



# Evaluation, Treatment, and Management of Adolescent Runners

Independent Study  
Course 30.1.4

**Michelle Fearheller, PT, DPT, OCS, SCS, CSCS**  
Nemours duPont Pediatrics  
Bryn Mawr, PA

CONTINUING PHYSICAL THERAPY EDUCATION

ACADEMY OF  
**ORTHOPAEDIC  
PHYSICAL THERAPY** 

 **APTA**  
American Physical Therapy Association

---

## REFERENCES

1. Taylor-Haas JA, Hugentobler JS, DiCesare CA, et al. Reduced hip strength is associated with increased hip motion during running in young adult and adolescent male long-distance runners. *Int J Sports Phys Ther.* 2014;9(4):456-467.
2. Luedke LE, Heiderscheid BC, Williams DS, Rauh MJ. Association of isometric strength of the knee muscles with injury risk in high school cross country runners. *Int J Sports Phys Ther.* 2015;10(6):868-876.
3. Greenberg E. Technology in running and rehabilitation & performance. Paper presented at: Current Topics for Care of the Pediatric and Adolescent Athlete 2018; October 19, 2018; Philadelphia, PA.
4. Rauh MJ, Koepsell Td, Rivara FP, Margherita AJ, Rice SG. Epidemiology of musculoskeletal injuries among high school cross-country runners. *Am J Epidemiol.* 2006;163(2):151-159.
5. LaPrade RL, Agel J, Baker J, et al. AOSSM early sport specialization consensus statement. *Orthop J Sports Med.* 2016;4(4):2325967116644241. doi: 10.1177/2325967116644241. eCollection 2016 Apr.
6. Bayli I, Way R, Higgs C. *Long-Term Athlete Development.* Champaign, IL: Human Kinetics; 2013.
7. Ford P, De Ste Croix M, Lloyd R, et al. The long-term athlete development model: physiological evidence and application. *J Sports Sci.* 2011;29(4):389-402. doi: 10.1080/02640414.2010.536849.
8. Findley S, Frappier JY, Goldberg E, et al. Age limits and adolescents. *Pediatr Child Health.* 2003;8(9):577.
9. Sawyer SM, Azzopardi PS, Wickremarathne D, Patton GC. The age of adolescence. *Lancet.* 2018;2(3):223-228. doi: 10.1016/S2352-4642(18)30022-1. Epub 2018 Jan 30.
10. Chadar PS. Physiological basis of growth and development among children and adolescent in relation to physical activity. *Am J Sport Sci Med.* 2014;2(5A):17-22.
11. Stang J, Story M, eds. Guidelines for Adolescent Nutrition Services (2005). [http://www.epi.umn.edu/let/pubs/adol\\_book.shtm](http://www.epi.umn.edu/let/pubs/adol_book.shtm). Accessed June 30, 2014.
12. Tonnessen E, Svendsen IS, Olsen IC, Guttormsen A, Haugen T. Performance development in adolescent track and field athletes according to age, sex, and sport discipline. *PLoS One.* 2015;10(6):e0129014. doi: 10.1371/journal.pone.0129014. eCollection 2015.
13. Baechle TR, Earle RW, eds. *Essentials of Strength Training and Conditioning.* 3rd ed. Champaign, IL: Human Kinetics; 2008.
14. Beunen G, Malina RM. Growth and physical performance relative to the timing of the adolescent spurt. *Exerc Sport Sci Rev.* 1988;16(1):503-540.

15. Haff GG, Triplett NT, eds. *Essentials of Strength Training and Conditioning*. Champaign, IL: Human Kinetics; 2016.
16. Krabak BJ. *The Child and Adolescent Athlete*. Philadelphia, PA: Saunders; 2008.
17. Emmanuel M, Bokor BR. Tanner Stages. StatPearls Publishing; 2018. <https://www.ncbi.nlm.nih.gov/books/NBK470280/>. Accessed March 3, 2019.
18. Krabak BJ, Snitily B, Milani CJ. Running injuries during adolescence and childhood. *Phys Med Rehabil Clin N Am*. 2016;27(1):179-202. doi: 10.1016/j.pmr.2015.08.010.
19. Barnes M. Running medicine: unique approach to evaluation and intervention for the youth athlete. Paper presented at: Current Topics for Care of the Pediatric and Adolescent Athlete 2018; October 19, 2018; Philadelphia, PA.
20. Jones MA, Hitchen PJ, Stratton G. The importance of considering biological maturity when assessing physical fitness measures in girls and boys aged 10 to 16 years. *Ann Hum Biol*. 2000;27:57-65.
21. Tucker A, Grady M. Role of the adolescent preparticipation physical examination. *Phys Med Rehabil Clin N Am*. 2008;19(2):217-234, vii-viii. doi: 10.1016/j.pmr.2007.12.004.
22. Naughton G, Farpour-Lambert N, Carlson J, Bradney M, Van Praagh E. Physiological issues surrounding the performance of adolescent athletes. *Sports Med*. 2000;30:309-325.
23. Heiderscheid B. Gait retraining for runners: in search of the ideal. *J Orthop Sports Phys Ther*. 2011;41(12):909-910. doi: 10.2519/jospt.2011.0111. Epub 2011 Nov 28.
24. Ferber R, Noehren B, Hamill JH, Davis I. Competitive female runners with a history of iliotibial band syndrome demonstrate atypical hip and knee kinematics. *J Orthop Sports Phys Ther*. 2010;40(2):52-58. doi: 10.2519/jospt.2010.3028.
25. Cheung RT, Davis IS. Landing pattern modification to improve patellofemoral pain in runners: a case series. *J Orthop Sports Phys Ther*. 2011;41(12):914-919. doi: 10.2519/jospt.2011.3771. Epub 2011 Oct 25.
26. Bosch F, Klomp R. *Running Biomechanics and Exercise Physiology Applied in Practice*. Philadelphia, PA: Elsevier; 2005.
27. Jeffreys I. *Gamespeed: Movement Training for Superior Sports Performance, 2nd ed*. Monterey, CA: Coaches Choice; 2017.
28. Lachniet PB, Taylor-Haas JA, Paterno MV, DiCesare CA, Ford KR. Altered sagittal plane hip biomechanics in adolescent male distance runners with a history of lower extremity injury. *Int J Sports Phys Ther*. 2018;13(3):441-452.
29. Paterno MV, Taylor-Haas JA, Myer GD, Hewett TE. Prevention of overuse sports injuries in the young athlete. *Orthop Clin North Am*. 2013;44(4):553-564. doi: 10.1016/j.ocl.2013.06.009. Epub 2013 Aug 29.
30. Tenforde AS, Sayres LC, McCurdy ML, Sainani KL, Fredericson M. Identifying sex-specific risk factors for stress fractures in adolescent runners. *Med Sci Sports Exerc*. 2013;45(10):1843-1851. doi: 10.1249/MSS.0b013e3182963d75.
31. Van der Worp MP, ten Haaf DSM, van Cingel R, de Wijer A, Nijhuis-van der Sanden MWG, Staal JB. Injuries in runners; a systematic review on risk factors and sex differences. *PLoS One*. 2015;10(2):e0114937. doi: 10.1371/journal.pone.0114937. eCollection 2015.
32. Martinez-Silvan D, Diaz-Ocejo J, Murray A. Predictive indicators of overuse injuries in adolescent endurance athletes. *Int J Sports Physiol Perform*. 2017;12(Suppl 2):S2153-S2156. doi: 10.1123/ijsp.2016-0316. Epub 2016 Dec 5.
33. Buist I, Bredeweg SW, Lemmink KA, et al. Predictors of running-related injuries in novice runners enrolled in a systematic training program: a prospective cohort study. *Am J Sports Med*. 2010;38(2):273-280. doi: 10.1177/0363546509347985. Epub 2009 Dec 4.
34. Van Oeveren BT, De Ruyter CJ, Beek PJ, Van Dieen JH. Optimal stride frequencies in running at different speeds. *PLoS One*. 2017;12(10):e0184273. doi: 10.1371/journal.pone.0184273. eCollection 2017.
35. Kennedy JG, Knowles B, Dolan M, Bohne W. Foot and ankle injuries in the adolescent runner. *Curr Opin Pediatr*. 2005;17:34-42.
36. Fredericson M, Ngo J, Cobb K. Effects of ball sports on future risk of stress fracture in runners. *Clin J Sport Med*. 2005;15(3):136-141.
37. Patient reported outcome measures. Pediatric research in sports medicine. <https://www.prismssports.org/research/patient-reported-outcome-measures>. Accessed March 10, 2019.
38. Callahan LR. Overview of running injuries of the lower extremity. *UpToDate*. <https://www.uptodate.com/contents/overview-of-running-injuries-of-the-lower-extremity#topicContent>. Accessed February 16, 2019.
39. Barber Foss K, Ford K, Myer G, Hewett T. Generalized joint laxity associated with increased medial foot loading in female athletes. *J Athl Train*. 2009;44(4):356-362.
40. Boyle KL, Witt P, Riegger-Krugh C. Intrarater and interrater reliability of the Beighton and Horan joint mobility index. *J Athl Train*. 2003;38(4):281-285.
41. Quatman C, Ford K, Myer G, Paterno M, Hewett T. The effects of gender and pubertal status on generalized joint laxity in young athletes. *J Sci Med Sport*. 2008;11(3):257-263. Epub 2007 Jun 26.
42. Croix Mde S. Advances in paediatric strength assessment: changing our perspective on strength development. *J Sports Sci Med*. 2007;6(3):292-304.

43. Brumitt J. The Bunkie test: descriptive data for a novel test of core muscular endurance. *Rehabil Res Pract*. 2015;2015:780127. doi: 10.1155/2015/780127. Epub 2015 Feb 11.
44. Ferber R, MacDonald S. *Running Mechanics and Gait Analysis*. Champaign, IL: Human Kinetics; 2014.
45. Cook CE, Hegedus EJ. *Orthopedic Physical Examination Tests*. Upper Saddle River, NJ: Pearson; 2008.
46. Clagg S, Paterno MV, Hewett TE, Schmitt LG. Performance on the modified star excursion balance test at the time of return to sport following anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther*. 2015;45(6):444-452. doi: 10.2519/jospt.2015.5040. Epub 2015 Apr 21.
47. Stiffler MR, Bell DR, Sanfilippo JL, Hertz SJ, Pickett KA, Heiderscheit BC. Star excursion balance test anterior asymmetry is associated with injury status in division I collegiate athletes. *J Orthop Sports Phys Ther*. 2017;47(5):339-346. doi: 10.2519/jospt.2017.6974. Epub 2017 Mar 29.
48. Balance error scoring system (BESS). <https://idph.iowa.gov/Portals/1/Files/ACBI/BESS%20manual%20310.pdf>. Accessed February 26, 2019.
49. Jones AM, Carter H. The effect of endurance training on parameters of aerobic fitness. *Sports Med*. 2000;29(6):373-386.
50. Gokeler A, Welling W, Benjaminse A, Lemmink K, Seil R, Saffagnini S. A critical analysis of limb symmetry indices of hop tests in athletes after anterior cruciate ligament reconstruction: a case control study. *Orthop Traumatol Surg Res*. 2017;103(6):947-951. doi: 10.1016/j.otsr.2017.02.015. Epub 2017 Apr 17.
51. Gokeler A, Welling W, Zaffagnini S, Seil R, Padua D. Development of a test battery to enhance safe return to sports after anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2017;25(1):192-199. doi: 10.1007/s00167-016-4246-3. Epub 2016 Jul 16.
52. Logerstedt DS, Scalzitti D, Risberg MA, et al. Knee stability and movement coordination impairments: knee ligament sprain revision 2017. *J Orthop Sports Phys Ther*. 2017;47(11):A1-A42. doi: 10.2519/jospt.2017.0303.
53. Faigenbaum AD, McFarland JE, Keiper FB, et al. Effects of a short-term plyometric and resistance training program on fitness performance in boys age 12-15 years. *J Sports Sci Med*. 2007;6(4):519-525. eCollection 2007.
54. Valovich McLeod TC, Bay RC, Parson JT, Sauers EL, Snyder AR. Recent injury and health-related quality of life in adolescent athletes. *J Athl Train*. 2009;44(6):603-610. doi: 10.4085/1062-6050-44.6.603.
55. May KH, Guccione AA, Edwards MC, Goldstein MS. The adolescent measure of confidence and musculoskeletal performance (AMCAMP): development and initial validation. *Int J Sports Phys Ther*. 2016;11(5):698-707.
56. Yamato TP, Saragiotto BT, Lopes AD. A consensus definition of running-related injury in recreational runners: a modified Delphi approach. *J Orthop Sports Phys Ther*. 2015;45(5):375-380. doi: 10.2519/jospt.2015.5741. Epub 2015 Mar 26.
57. Tenforde AS, Fredericson M. Influence of sports participation on bone health in the young athlete: a review of the literature. *PM R*. 2011;3(9):861-867. doi: 10.1016/j.pmrj.2011.05.019.
58. Vasiliadis AV. Common stress fractures in runners: an analysis. *Saudi J Sports Med*. 2017;17(1):1-6.
59. Kovacevic D, Mariscalco M, Goodwin RC. Injuries about the hip in the adolescent athlete. *Sports Med Arthrosc Rev*. 2011;19(1):64-74. doi: 10.1097/JSA.0b013e31820d5534.
60. Atanda A Jr, Shah SA, O'Brien K. Osteochondrosis: common causes of pain in growing bones. *Am Fam Physician*. 2011;83(3):285-291.
61. Cuoco A. Principles of strength and conditioning. In: *Sports Certified Specialist Exam Preparatory Course*. Indianapolis, IN: 2015:1-35.
62. Waite BL. Examination and treatment of pediatric injuries of the hip and pelvis. *Phys Med Rehabil Clin N Am*. 2008;19(2):305-318, ix. doi: 10.1016/j.pmr.2007.12.005.
63. Behm DG, Blazevich AJ, Kay AD, McHugh M. Acute effects of muscle stretching on physical performance, range of motion, and injury incidence in healthy active individuals: a systematic review. *Appl Physiol Nutr Metab*. 2016;41(1):1-11. doi: 10.1139/apnm-2015-0235. Epub 2015 Dec 8.
64. Mullaney MJ. Prevention of common musculoskeletal sports injuries. In: *Sports Certified Specialist Exam Preparatory Course*. Indianapolis, IN: 2015:1-6.
65. Zakaria AA, Kiningham RB, Sen A. Effects of static and dynamic stretching on injury prevention in high school soccer athletes: a randomized trial. *J Sport Rehabil*. 2015;24(3):229-235. doi: 10-1123/jsr.2013-0114. Epub 2015 May 1.
66. Su H, Chang NJ, Wu, WL, Guo LY, Chu IH. Acute effects of foam rolling, static stretching, and dynamic stretching during warm-ups on muscular flexibility and strength in young adults. *J Sport Rehabil*. 2017;26(6):469-477. doi: 10.1123/jsr.2016-0102. Epub 2016 Oct 13.
67. Goossens L, Witvrouw E, Bossche LV, De Clercq D. Lower eccentric hamstring strength and single leg hop for distance predict hamstring injury in PETE students. *Eur J Sport Sci*. 2014;5:436-442. doi: 10.1080/17461391.2014.955127. Epub 2014 Sep 5.
68. Sugiura Y, Saito T, Sakuraba K, et al. Strength deficits identified with concentric action of the hip extensors and eccentric action of the hamstrings predispose to ham-

- string injury in elite sprinters. *J Orthop Sports Phys Ther.* 2008;38(8):457-464. doi: 10.2519/jospt.2008.2575. Epub 2008 Aug 1.
69. Van Dyk N, Bahr R, Whiteley R, et al. Hamstring and quadriceps isokinetic strength deficits are weak risk factors for hamstring strain injuries: a 4-year cohort study. *Am J Sports Med.* 2016;44(7):1789-1795. doi: 10.1177/0363546516632526. Epub 2016 Mar 21.
  70. Kary JM. Diagnosis and management of quadriceps strains and contusions. *Curr Rev Musculoskelet Med.* 2010;3:26-31. doi: 10.1007/s12178-010-9064-5.
  71. Aslan HI, Buddhadev HH, Suprak DN, San Juan JG. Acute effects of two hip flexor stretching techniques on knee joint position sense and balance. *Int J Sports Phys Ther.* 2018;13(5):846-859.
  72. Hébert KJ, Laor T, Divine JG, Emery KH, Wall EJ. MRI appearance of chronic stress injury of the iliac crest apophysis in adolescent athletes. *Am J Roentgenol.* 2008;190:1487-1491.
  73. Zhang C, Li L, Forster BB, et al. Femoroacetabular impingement and osteoarthritis of the hip. *Can Fam Physician.* 2015;61(12):1055-1060.
  74. Levy DM, Kuhns BD, Frank RM, et al. High rate of return to running for athletes after hip arthroscopy for the treatment of femoroacetabular impingement and capsular plication. *Am J Sports Med.* 2016;45(1):127-134. doi: 10.1177/0363546516664883. Epub 2016 Oct 1.
  75. Atanda A. Sinding-Larsen-Johansson Syndrome. TeensHealth from the Kids Health websites. <https://kidshealth.org/en/teens/slj-syndrome.html>. Accessed February 23, 2019.
  76. Dierks TA, Manal KT, Hamill J, Davis IS. Proximal and distal influences on hip and knee kinematics in runners with patellofemoral pain during a prolonged run. *J Orthop Sports Phys Ther.* 2008;38(8):448-456. doi: 10.2519/jospt.2008.2490. Epub 2008 Aug 1.
  77. Pamukoff DN, Montgomery MM, Choe KH, Moffit TJ, Garcia SA, Vakula MN. Bilateral alterations in running mechanics and quadriceps function following unilateral anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther.* 2018;48(12):960-967. doi: 10.2519/jospt.2018.8170. Epub 2018 Jul 22.
  78. Patel DR, Villalobos A. Evaluation and management of knee pain in young athletes: overuse injuries of the knee. *Transl Pediatr.* 2017;6(3):190-198. doi: 10.21037/tp.2017.04.05.
  79. Crossley KM, Middelkoop M, Callaghan MJ, Collins NJ, Rathleff MS, Barton CJ. 2016 Patellofemoral pain consensus statement from the 4th International Patellofemoral Pain Research Retreat, Manchester. Part 2: recommended physical interventions (exercise, taping, bracing, foot orthoses, and combined interventions). *Br J Sports Med.* 2016;50:844-852. doi: 10.1136/bjsports-2016-096268. Epub 2016 May 31.
  80. Wilhelm M, Matthijs O, Browne K, et al. Deformation response of the iliotibial band-tensor fascia lata complex to clinical-grade longitudinal tension loading in-vitro. *Int J Sports Phys Ther.* 2017;12(1):16-24.
  81. Stickley CD, Presuto MM, Radzak KN, Bourbeau CM, Hetzler RK. Dynamic varus and the development of iliotibial syndrome. *J Athl Train.* 2018;53(2):128-134.
  82. Okamoto T, Mashuara M, Ikuta K. Acute effects of self-myofascial release using a foam roller on arterial function. *J Strength Cond Res.* 2014;28(1):69-73. doi: 10.1519/JSC.0b013e31829480f5.
  83. Thapa MM, Chaturvedi A, Iyer RS, et al. MRI of pediatric patients: part 2, normal variants and abnormalities of the knee. *AJR Am J Roentgenol.* 2012;198:W456-W465. doi: 10.2214/AJR.10.7317.
  84. Watanabe H, Fujii M, Yoshimoto M, Abe H, Higashiyama H, Takahira N. Pathogenic factors associated with Osgood-Schlatter disease in adolescent male soccer players a prospective cohort study. *Orthop J Sports Med.* 2018;6(8): 2325967118792192. doi: 10.1177/2325967118792192. eCollection 2018 Aug.
  85. Plisky MS, Rauh MJ, Heiderscheid B, Underwood FB, Tank RT. Medial tibial stress syndrome in high school cross-country runners: incidence and risk factors. *J Orthop Sports Phys Ther.* 2007;37(2):40-47.
  86. Nussbaum ED, Bjornaraa J, Gatt CJ Jr. Identifying factors that contribute to adolescent bony stress injury in secondary school athletes: a comparative analysis with a healthy athletic control group. *Sports Health.* 2019;11(4):375-379. doi: 10.1177/1941738118824293. Epub 2019 Jan 15.
  87. Dressendorfer R, Matlick D, Richman S. Clinical review: metatarsal stress fracture. *CINAHL Rehabil Guide.* 2017:1-12.
  88. Dobrindt O, Hoffmeyer B, Ruf J, et al. Estimation of return-to-sports-time for athletes with stress fracture - an approach combining risk level of fracture site with severity based on imaging. *BMC Musculoskelet Disord.* 2012;13:139. doi: 10.1186/1471-2474-13-139.
  89. Goolsby MA, Barrack MT, Nattiv A. A displaced femoral neck stress fracture in an amenorrhoeic adolescent female runner. *Sports Health.* 2011;4 (4):352-356.
  90. Goolsby MA, Boniquit N. Bone health in athletes: the role of exercise, nutrition, and hormones. *Sports Health.* 2016;9(2):108-117. doi: 10.1177/1941738116677732. Epub 2016 Nov 30.
  91. Kaeding CC, Najarian RG. Stress fractures: classification and management. *Phys Sportsmed.* 2010;38:45-54. doi: 10.3810/psm.2010.10.1807.
  92. Schneiders AG, Sullivan SJ, Hendrick PA, et al. The ability of clinical tests to diagnose stress fractures: a systematic review and meta-analysis. *J Orthop Sports Phys Ther.* 2012;42:760-771. doi: 10.2519/jospt.2012.4000. Epub 2012 Jul 19.

93. Okamoto S, Arai Y, Hara K, Tsuzihara T, Kubo T. A displaced stress fracture of the femoral neck in an adolescent female distance runner with female athlete triad: a case report. *BMC Sports Sci Med Rehabil.* 2010;2(6):1-5.
94. Kiel J, Kaiser K. Stress reaction and fractures. *StatPearls.* 2018; <https://www.ncbi.nlm.nih.gov/books/NBK507835/>. Accessed February 24, 2019.
95. Field AE, Gordon CM, Pierce LM, Ramappa A, Kocher MS. Prospective study of physical activity and risk developing a stress fracture among preadolescent and adolescent girls. *Arch Pediatr Adolesc Med.* 2011;165(8):723-728. doi: 10.1001/archpediatrics.2011.34. Epub 2011 Apr 4.
96. Crowell HP, Milner CE, Hamill J, Davis IS. Reducing impact loading during running with use of real-time visual feedback. *J Orthop Sports Phys Ther.* 2010;40(4):206-213. doi: 10.2519/jospt.2010.3166.
97. Franklyn-Miller A. Exertional lower limb pain: a biomechanical approach to load distribution in running. *J Sci Med Sport.* 2017;3:9.
98. Reinking MF, Austin TM, Hayes AM. Exercise-related leg pain in collegiate cross-country athletes: extrinsic and intrinsic risk factors. *J Orthop Sports Phys Ther.* 2007;37(11):670-678.
99. James AM, Williams CM, Haines TP. Effectiveness of interventions in reducing pain and maintaining physical activity in children and adolescents with calcaneal apophysitis (Sever's disease): a systematic review. *J Foot Ankle Res.* 2013;6(1):16. doi: 10.1186/1757-1146-6-16.
100. Cassel M, Baur H, Hirschmuller A, Carlsohn A, Frohlich K, Mayer F. Prevalence of Achilles and patellar tendinopathy and their association to intratendinous changes in adolescent athletes. *Scand J Med Sci Sports.* 2014;25(3):e310-e318. doi: 10.1111/sms.12318. Epub 2014 Sep 11.
101. Grieve R, Cranston A, Henderson A, John R, Malone G, Mayall CH. The immediate effect of triceps surae myofascial trigger point therapy on restricted active ankle joint dorsiflexion in recreational runners: a cross-over randomised controlled trial. *J Bodyw Mov Ther.* 2013;17(4):453-461. doi: 10.1016/j.jbmt.2013.02.001. Epub 2013 Apr 21.
102. Malanga GA, Ramirez-Del Toro JA. Common injuries of the foot and ankle in the child and adolescent athlete. *Phys Med Rehabil Clin N Am.* 2008;19:347-371, ix. doi: 10.1016/j.pmr.2007.11.003.
103. Siow HM, Cameron DB, Ganley TJ. Acute knee injuries in skeletally immature athletes. *Phys Med Rehabil Clin N Am.* 2008;19:319-345, ix. doi: 10.1016/j.pmr.2007.11.005.
104. Weekrakkody Y, Gaillard AF. Salter-Harris classification. Radiopaedia. <https://radiopaedia.org/articles/salter-harris-classification?lang=us>. Accessed February 23, 2019.
105. Frush TJ, Lindenfeld TN. Peri-epiphyseal and over-use injuries in adolescent athletes. *Sports Health.* 2009;1(3):201-211.
106. Puentedura EJ, Louw A. A neuroscience approach to managing athletes with low back pain. *Phys Ther Sport.* 2012;13(3):123-133. doi: 10.1016/j.ptsp.2011.12.001. Epub 2011 Dec 27.
107. Standaert CJ. Low back pain in the adolescent athlete. *Phys Med Rehabil Clin N Am.* 2008;19:287-304, ix. doi: 10.1016/j.pmr.2008.01.002.
108. Wilson AC, Lewandowski AS, Palermo TM. Fear-avoidance beliefs and parental responses to pain in adolescents with chronic pain. *Pain Res Manage.* 2011;16(3):178-182.
109. Spitznagle TM, Sahrman S. Diagnosis and treatment of 2 adolescent female athletes with transient abdominal pain during running. *J Sport Rehabil.* 2011;20(2):228-249.
110. Scott M. How far does a soccer player run in a game? <http://www.livestrong.com/article/387950-how-far-does-a-soccer-player-run-during-a-game/>. Accessed March 10, 2019.
111. Creighton DW, Shrier I, Shultz R, et al. Return-to-play in sport: a decision-based model. *Clin J Sport Med.* 2010;20(5):379-385.
112. Burfoot A. The 10-Percent Rule. *Runner's World.* <http://www.runnersworld.com/running-tips/10-percent-rule>. Accessed February 3, 2019.
113. Beck K. Debunking the 10% rule. *Running Times.* <http://www.runnersworld.com/race-training/debunking-10-rule?page=single>. Accessed February 3, 2019.
114. Wilcox R, Canoa D, Boudreau S. Running injury prevention tips and return to running program. The Brigham and Women's Hospital, Inc. <https://www.brigham-womens.org/assets/BWH/patients-and-families/pdfs/le---running-injury-prevention-tips-and-return-to-running-program.pdf>. Accessed February 23, 2019.
115. Coyle EF, Martin WH, Sinacore DR, Joyner MJ, Hagberg JM, Holloszy JO. Time course of loss of adaptations after stopping prolonged intense endurance training. *J Appl Physiol Respir Environ Exerc Physiol.* 1984;57(6):1857-1864.
116. Ogasawara R, Yasuda T, Sakamaki M, Ozaki H, Abe T. Effects of periodic and continued resistance training on muscle CSA and strength in previously untrained men. *Clin Physiol Funct Imaging.* 2011;31(5):399-404. doi: 10.1111/j.1475-097X.2011.01031.x. Epub 2011 May 31.
117. Lemmer JT, Hurlbut DE, Martel GF, et al. Age and gender responses to strength training and detraining. *Med Sci Sports Exerc.* 2000;32(8):1505-1512.
118. Paquette MR, Peel SA, Smith RE, Temme M, Dwyer JN. The impact of different cross-training mo-

- dalities on performance and injury-related variables in high school cross country runners. *J Strength Cond Res.* 2018;32(6):1745-1753. doi: 10.1519/JSC.0000000000002042.
119. McCrory P, Meeuwisse W, Dvorak J, et al. Consensus statement on concussion in sport. The 5th International Conference on Concussion in Sport, Berlin, October 2016. *Br J Sports Med.* 2018;51:838-847.
  120. Chumanov ES, Wille CM, Michalski MP, Heiderscheit BC. Changes in muscle activation patterns when running step rate is increased. *Gait Posture.* 2012;36(2):231-235. doi: 10.1016/j.gaitpost.2012.02.023. Epub 2012 Mar 17.
  121. Lieberman DE, Warrener AG, Wang J, Castillo ER. Effects of stride frequency and foot position at landing on braking force, hip torque, impact peak force and the metabolic cost of running in humans. *J Exp Biol.* 2015;218(Pt 21):3406-3414. doi: 10.1242/jeb.125500.
  122. Heiderscheit BC, Chumanov ES, Michalski MP, Wille CM, Ryan MB. Effects of step rate manipulation on joint mechanics during running. *Med Sci Sports Exerc.* 2011;43(2):296-302. doi: 10.1249/MSS.0b013e3181e3181ebedf4.
  123. Lenhart R, Thelen D, Heiderscheit B. Hip muscle loads during running at various step rates. *J Orthop Sports Phys Ther.* 2014;44(10):766-774, A1-4. doi: 10.2519/jospt.2014.5575. Epub 2014 Aug 25.
  124. Hergenroeder AC. Prevention of sports injuries. *Pediatrics.* 1998;101(6):1057-1063.
  125. Cheatham SW, Kolber MJ, Cain M, Lee M. The effects of self-myofascial release using a foam roll or roller massager on joint range of motion, muscle recovery, and performance: a systematic review. *Int J Sports Phys Ther.* 2015;10(6):827-838.
  126. Sanjana F, Chaudhry H, Findley T. Effect of MELT method on thoracolumbar connective tissue: the full study. *J Bodyw Mov Ther.* 2017;21(1):179-185. doi: 10.1016/j.jbmt.2016.05.010. Epub 2016 Jun 3.
  127. Gamble P. *Training for Sports Speed and Agility.* New York, NY: Routledge; 2012.
  128. Blagrove, RC, Howe LP, Cushion EJ, et al. Effects of strength training on postpubertal adolescent distance runners. *Med Sci Sports Exerc.* 2018;50(6):1224-1232. doi: 10.1249/MSS.0000000000001543.
  129. Vaughn JM, Micheli L. Strength training recommendations for the young athlete. *Phys Med Rehabil Clin N Am.* 2008;19:235-245, viii. doi: 10.1016/j.pmr.2007.11.004.
  130. Faigenbaum AD, Kraemer WJ, Blimkie CJ, et al. Youth resistance training: updated position statement paper from the national strength and conditioning association. *Strength Cond Res.* 2009; 23(5): S60-S79. doi: 10.1519/JSC.0b013e31819df407.
  131. Ingle L, Sleaf M, Tolfrey K. The effect of a complex training and detraining programme on selected strength and power variables in early pubertal boys. *J Sports Sci.* 2006;9:987-997.
  132. Norris SR, Smith DJ. Planning, periodization, and sequencing of training and competition: the rationale for a competently planned, optimally executed training and competition program, supported by a multidisciplinary team. In: Kellmann M, ed. *Enhancing Recovery: Preventing Underperformance in Athletes.* Champaign, IL: Human Kinetics; 2002:119-141.
  133. Clark AW, Goedeke MK, Cunningham SR, Rockwell DE, Lehecka BJ, Manske RC. Effects of pelvic and core strength training on high school cross-country race times. *J Strength Cond Res.* 2017;31(8):2289-2295. doi: 10.1519/JSC.0000000000001729.
  134. Eisenmann J, Malina R. Age- and sex-associated variation in neuromuscular capacities of adolescent distance runners. *J Sports Sci.* 2003;21(7):551-557.
  135. Davies G, Riemann BL, Manske R. Current concepts of plyometric exercise. *Int J Sports Phys Ther.* 2015;10(6):760-786.
  136. Chmielewski TL, Myer GD, Kauffman D, Tillman SM. Plyometric exercise in the rehabilitation of athletes: physiological responses and clinical application. *J Orthop Sports Phys Ther.* 2006;36(5):308-319.
  137. Temfemo A, Hugues J, Chardon K, Mandengue SH, Ahmaidi S. Relationship between vertical jumping performance and anthropometric characteristics during growth in boys and girls. *Eur J Pediatr.* 2009;168:457-464. doi: 10.1007/s00431-008-0771-5. Epub 2008 Jul 3.
  138. Armstrong N, Welsman JR. Assessment and interpretation of aerobic fitness in children and adolescents. *Exerc Sport Sci Rev.* 1994;22:435-476.
  139. Joy E, De Souza MJ, Nattiv A, et al. 2014 female athlete triad coalition consensus statement on treatment and return to play of the female athlete triad. *Curr Sports Med Rep.* 2014;13(4):219-232. doi: 10.1249/JSR.0000000000000077.
  140. Thein-Nissenbaum JM, Carr KE. Female athlete triad syndrome in the high school athlete. *Phys Ther Sport.* 2011;12(3):108-116. doi: 10.1016/j.ptsp.2011.04.002. Epub 2011 Jul 13.
  141. Thein-Nissenbaum JM, Hammer E. Treatment strategies for the female athlete triad in the adolescent athlete: current perspective. *Open Access J Sports Med.* 2017;8:85-95. doi: 10.2147/OAJSM.S100026. eCollection 2017.
  142. Female athlete triad: committee opinion no.702. American College of Obstetricians and Gynecologists. *Obstet Gynecol.* 2017;129:e160-e167. doi: 10.1097/AOG.0000000000002113.
  143. Deimel JF, Dunlap BJ. The female athlete triad. *Clin Sports Med.* 2012;31(2):247-254. doi: 10.1016/j.csm.2011.09.007.

144. Kraus E, Tenforde AS, Nattiv A, Sainani KL, Kussman A, Deakins-Roche M. Bone stress injuries in male distance runners: higher modified Female Athlete Triad Cumulative Risk Assessment scores predict increased rates of injury. *Br J Sports Med.* 2018;53(3):237-242.
145. Link M. What is relative energy deficiency in sport (RED-S)? Beyond the female athlete triad and the role of the physical therapist. Paper presented at: Current Topics for Care of the Pediatric and Adolescent Athlete 2018; October 19, 2018; Philadelphia, PA.
146. Javed A, Tebben PJ, Fischer PR, Lteif AN. Female athlete triad and its components: toward improved screening and management. *Mayo Clin Proc.* 2013;88(9):996-1009. doi: 10.1016/j.mayocp.2013.07.001.
147. Chen YT, Tenforde AS, Fredericson M. Update on stress fracture in female athletes: epidemiology, treatment, and prevention. *Curr Rev Musculoskelet Med.* 2013;6:173-181. doi: 10.1007/s12178-013-9167-x.
148. Hoch AZ, Gooseen K, Kretschmer T. Nutritional requirements of the child and teenage athlete. *Phys Med Rehabil Clin N Am.* 2008;19:373-398. doi: 10.1016/j.pmr.2007.12.001.
149. Barrack MT, Van Loan MD, Rauh MJ, Nichols JF. Body mass, training, menses, and bone in adolescent runners: a 3-yr follow-up. *Med Sci Sports Exerc.* 2011;43(6):959-966. doi: 10.1249/MSS.0b013e318201d7bb.
150. Joy E. Is the pill the answer for patients with the female athlete triad? *Curr Sports Med Rep.* 2012;11(2):54-55. doi: 10.1249/JSR.0b013e3182499e86.
151. Barrack MT, Gibbs JC, De Souza MJ, et al. Higher incidence of bone stress injuries with increasing female athlete triad-related risk factors: a prospective multisite study of exercising girls and women. *Am J Sports Med.* 2014;42(4):949-958. doi: 10.1177/0363546513520295. Epub 2014 Feb 24.
152. Gavin ML. Vitamin D. TeensHealth. <https://kidshealth.org/en/teens/vitamind.html>. Accessed March 2, 2019.
153. Sonnevile KR, Gordon CM, Kocher MS, Pierce LM, Ramappa A, Field AE. Vitamin D, calcium, and dairy intakes and stress fractures among female adolescents. *Arch Pediatr Adolesc Med.* 2012;166(7):595-600. doi: 10.1001/archpediatrics.2012.5.
154. Wentz L, Liu PY, Ilich JZ, Haymes EM. Dietary and training predictors of stress fractures in female runners. *Int J Sport Nutr Exerc Metab.* 2012;22(5):374-382.
155. Brocherie F, Girard O, Millet GP. Emerging environmental and weather challenges in outdoor sports. *Climate.* 2015;3(3):492-521.
156. Khodae M, Grothe HL, Seyfert JH, VanBaak K. Athletes at high altitude. *Sports Health.* 2016;8(2):126-132.
157. Tenforde AS, Sayres LC, McCurdy ML, Sainani KL, Fredericson M. Evaluating the relationship of calcium and vitamin D in the prevention of stress fracture injuries in the young athlete: a review of the literature. *PM R.* 2010;2(10):945-949. doi: 10.1016/j.pmrj.2010.05.006.
158. American Academy of Pediatrics. American Academy of Pediatrics supports childhood sleep guidelines. <https://www.aap.org/en-us/about-the-aap/aap-press-room/Pages/American-Academy-of-Pediatrics-Supports-Childhood-Sleep-Guidelines.aspx>. Accessed February 26, 2019.
159. The impact of childhood obesity on bone, joint, and muscle health. OrthoInfo. <https://orthoinfo.aaos.org/en/staying-healthy/the-impact-of-childhood-obesity-on-bone-joint-and-muscle-health/>. Accessed March 16, 2019.
160. Dugan S. Exercise for preventing childhood obesity. *Phys Med Rehabil Clin N Am.* 2008;19:205-216, vii. doi: 10.1016/j.pmr.2007.11.001.
161. Drake C, Roehrs T, Shambroom J, Roth T. Caffeine effects on sleep taken 0, 3, or 6 hours before going to bed. *J Clin Sleep Med.* 2013;9(11):1195-1200. doi: 10.5664/jcsm.3170.
162. Smith K, Iversen C, Kossowsky J, O'Dell S, Gambhir R, Coakley R. Apple apps for the management of pediatric pain and pain-related stress. *Clin Pract Pediatr Psychol.* 2015;3(2):93-107.
163. De Brito Fontana HB. Effect of gender, cadence, and water immersion on ground reaction forces during stationary running. *J Orthop Sports Phys Ther.* 2012;42(5):437-443. doi: 10.2519/jospt.2012.3572. Epub 2012 Mar 8.
164. Schubert AG, Kempf J, Heiderschiet BC. Influence of stride frequency and length of running mechanics: a systematic review. *Sports Health.* 2014;6(3):210-217. doi: 10.1177/1941738113508544.
165. Luedke LE, Heiderschiet BC, Williams DS, Rauh MJ. Factors associated with self-selected step rate in high school cross country runners. *J Strength Cond Res.* 2018 Oct 17. doi: 10.1519/JSC.0000000000002891. [Epub ahead of print]
166. Nippert AH, Smith AM. Psychologic stress related to injury and impact on sport performance. *Phys Med Rehabil Clin N Am.* 2008;19:399-418. doi: 10.1016/j.pmr.2007.12.003.