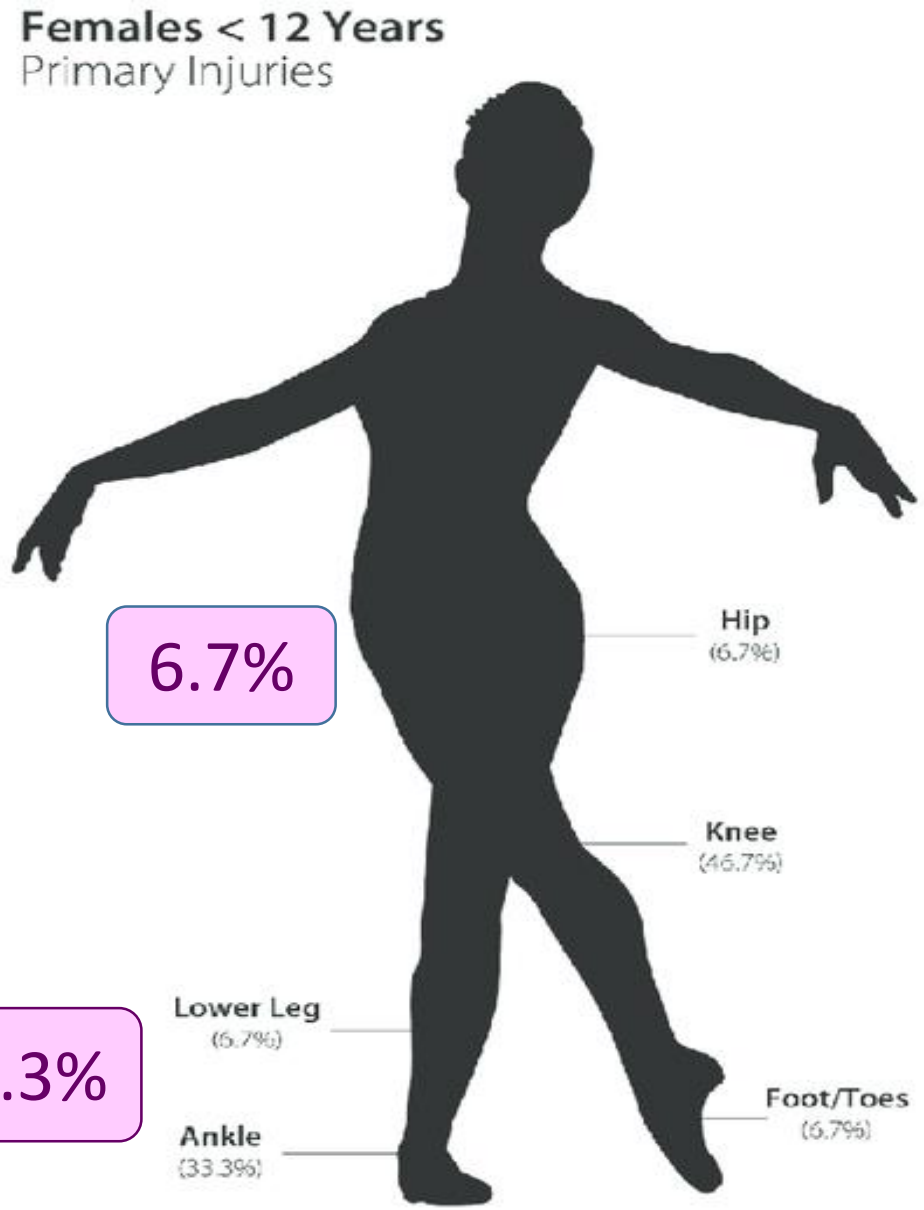
Location: LE injuries

Most common acute injury: Ankle sprain

Most common injury type → **OVERUSE**

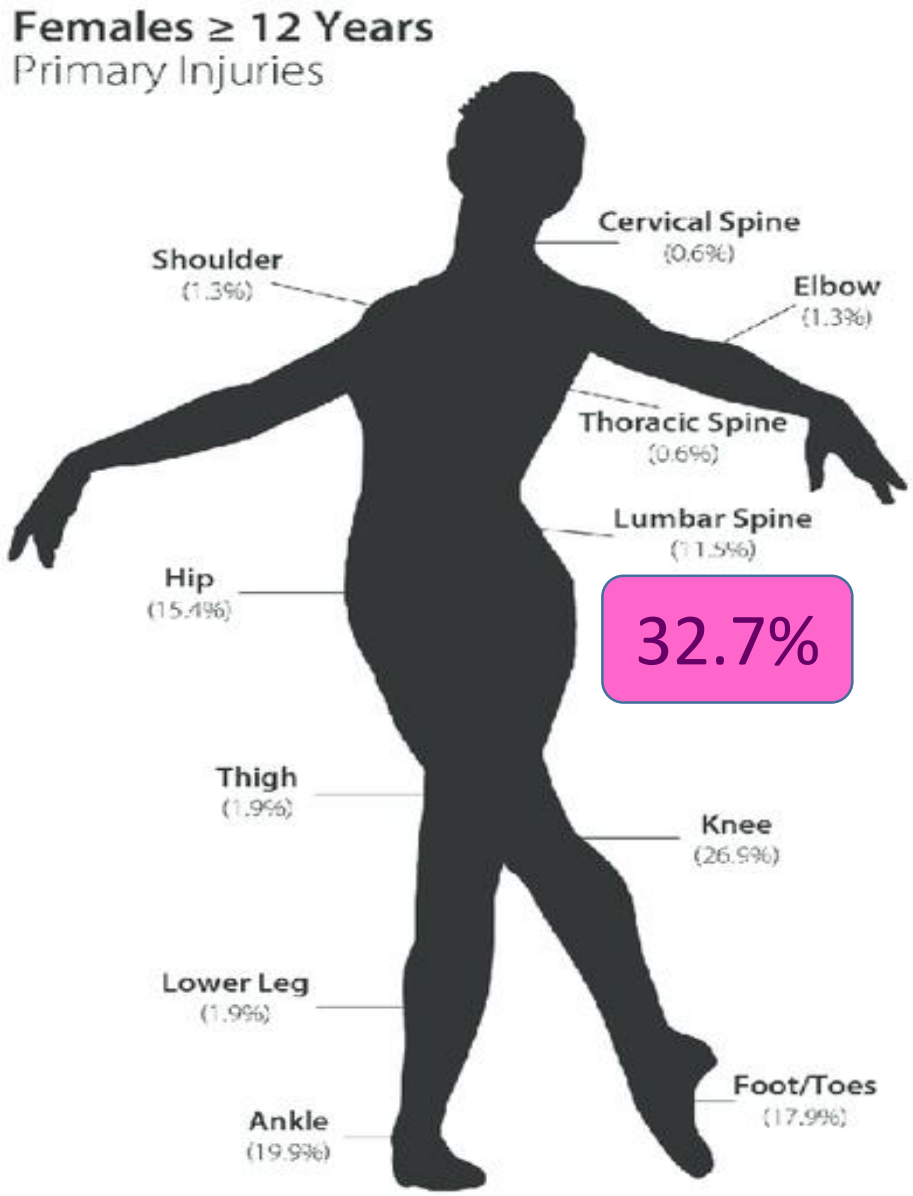
- Patellar tendonitis, stress fractures
- Fatigue is a factor, there is more credit for difficulty in second half of the program

LE injuries in young dancers Stracciolini 2015



6.7%

93.3%



32.7%

67.3%

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

Beese ME, Joy E, Switzler CL, et al. Landing error scoring system differences between single-sport and multi-sport female high school-aged athletes. J Athl Train. 2015;50(8):806–811.

Bell DR, Post EG, Biese K, et al. Sport Specialization and Risk of Overuse Injuries: A Systematic Review With Meta-analysis. Pediatrics. 2018;142(3):e20180657

Bowerman EA, et al. A review of the risk factors for lower extremity overuse injuries in young elite female ballet dancers. J Dance Med Sci. 2015 Jun;19(2):51-6

Brenner JS; American Academy of Pediatrics, Council on Sports Medicine and Fitness. Overuse injuries, overtraining, and burnout in child and adolescent athletes. Pediatrics. 2007;119(6):1242–1245. Reaffirmed June 2014

Brenner J.S.: Overuse injuries, overtraining, and burnout in child and adolescent athletes. Pediatrics 2007; 119: pp. 1242-1245

Butcher J et al. Withdrawal from competitive youth sport: a retrospective ten-year study. J Sport Behav. 2002;25(2):145–163

Campbell RA, Bradshaw EJ, Ball NB, et al. Injury epidemiology and risk factors in competitive artistic gymnasts: a systematic review. Br J Sports Med Published Online First: 22 January 2019. doi: 10.1136/bjsports-2018-099547

Hall R, Barber Foss K, Hewett TE, et al. Sport specialization's association with an increased risk of developing anterior knee pain in adolescent female athletes. J Sport Rehabil. 2015;24(1):31–35.

References

Hans JS, Geminiani ET, Micheli LJ. Epidemiology of Figure Skating Injuries: A Review of the Literature. Sports Health. 2018 Nov/Dec;10(6):532-537.

Hibbard EE, Myers JB. Practice habits and attitudes and behaviors concerning shoulder pain in high school competitive club swimmers. Clin J Sport Med. 2013;23(6):450-455.

Jayanthi NA, et al., Sports-specialized intensive training and the risk of injury in young athletes: a clinical case-control study. Am J Sports Med. 2015;43(4):794–801

Jayanthi NA, et al, Sports specialization in young athletes: evidence-based recommendations. Sports Health. 2013;5(3):251–257pmid

Jayanthi N, Dechert A, Durazo R, et al. Training and sports specialization risks in junior elite tennis players. J Med Sci Tennis. 2011;16:14–20.

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

Launay F. Sports-related overuse injuries in children. Orthop Traumatol Surg Res.2015 Feb;101(1 Suppl):S139-47. doi: 10.1016/j.otsr.2014.06.030. Epub 2014 Dec 30.

Leanderson C et al, Musculoskeletal injuries in young ballet dancers. Knee Surg Sports Traumatol Arthrosc. 2011 Sep;19(9):1531-5.

Loucks A, Callister R. Induction and prevention of low-T3 syndrome in exercising women. Am J Physiol Regul Integr Comp Physiol. 1993;264(5):R924–30.

References

Martinsen M, Holme I, Pensgaard AM, et al. The development of the brief eating disorder in athletes questionnaire. Med Sci Sports Exerc. 2014;46(8):1666–75.

Malina RM, et al. Role of intensive training in the growth and maturation of artistic gymnasts. Sports Med. 2013 Sep;43(9):783-802.

Malina RM. Early sport specialization: roots, effectiveness, risks. Curr Sports Med Rep. 2010;9(6):364–371

Melin AK, Heikura IA, Tenforde A, Mountjoy M, Energy Availability in Athletics: Health, Performance and Physique. Int J Sport Nutr Exerc Metab. 2019 Jan 11:1-35. doi: 10.1123/ijsnem.2018-0201.

Melin A, Tornberg AB, Skouby S, et al. The LEAF questionnaire: a screening tool for the identification of female athletes at risk for the female athlete triad. Br J Sports Med. 2014;48(7):540–5

National Collegiate Athletic Association. After School Specialized. Accessed 2016 December 8. Available from: http://www.ncaa.org/champion/after-school-specialized?

National Collegiate Athletic Association, Estimated probability of competing in athletics beyond the high school interscholastic level. Available at: www.ncaa.org/sites/default/files/Probability-of-going-pro-methodology_Update2013.pdf. Accessed December 15, 2015

References

O'Kane JW, Levy MR, Pietila KE, Caine DJ, Schiff MA. Survey of injuries in Seattle area levels 4 to 10 female club gymnasts. Clin J Sport Med. 2011;21(6):486-492.

O'Kane JW et al. Risk Factors for Lower Extremity Overuse Injuries in Female Youth Soccer Players. Orthop J Sports Med. 2017 Oct 23;5(10):2325967117733963.

Padaki AS, Popkin CA, Hodgins JL, Kovacevic D, Lynch TS, Ahmad CS , Factors That Drive Youth Specialization. Sports Health. 2017 Nov/Dec;9(6):532-536

Payne J, Kirchner J. Should you suspect the female athlete triad?. The Journal Of Family Practice. 2014 Apr; 63(4): 187-192. Pasulka J, et al, Specialization patterns across various youth sports and relationship to injury risk. Phys Sportsmed. 2017 Sep;45(3):344-352. Epub 2017 Apr 10.

Post EG, Trigsted SM, Riekena JW, et al. The association of sport specialization and training volume with injury history in youth athletes. Am J Sports Med. 2017;45(6):1405–1412

Rose MS, et al, Sociodemographic predictors of sport injury in adolescents. Med Sci Sports Exerc. 2008;40(3):444–450

References

Slater J, Brown R, McLay-Cooke R, Black K. Low Energy Availability in Exercising Women: Historical Perspectives and Future Directions. Sports Med. 2017 Feb;47(2):207-220.

Stracciolini A, Casciano R, Friedman HL, et al. A closer look at overuse injuries in the pediatric athlete. Clin J Sports Med. 2015;25(1):30–35.

Stracciolini A, Yin AX, Sugimoto D, Etiology and body area of injuries in young female dancers presenting to sports medicine clinic: A comparison by age group. Phys Sportsmed. 2015 Nov;43(4):342-7.

Sugimoto D, Jackson SS, Howell DR, Meehan WP, Stracciolini A. Association between training volume and lower extremity overuse injuries in young female athletes: implications for early sports specialization. Phys Sportsmed. 2018 Nov 7:1-6.

Vadocz, Siegel, Malina, Age at menarche in competitive figure skaters: variation by competency and discipline. J Sports Sci. 2002;20(2):93–100.

Wu et al. Overuse injuries in the pediatric population. Sports Med Arthrosc Rev. 2016;24(4):150–158pmid:27811514