

Overuse Injuries in Youth Runners

Aubrey Armento, MD, CAQSM
University of Colorado, Children's Hospital Colorado
Medical Director of The Running Athlete Clinic



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

SPORTS MEDICINE
CENTER

 Children's Hospital Colorado

Objectives

- Review the epidemiology of running-related injuries in youth
- Understand the presentation and treatment of some of the more common overuse injuries in young runners
- Describe injury prevention strategies for youth runners



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS



Youth Running

- Running is a popular sport!
 - *National Federation of State High School Associations 2021-2022 Participation Survey:
 - Boy's and Girl's XC: 422,170
 - Boy's and Girl's T&F: 1,025,959 - the second most popular boy's sport behind football and the most popular girl's sport
- Not to mention all of the running-heavy sports such as soccer, basketball, lacrosse, etc, as well as running as a recreational activity



<https://runningwritings.com/2015/07/running-specialization-for-young.html>



Affiliated with

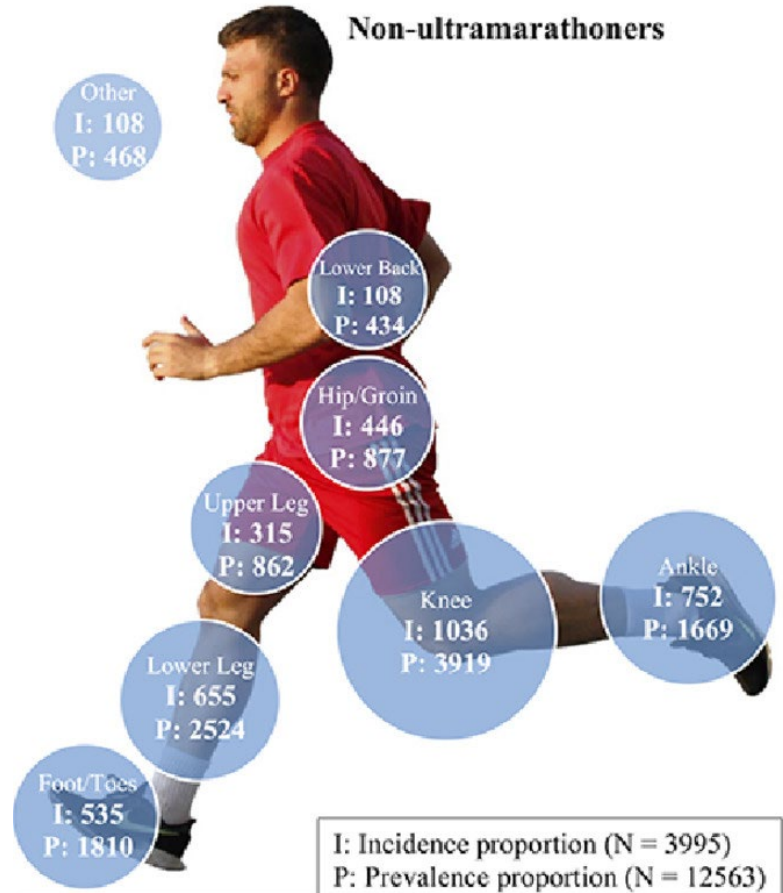
School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

SPORTS MEDICINE
CENTER
Children's Hospital Colorado

Running Injury Epidemiology

- Much less data in the pediatric population than in the adult literature
- Systematic review of studies assessing prevalence of running-related musculoskeletal injuries in adults (Kakouris N, et al 2021):
 1. Patellofemoral pain syndrome (16.7%)
 2. Medial tibial stress syndrome (9.1%)
 3. Plantar fasciitis (7.9%)
 4. IT band syndrome (7.9%)
 5. Achilles tendinopathy (6.6%)



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

How common are running-related injuries in youth?

- In a review of ED visits for running-related injuries from 1994 to 2007 (Mehl AJ, et al 2011):
 - 12-14 yo had the highest injury rates, and overall annual injury incidence increased by 34%
- In a study of 748 high school runners (Tenforde AS, et al 2011):
 - 68% of females and 59% of males reported at least one prior injury before the age of 15
- In a study of 2113 middle school runners (Tenforde AS, et al 2022):
 - 56% of females and 50% of males reported one or more overuse injury
 - Ankle sprain (22%), patellofemoral pain (13%), shin splints (9%)



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Unique Considerations for Youth Runners

- Youth runners are at risk for pediatric-specific overuse injuries, specifically apophyseal injuries
- Pubertal changes
 - Rising levels of sex hormones
 - Peak height velocity → long bones tend to lengthen before the muscle-tendon complex, which creates more tension at muscle-tendon-apophyseal connection
 - Growing cartilage is weaker than mature cartilage
 - Bone mineral density is at its lowest just before peak height velocity



Affiliated with

School of Medicine

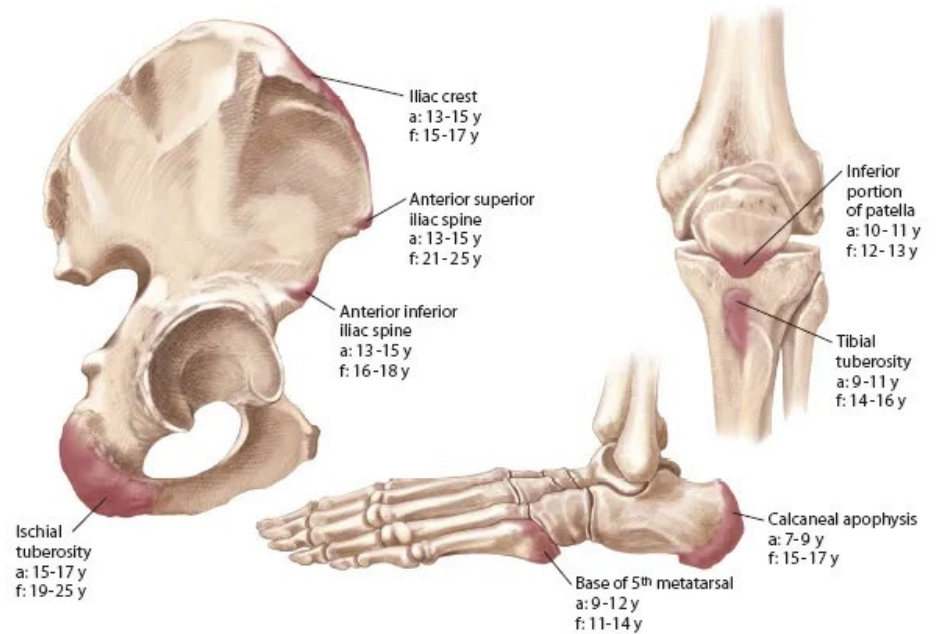
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Krabak BJ, et al 2016



Apophyseal Injuries

- Osgood Schlatter's Disease
- Sinding-Larsen-Johansson
- Severs Disease
- Iselin's Disease
- Pelvic apophysitis



<https://www.activatephysio.com.au/overuse-injuries-in-young-athletes-apophysitis/>

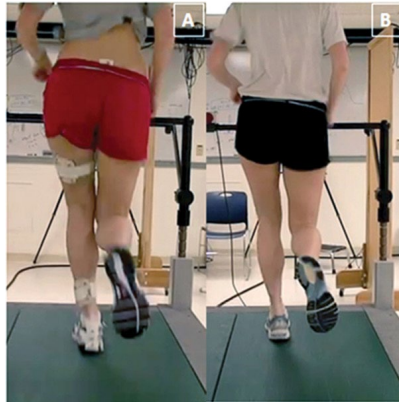
Treatment

- ✓ Activity modification
- ✓ Physical Therapy
- ✓ Supportive care - ice, NSAIDs, bracing

Patellofemoral Pain Syndrome



- Pain that manifests around and/or behind the patella in activities that load the patellofemoral joint i.e. running
- Risk factors
 - Female sex
 - Quad weakness
 - Hip abductor/external rotator weakness
 - Quad, gastroc, hamstring, IT band inflexibility
 - Gait deviations: excessive hip adduction, increased ground reaction force, heel-strike foot pattern, foot overpronation



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

<https://www.runnersworld.com/health-injuries/a36650122/heel-striking/>

<https://lerrmagazine.com/article/retraining-fixes-faulty-gait-in-injured-runners>

Dutton RA, et al 2016

SPORTS MEDICINE
CENTER



Patellofemoral Pain Syndrome

- Diagnosis: Key Features
 - Physical exam: Positive J-sign, abnormal patellar mobility, poor single leg squat
 - Radiographs: Shallow trochlear groove, patellar tilt, patella alta
- Treatment
 - Physical Therapy → emphasis on quad, hip, and core strengthening, flexibility
 - McConnell taping technique, patellar bracing
 - Gait re-training
 - Don't forget to address training load!



https://prod-images-static.radiopaedia.org/images/1283541/0684f2563962765b67c1d0e9945216_gallery.jpg

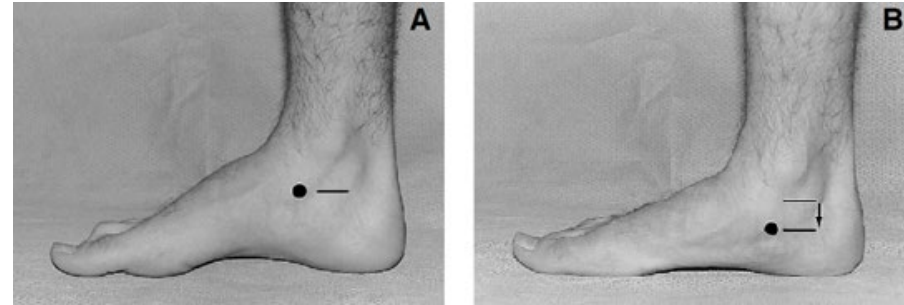
<https://drrobertlaprademd.com/wp-content/uploads/2020/01/23-x-ray-of-trochlear-dysplasia.jpg>



https://s3.amazonaws.com/actionsportphysio/thumbs/2021011323295494/mcconnell_taping.JPG

Medial Tibial Stress Syndrome (aka shin splints)

- Shin pain, typically middle-distal posteromedial tibia, that worsens with exertion and typically gets better with rest
- Risk factors (Hamstra-Wright K, et al 2015)
 - Increased BMI
 - Increased navicular drop
 - Greater plantar flexion ROM
 - Greater hip external rotation ROM



https://www.physio-pedia.com/images/f/fa/Navicular_drop_test.png



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Medial Tibial Stress Syndrome

- Diagnosis: Key Features
 - Physical exam: Diffuse tenderness along the distal 2/3 of the posteromedial tibia, often more discomfort to palpation than single leg hop test
 - Imaging is not necessary but want to consider tibia bone stress injury in the differential
- Treatment
 - Typically requires a period of rest from impact activities (~2-6 weeks)
 - Low level evidence to support efficacy of iontophoresis, phonophoresis, ice massage, periosteal pecking, and extracorporeal shockwave therapy (Winters M, et al 2016)



<https://images.squarespace-cdn.com/content/v1/5af44d27f793927641820d2c/5d44fcb8-0321-4a6d-9714-99de0246c836/Medial+tibial+stress+syndrome4.png>



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Rajasekaran S, et al 2016

SPORTS MEDICINE
CENTER
Children's Hospital Colorado

Bone Stress Injuries (BSI)

Epidemiology study of stress fractures in US high school athletes (Changstrom BG, et al 2015)

- Overall stress fracture rate of 1.54 per 100,000 athlete-exposures
- Rates were highest in:
 - Girl's cross country
 - Girl's gymnastics
 - Boy's cross country
- 40% occurred in the lower leg, 35% in the foot, 15% in lower back/pelvis

Most common locations:

- Tibia
- Tarsal navicular
- Metatarsal
- Fibula
- Femur
- Pelvis
- Spine



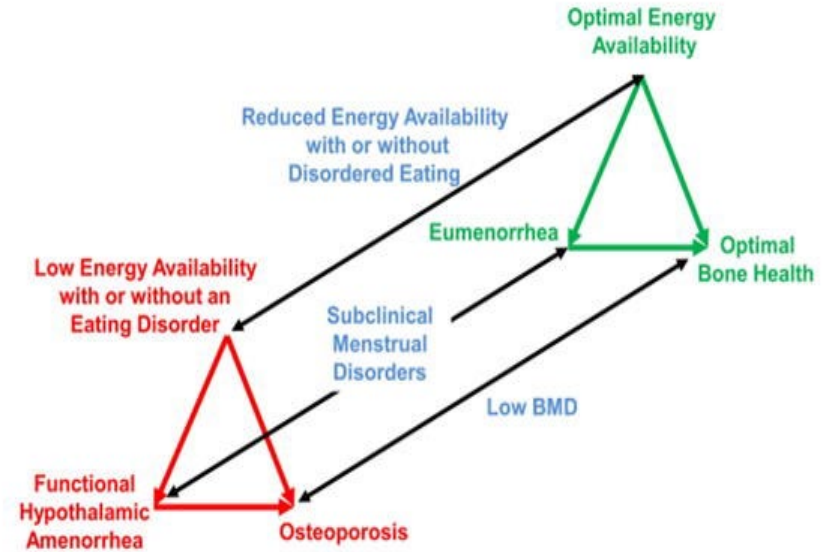
Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Bone Stress Injuries

- Risk Factors
 - Female sex
 - Running > 20 miles per week
 - Rapid ramp up in running
 - Vitamin D and calcium insufficiency/deficiency
 - Relative Energy Deficiency in Sport (RED-S)/Athlete Triad
 - Biomechanics (tibia in particular) - Greater average vertical loading rates higher peak hip adduction, knee internal rotation, tibial internal rotation, rear foot eversion



De Souza MJ, et al 2014



Affiliated with

School of Medicine

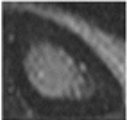
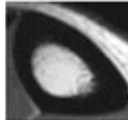

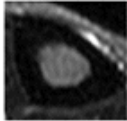
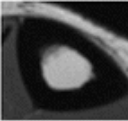

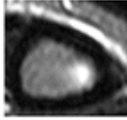
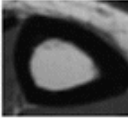

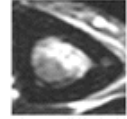
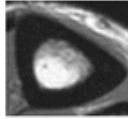

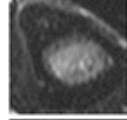
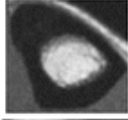

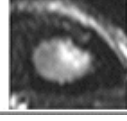
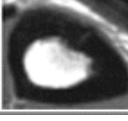

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Tenforde AS, et al 2016

Bone Stress Injuries

Diagnosis: Key Features

- Physical exam: Focal bony tenderness, positive single leg hop test, fulcrum test, squeeze test
- Imaging: Radiographs may show periosteal thickening/reaction or fracture line, MRI for definitive diagnosis and grading

Grade	STIR	T1	Illustration
0			
1			
2			
3			
4a			
4b			

https://media.springernature.com/full/springer-static/image/art%3A10.1007%2F978-1-4939-9139-5/MediaObjects/10140_2016_1390_Fig3_HTML.gif



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Tenforde AS, et al 2016

Bone Stress Injuries

Treatment

- High risk (femoral neck, anterior tibia, 5th metatarsal, sacrum)
 - Sometimes surgical management
 - Typically period of 4-6 weeks NWB
- Lower risk (posteromedial tibia, fibula, 2nd-4th metatarsals, calcaneus)
 - Walking boot 4-6 weeks
- Physical therapy
- Gradual return to run, timing dependent on location, severity, progression in PT
- Address underlying nutritional concerns



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Tenforde AS, et al 2016

Youth running consensus statement: minimising risk of injury and illness in youth runners

Increases risk of injury

Strong evidence	Limited evidence	Not supported	Conflicting evidence/unclear
<p><u>Prior Injury</u></p> <p><u>Sex</u> Girls>boys</p> <p><u>Menstrual dysfunction</u></p> <p><u>BMI</u> <19 kg/m² for BSI in girls</p>	<p><u>Anatomical</u></p> <ul style="list-style-type: none">• Quadriceps angle $\geq 20^{\circ}$• Leg-length inequality (>1.5 cm) in boys <p><u>Training/biomechanics</u></p> <p>Summer training (<8 weeks, >33% on hills, <25% alternating short and long mileage on different days)</p> <p>Low running step rate (<166 steps/min)</p> <p><u>Sports specialisation</u></p>	<p><u>Height</u></p> <p><u>Weight</u></p> <p><u>Running Surface</u></p> <p><u>Type</u></p>	<p><u>Age/development</u></p> <p><u>Muscle weakness</u> Hip abductors Knee extensor Knee flexors</p> <p><u>Footwear</u></p> <p><u>Footstrike mechanics</u></p>



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Recommendations for reducing injury risk in youth runners:

- Athletes should be screened for prior injury, low BMI, low EA, menstrual dysfunction, biomechanical concerns, and training errors
- Youth runners should participate in high-impact and multi-directional activities with focus on improved neuromuscular control of the lumbopelvic region and lower extremities at least through puberty
- Readiness for running should be determined by growth and development rather than chronological age
- Youth runners should incorporate at least one rest day per week, 1-2 weeks every 3 months, and limit participation to less than 9 months per year
- Single sport specialization in running should be discouraged under girls and boys pass through puberty



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

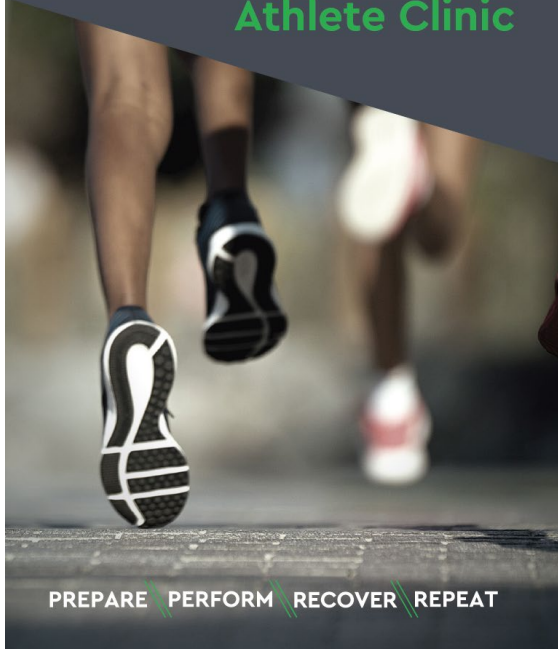
Krabak BJ, et al 2020



SPORTS MEDICINE
CENTER
Children's Hospital Colorado

ORTHOPEDICS INSTITUTE – SPORTS MEDICINE CENTER

The Running Athlete Clinic



PREPARE | PERFORM | RECOVER | REPEAT



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Scan to learn more



Thank you!

Aubrey.armento@childrenscolorado.org

SPORTS MEDICINE
CENTER
Children's Hospital Colorado

References:

- https://www.nfhs.org/media/5989280/2021-22_participation_survey.pdf
- Kakouris N, Yener N, Fong DTP. A systematic review of running-related musculoskeletal injuries in runners. *J Sport Health Sci.* 2021 Sep;10(5):513-522. doi: 10.1016/j.jshs.2021.04.001. Epub 2021 Apr 20. PMID: 33862272; PMCID: PMC8500811.Mehl A.J., Nelson N.G., McKenzie L.B.: Running-related injuries in school-age children and adolescents treated in emergency departments from 1994 through 2007. *Clin Pediatr (Phila)* 2011; 50: pp. 126-132.
- Tenforde A.S., Sayres L.C., McCurdy M.L., et. al.: Overuse injuries in high school runners: lifetime prevalence and prevention strategies. *PM R* 2011; 3: pp. 125-131.
- Wu AC, Rauh MJ, DeLuca S, Lewis M, Ackerman KE, Barrack MT, Heiderscheid B, Krabak BJ, Roberts WO, Tenforde AS. Running-related injuries in middle school cross-country runners: Prevalence and characteristics of common injuries. *PM R.* 2022 Jul;14(7):793-801. doi: 10.1002/pmrj.12649. Epub 2021 Jul 8. PMID: 34053194.
- Krabak BJ, Snitily B, Milani CJ. Running Injuries During Adolescence and Childhood. *Phys Med Rehabil Clin N Am.* 2016 Feb;27(1):179-202. doi: 10.1016/j.pmr.2015.08.010. PMID: 26616183.
- Dutton RA, Khadavi MJ, Fredericson M. Patellofemoral Pain. *Phys Med Rehabil Clin N Am.* 2016 Feb;27(1):31-52. doi: 10.1016/j.pmr.2015.08.002. PMID: 26616176.
- Rajasekaran S, Finnoff JT. Exertional Leg Pain. *Phys Med Rehabil Clin N Am.* 2016 Feb;27(1):91-119. doi: 10.1016/j.pmr.2015.08.012. PMID: 26616179.
- Hamstra-Wright KL, Bliven KCH, Bay C. Risk factors for medial tibial stress syndrome in physically active individuals such as runners and military personnel: a systematic review and meta-analysis. *British Journal of Sports Medicine* 2015;49:362-369.
- Winters M, Eskes M, Weir A, Moen MH, Backx FJ, Bakker EW. Treatment of medial tibial stress syndrome: a systematic review. *Sports Med.* 2013 Dec;43(12):1315-33. doi: 10.1007/s40279-013-0087-0. PMID: 23979968.
- Changstrom BG, Brou L, Khodae M, Braund C, Comstock RD. Epidemiology of stress fracture injuries among US high school athletes, 2005-2006 through 2012-2013. *Am J Sports Med.* 2015;43(1):26-33. doi:10.1177/0363546514562739
- Tenforde AS, Kraus E, Fredericson M. Bone Stress Injuries in Runners. *Phys Med Rehabil Clin N Am.* 2016 Feb;27(1):139-49. doi: 10.1016/j.pmr.2015.08.008. PMID: 26616181.
- Krabak BJ, Roberts WO, Tenforde AS, Ackerman KE, Adami PE, Baggish AL, Barrack M, Cianca J, Davis I, D'Hemecourt P, Fredericson M, Goldman JT, Harrast MA, Heiderscheid BC, Hollander K, Kraus E, Luke A, Miller E, Moyer M, Rauh MJ, Toresdahl BG, Wasfy MM. Youth running consensus statement: minimising risk of injury and illness in youth runners. *Br J Sports Med.* 2021 Mar;55(6):305-318. doi: 10.1136/bjsports-2020-102518. Epub 2020 Oct 29. PMID: 33122252.



Affiliated with

School of Medicine

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

