SUPPLEMENTARY INFORMATION

TABLE 1– HEIGHT, WEIGHT and BMI

Author (Year)	Study Design	No. of Subjects	Population Age Range	Population Sex	Outcome Measure	Summary	Level of Evidence
Rauh 2006[14]	Prospective Cohort	421	14-8 yr	186 F / 235 M high school cross country runners	Injuries	• The overall incidence rate of injury was 17.0/1,000 AE. • Runners with a BMI in the first (RR=0.8; 95% CI: 0.6, 1.1) and fourth (RR=1.1; 95% CI: 0.8, 1.5) quartiles had a similar injury risk as runners with a BMI in the combined second and third quartiles (reference group).	2
Yagi 2013[15]	Cohort	230	14-18 yr	186 F / 235 M high school cross country runners	Shin pain (medial tibial stress syndrome & stress fracture)	• Injury rate for medial tibial stress syndrome was 0.29/1000 AE (n=102) and for stress fracture was 0.06/1000 AE (n=21). • In females, the odds of incurring medial tibial stress syndrome increased with BMI (adjusted OR, 0.51; 95% CI: 0.31, 0.86).	4
Plisky 2006[16]	Prospective Cohort	105	13-18 yr	46 F / 59 M high school cross country runners	Medial tibial stress syndrome	• Injury rate for medial tibial stress syndrome was 2.8/1000 AE overall • Runners with a BMI in the third quartile (20.2-21.6 kg/m^2) had 7.3 times greater odds of developing medial tibial stress syndrome (OR=7.3, 95% CI: 1.2, 43.5) than runners in the second quartile (18.8-20.1 kg/m^2 [reference group]).	2
Tenforde 2013[17]	Prospective Cohort	748	13-18 yr	442 F / 306 M high school runners	Stress fractures	• Prospective stress fractures in 5.4% of girls (n = 23) and 4.0% of boys (n = 11). • BMI < 19 kg/m^2, (HR=2.67; 95% CI: 1.11, 6.41) was an independent risk factors for stress fractures in girls.	2

BMI, body mass index; HR, hazard ratio; OR, odds ratio; RR, rate ratio, CI, confidence interval; AE, athletic exposure

REFERENCES: TABLE 1– HEIGHT, WEIGHT and BMI

14. Rauh MJ, Koepsell TD, Rivara FP, et al. Epidemiology of musculoskeletal injuries among high school cross-country runners. *Am J Epidemiol* 2006;163(2):151-9. doi: 10.1093/aje/kwj022 [published Online First: 2005/11/23] [LOE 2]
15. Yagi S, Muneta T, Sekiya I. Incidence and risk factors for medial tibial stress syndrome and tibial stress fracture in high school runners. *Knee Surg Sports Traumatol Arthrosc* 2013;21(3):556-63. doi: 10.1007/s00167-012-2160-x [published Online First: 2012/08/09] [LOE 4]
16. Plisky MS, Rauh MJ, Heiderscheit B, et al. Medial tibial stress syndrome in high school cross-country runners: incidence and risk factors. *J Orthop Sports Phys Ther* 2007;37(2):40-7. doi: 10.2519/jospt.2007.2343 [LOE 2]
17. Tenforde AS, Sayres LC, McCurdy ML, et al. Identifying sex-specific risk factors for stress fractures in adolescent runners. *Med Sci Sports Exerc* 2013;45(10):1843-51. doi: 10.1249/MSS.0b013e3182963d75 [LOE 2]

TABLE 2 – AGE

Author (Year)	Study Design	No. of Subjects	Population Age Range	Population Sex	Outcome Measure	Summary	Level of Evidence
Mehl 2011[4]	Descriptive Epidemiology	6327	6-18 yr	3064 F / 3263 M runners	Injuries	• Overall annual injury was 30.7 injuries per 100,000 US population and increased 21.0% during the study period, from 24.2 injuries per 100,000 US population in 1994 to 29.3 injuries per 100,000 U.S. population in 2007. • Children aged 12-14 yr had the highest injury rate, 45.8 injuries per 100,000 US population.	4
Roberts 2010[18]	Retrospective Cohort	310	7-17 yr	85 F / 225 M marathon runners	Medical encounters	• 310 youth successfully finished Twin Cities Marathon over 26 years with only 4 requiring post-race medical encounter. • The risk for an acute race day medical attention in youths was less than, but not significantly different from adults (odds ratio =0.52, 95% CI: 0.19, 1.39).	4
Rauh 2014[19]	Prospective Cohort	421	13-18 yr	186 F / 235 M high school cross country	Injuries	• Age was not significantly different between runners who did (15.6±1.3 yr) and did not (15.6±1.1 yr) sustain an injury (P = 0.80). • For girls, age was not significantly different between runners who did (15.7±1.2 yr) and did not (15.6±1.1 yr) sustain an injury. (P=0.65) • For boys, age was not significantly different between runners who did (15.4±1.4 yr) and did not (15.6±1.2 yr) sustain an injury. (P=0.38)	2
Bennett 2001[20]	Prospective Cohort	125	13-18 yr	68 F / 57 M high school cross country	Medial tibial stress syndrome	• Age was not significantly different between runners who did (15.3±1.0 yr) and did not (15.7±1.5 yr) develop medial tibial stress syndrome.	4
Huxley 2014[21]	Prospective Cohort	103	13-17 yr	66 F / 34 M / 3 Unidentified Elite track and field	Injuries	• Injured athletes self-reported training at a higher weekly intensity and a higher yearly training load at 13-14 years ($p<0.01$) compared to uninjured athletes • Injured athletes reported training was 'harder' each week than uninjured athletes at 13-14 years ($p<0.01$). and at 15-16 years ($p<0.05$)	4

REFERENCES: TABLE 2 – AGE

4. Mehl AJ, Nelson NG, McKenzie LB. Running-related injuries in school-age children and adolescents treated in emergency departments from 1994 through 2007. *Clin Pediatr (Phila)* 2011;50(2):126-32. doi: 10.1177/0009922810384719 [published Online First: 2010/10/20] [LOE 4]
18. Roberts WO, Nicholson WG. Youth marathon runners and race day medical risk over 26 years. *Clin J Sport Med* 2010;20(4):318-21. doi: 10.1097/JSM.0b013e3181e6301d [LOE 4]
19. Rauh MJ. Summer training factors and risk of musculoskeletal injury among high school cross-country runners. *J Orthop Sports Phys Ther* 2014;44(10):793-804. doi: 10.2519/jospt.2014.5378 [published Online First: 2014/09/05] [LOE 2]
20. Bennett JE, Reinking MF, Pluemer B, et al. Factors contributing to the development of medial tibial stress syndrome in high school runners. *J Orthop Sports Phys Ther* 2001;31(9):504-10. doi: 10.2519/jospt.2001.31.9.504 [LOE 4]
21. Huxley DJ, O'Connor D, Healey PA. An examination of the training profiles and injuries in elite youth track and field athletes. *Eur J Sport Sci* 2014;14(2):185-92. doi: 10.1080/17461391.2013.809153 [published Online First: 2013/06/19] [LOE 4]

TABLE 3 – SEX

Author (Year)	Study Design	No. of Subjects	Population Age Range	Population Sex	Outcome Measure	Summary	Level of Evidence
Rauh 2006[14]	Prospective Cohort	421	14-18 yr	186 F / 235 M high school cross country	Injuries	• Girls had a higher overall injury rate (19.6/1,000 AEs) than boys did (15.0/1,000 AE) (incidence rate ratio=1.3, 95% CI: 1.0, 1.6). • Compared with boys, girls had significantly higher rates of injuries resulting in ≥15 days of disability (incidence rate ratio=3.2, 95% CI: 1.4-8.0).	2
Plisky 2006[16]	Prospective Cohort	105	13-18 yr	46 F / 59 M high school cross country	Medial tibial stress syndrome	• Overall injury rate for girls was 4.3/1000 AE and for boys was 1.7/1000 AE (rate ratio=2.5, 95% CI: 0.9, 8.2).	2
Tenforde 2013[17]	Prospective Cohort	748	13-18 yr	442 F / 306 M high school runners	Stress fractures	• 32 injuries occurred in 5.4% of girls (n=23). • 12 injuries occurred in 4.0% of boys (n=11).	2
Bennett 2001[20]	Prospective Cohort	125	13-18 yr	68 F / 57 M high school cross country	Medial tibial stress syndrome	• Injuries occurred in 19.6% of girls and 3.6% of boys. • Sex was associated with medial tibial stress syndrome (χ^2=7.15, df = 1, p=0.007 with 24% of the variability in occurrence of injury is due to sex.	4
Tirabassi 2016[22]	Descriptive Epidemiology	National database	high school aged	NA	Injuries (medical disqualification)	• Medial disqualification injury rates were higher among girls than boys for cross country (rate ratio=2.6; 95% CI: 1.0, 7.5) and track and field (rate ratio=2.6; 95% CI: 1.7, 4.0).	4
Changstrom 2015[23]	Descriptive Epidemiology	389	13-19 yr	210 F / 179 M high school	Stress fractures	• Stress fracture injury rates for girls' cross country (10.62/100,000 AE) was higher than boys' cross country (5.42/100,000 AE) (rate ratio=1.75; 95% CI: 1.38, 2.23).	4
Reinking 2010[24]	Prospective Cohort	125	13-18 yr	62 F /63 M high school cross country	Exercise-related leg pain	• No difference between girls and boys in occurrence of exercise-related leg pain (RR=0.93, 95% CI: 0.61, 1.42)	2
Rauh 2000[25]	Prospective Cohort	3233	14-18 yr	1202 F / 2031 M high school cross country	Injuries	• Girls had a higher injury rate (16.7/1,000 AE) than boys (10.9/1,000AE) (rate ratio=1.5, 95% CI: 1.4, 1.7). • Girls had a higher rate of subsequent injury to the same body part (44.1/1,000 AE) than boys (37.6/1,000AE) (rate ratio=1.4, 95% CI: 1.2, 1.6).	2

Beachy 1997[26]	Descriptive Epidemiology	4,024	7th-12th grade	787 F /501 M high school & middle school cross country 1531 F / 1205 M high school & middle school track & field	Injuries	• Cross country: Injury occurrence for boys was 48% and girls was 47.0%. • Track & Field: Injury occurrence for boys was 48% and girls was 52.0%.	4
McLain 1989[27]	Descriptive Epidemiology	229	9th-12th grade	40 F / 54 M high school cross country 65 F / 70 M high school track & field	Injuries	• Cross country: Injury occurrence for boys was 13.0% and girls was 7.5%. • Track & Field: Injury occurrence for boys was 10.0% and girls was 18.5%.	4
Lowe 1987[28]	Descriptive Epidemiology	634	9th-12th grade	63 F /125 M high school cross country 167 F / 279 M high school track & field	Injuries	• Cross country: Injury occurrence for boys was 1.6% and girls was 1.6%. • Track & Field: Injury occurrence for boys was 1.4% and girls was 1.2%.	4
Chandy 1985[29]	Prospective Cohort	12,920	9th-12th grade	711 F /1567 M high school cross country 4235 F / 6407 M high school track & field	Injuries	• Cross country: Injury occurrence for boys was 1.5% and girls was 1.1%. • Track & Field: Injury occurrence for boys was 1.6% and girls was 1.1%.	4
Shively 1981[30]	Prospective Cohort	3,399	9th-12th grade	187 F /389 M high school cross country 1141 F / 1682 M high school track & field	Injuries	• Cross country: Injury occurrence for boys was 2.3% and girls was 0.0%. • Track & Field: Injury occurrence for boys was 1.7% and girls was 0.7%.	4

Garrick 1978[31]	Prospective Cohort	167	9th-12th grade	26 F /141 M high school cross country	Injuries	• Injury occurrence for boys was 29.1% and girls was 34.6%.	4
Pierpoint 2016[32]	Descriptive Epidemiology	NA	9th-12th grade	NA	Injuries	• Girls had higher overall injury rates (rate ratio=1.37; 95% CI: 1.27, 1.48) and practice injury rates (rate ratio=1.60; 95% CI: 1.46, 1.76) than boys.	4
Knowles 2006[33]	Prospective Cohort	2,269	9th-12th grade	1266 F / 1003 M high school track & field	Injuries	• Injury rates for girls was 1.18/1,000 AE (95% CI: 0.75, 1.83) and boys was 1.06/1,000 AE (95% CI: 0.62, 1.81).	2
Watson 1987[34]	Prospective Cohort	234	9th-12th grade	78 F / 156 M high school track & field	Injuries	• Injury occurrence for boys was 19.1% and girls was 14.1%.	4
Requa 1981[35]	Prospective Cohort	516	9th-12th grade	208 F / 308 M high school track & field	Injuries	• Injury occurrence for boys was 32.8% and girls was 35.1%.	4
Beachy 2014[36]	Prospective Cohort	4,592	7th-8th grade	756 F / 710 M middle school cross country 1537 F / 1589 M middle school track & field	Injuries	• Cross-country: Girls had higher rate of injuries (10.9/1000 AE) than boys (8.0/1000 AE) (rate ratio=1.36, 95% CI 1.2, 1.6). • Track & Field: Girls had higher rate of injuries (12.2/1000 AE) than boys (8.3/1000 AE) (rate ratio=1.46, 95% CI 1.2, 1.6).	4

CI, confidence interval; AE, athletic exposure

REFERENCES: TABLE 3 – SEX

14. Rauh MJ, Koepsell TD, Rivara FP, et al. Epidemiology of musculoskeletal injuries among high school cross-country runners. *Am J Epidemiol* 2006;163(2):151-9. doi: 10.1093/aje/kwj022 [published Online First: 2005/11/23] [LOE 2]
16. Plisky MS, Rauh MJ, Heiderscheit B, et al. Medial tibial stress syndrome in high school cross-country runners: incidence and risk factors. *J Orthop Sports Phys Ther* 2007;37(2):40-7. doi: 10.2519/jospt.2007.2343 [LOE 2]
17. Tenforde AS, Sayres LC, McCurdy ML, et al. Identifying sex-specific risk factors for stress fractures in adolescent runners. *Med Sci Sports Exerc* 2013;45(10):1843-51. doi: 10.1249/MSS.0b013e3182963d75 [LOE 2]
20. Bennett JE, Reinking MF, Pluemer B, et al. Factors contributing to the development of medial tibial stress syndrome in high school runners. *J Orthop Sports Phys Ther* 2001;31(9):504-10. doi: 10.2519/jospt.2001.31.9.504 [LOE 4]
22. Tirabassi J, Brou L, Khodaee M, et al. Epidemiology of High School Sports-Related Injuries Resulting in Medical Disqualification: 2005-2006 Through 2013-2014 Academic Years. *Am J Sports Med* 2016;44(11):2925-32. doi: 10.1177/0363546516644604 [published Online First: 2016/05/10] [LOE 4]
23. Changstrom BG, Brou L, Khodaee M, et al. 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 [published Online First: 2014/12/05] [LOE 4]
24. Reinking MF, Austin TM, Hayes AM. Risk factors for self-reported exercise-related leg pain in high school cross-country athletes. *J Athl Train* 2010;45(1):51-7. doi: 10.4085/1062-6050-45.1.51[LOE 2]
25. Rauh MJ, Margherita AJ, Rice SG, et al. High school cross country running injuries: a longitudinal study. *Clin J Sport Med* 2000;10(2):110-6. doi: 10.1097/00042752-200004000-00005 [LOE 2]
26. Beachy G, Akau CK, Martinson M, et al. High school sports injuries. A longitudinal study at Punahou School: 1988 to 1996. *Am J Sports Med* 1997;25(5):675-81. doi: 10.1177/036354659702500515 [LOE 2]
27. McLain LG, Reynolds S. Sports injuries in a high school. *Pediatrics* 1989;84(3):446-50. [LOE 4]
28. Lowe EB, Perkins ER, Herndon JH. Rhode Island high school athletic injuries 1985-86. *R I Med J* 1987;70(6):265-70. [LOE 4]
29. Chandy TA, Grana WA. SECONDARY SCHOOL ATHLETIC INJURY IN BOYS AND GIRLS: A THREE-YEAR COMPARISON. *Journal of Pediatric Orthopaedics* 1985;5(5):629. [LOE 4]
30. Shively RA, Grana WA, Ellis D. High School Sports Injuries. *Phys Sportsmed* 1981;9(8):46-50. doi: 10.1080/00913847.1981.11711135. [LOE 4]
31. Garrick JG, Requa RK. Injuries in high school sports. *Pediatrics* 1978;61(3):465-9. doi: 10.1542/peds.61.3.465 [LOE 4]
32.Pierpoint LA, Williams CM, Fields SK, et al. Epidemiology of Injuries in United States High School Track and Field: 2008-2009 Through 2013-2014. *Am J Sports Med* 2016;44(6):1463-8. doi: 10.1177/0363546516629950 [published Online First: 2016/02/26] [LOE 4]
33. Knowles SB, Marshall SW, Bowling JM, et al. A prospective study of injury incidence among North Carolina high school athletes. *Am J Epidemiol* 2006;164(12):1209-21. doi: 10.1093/aje/kwj337 [published Online First: 2006/09/29] [LOE 4]
34. Watson MD, DiMartino PP. Incidence of injuries in high school track and field athletes and its relation to performance ability. *Am J Sports Med* 1987;15(3):251-4. doi: 10.1177/036354658701500310 [LOE 4]
35. Requa RK, Garrick JG. Injuries in Interscholastic Track and Field. *Phys Sportsmed* 1981;9(3):42-9. doi: 10.1080/00913847.1981.11711030 [LOE 4]
36. Beachy G, Rauh M. Middle School Injuries: A 20-Year (1988–2008) Multisport Evaluation. *Journal of Athletic Training* 2014;49(4):493-506. doi: 10.4085/1062-6050-49.2.19 [LOE 4]

TABLE 4 – PREVIOUS INJURY

Author (Year)	Study Design	No. of Subjects	Population Age Range	Population Sex	Outcome Measure	Summary	Level of Evidence
Rauh 2006[14]	Prospective Cohort	421	14-18 yr	186 F / 235 M high school cross country	Injuries	• Overall injury rate of 17.0/1000 AE • Overall rate of re-injury to same body part was highest in the shin (73.6/1000 AE), hip (53.8/1000 AE) and knee (41.8/1000 AE) • Previous injury (adjusted RR 1.2, 95% CI: 1.0, 1.5) and summer preseason injury (adjusted RR 1.4, 95% CI: 1.0, 1.9) were associated with future injury	2
Plisky 2006[16]	Prospective Cohort	105	13-18 yr	46 F / 59 M high school cross country	MTSS	• Overall MTSS injury rate of 2.8/1000 AE • Runners with a previous injury were at greater odds (OR=2.2, 0.7, 6.4) of developing MTSS than runners without prior injury.	2
Tenforde 2013[17]	Prospective Cohort	748	13-18 yr	442 F: / 306 M high school runners	Stress fractures	• Stress fractures occurred in 5.4% of girls (n = 23) and 4.0% of boys (n = 11). • Prior fracture was an independent risk factor for stress fractures in girls (HR 5.83, 95% CI: 2.32, 14.67) and boys (HR 5.73, 95% CI: 1.52, 21.67).	2
Reinking 2010[24]	Prospective Cohort	125	13-18 yr	62 F /63 M high school cross country	Exercise-related leg pain	• 103/125 respondents (82.4%) reported a history of exercise-related leg pain. • 45/93 respondents (48%) reported experiencing exercise-related leg pain during the season. • Runners with a history of exercise-related leg pain were at 9 times greater risk of exercise-related leg pain during the season (RR=9.14. 1.36-61.59) than runners without a history.	2
Rauh 2000[25]	Prospective Cohort	3233	14-18 yr	1202 F / 2031 M high school cross country	Injuries	• Initial injury rate was 8.7/1,000 AE. • Subsequent injury rates were 37.6/1,000 AE to the same body part and 3.7/1,000 AE to a new body part.	2

AE, athletic exposure; RR, rate ratio; OR, odds ratio; HR, hazard ratio; CI, confidence interval

REFERENCES: TABLE 4 – PREVIOUS INJURY

14. Rauh MJ, Koepsell TD, Rivara FP, et al. Epidemiology of musculoskeletal injuries among high school cross-country runners. *Am J Epidemiol* 2006;163(2):151-9. doi: 10.1093/aje/kwj022 [published Online First: 2005/11/23] [LOE 2]
16. Plisky MS, Rauh MJ, Heiderscheit B, et al. Medial tibial stress syndrome in high school cross-country runners: incidence and risk factors. *J Orthop Sports Phys Ther* 2007;37(2):40-7. doi: 10.2519/jospt.2007.2343 [LOE 2]
17. Tenforde AS, Sayres LC, McCurdy ML, et al. Identifying sex-specific risk factors for stress fractures in adolescent runners. *Med Sci Sports Exerc* 2013;45(10):1843-51. doi: 10.1249/MSS.0b013e3182963d75 [LOE 2]
24. Reinking MF, Austin TM, Hayes AM. Risk factors for self-reported exercise-related leg pain in high school cross-country athletes. *J Athl Train* 2010;45(1):51-7. doi: 10.4085/1062-6050-45.1.51[LOE 2]
25. Rauh MJ, Margherita AJ, Rice SG, et al. High school cross country running injuries: a longitudinal study. *Clin J Sport Med* 2000;10(2):110-6. doi: 10.1097/00042752-200004000-00005 [LOE 2]

TABLE 5 – ALIGNMENT and STRENGTH

Author (Year)	Study Design	No. of Subjects	Population Age Range	Population Sex	Outcome Measure	Summary	Level of Evidence
Yagi 2013[15]	Cohort	230	14-18 yr	96 F / 134 M high school cross country	Shin pain (Medial tibial stress syndrome & stress fracture)	• Increased internal rotation of the hip significantly decreased the odds of sustaining medial tibial stress syndrome in females (adjusted OR=0.91; 95% CI: 0.85, 0.99). • Increased straight leg raise significantly increased the risk of stress fracture in males (adjusted OR=1.38; 95 % CI: 1.04, 1.83).	4
Plisky 2006[16]	Prospective Cohort	105	13-18 yr	46 F / 59 M high school cross country	Medial tibial stress syndrome	• Runners with a navicular drop >10mm were at the same risk (OR=0.9; 95% CI: 0.3, 2.8) than runners with a navicular drop ≤10mm.	2
Rauh 2007[37]	Prospective Cohort	393	14-18 yrs	171 F / 222 M high school cross country	Injuries	• Runners with a Q-angle ≥20° had higher risk of injury than runners with a Q-angle <20° (rate ratio=1.7; 95% CI: 1.2, 2.4). • Runners with a right-left Q-angle difference ≥4° had a higher injury risk than runners with a right-left Q-angle difference <4° (rate ratio=1.8; 95% CI: 1.4, 2.5).	2
Rauh 2018[38]	Prospective Cohort	393	14-18 yrs	171 F / 222 M high school cross country	Injuries	• Boys with a leg-length inequality >1.5 cm had higher odds of injury than boys with a leg-length inequality <0.5 cm (OR=7.47, 95% CI: 1.5, 36.9).	4
Luedke 2015[39]	Prospective Cohort	68	13-18 yrs	47 F / 20 M high school cross country	Injuries	• Runners in the tertiles indicating weakest hip abductors (p=0.046), knee extensor (p=0.038), and hip knee flexor muscle strength (p=0.046) had higher occurrence of anterior knee pain.	2
Finnoff 2011[40]	Prospective Cohort	98	14-18 yrs	45 F /53 M high school cross country	Patellofemoral pain	• Greater baseline hip abduction strength (OR=5.35, 95% CI: 1.46-19.53) and abduction-to-adduction strength ratio (OR=14.14, 95% CI: 0.90, 221.06) increased the odds of patellofemoral pain. • Greater pre-injury hip ER:IR strength ratio decreased the odds of patellofemoral pain (OR=0.01, 95% CI: <0.01, 0.44).	2

CI, confidence interval; OR, odds ratio

REFERENCES: TABLE 5 – ALIGNMENT and STRENGTH

15. Yagi S, Muneta T, Sekiya I. Incidence and risk factors for medial tibial stress syndrome and tibial stress fracture in high school runners. *Knee Surg Sports Traumatol Arthrosc* 2013;21(3):556-63. doi: 10.1007/s00167-012-2160-x [published Online First: 2012/08/09] [LOE 4]
16. Plisky MS, Rauh MJ, Heiderscheit B, et al. Medial tibial stress syndrome in high school cross-country runners: incidence and risk factors. *J Orthop Sports Phys Ther* 2007;37(2):40-7. doi: 10.2519/jospt.2007.2343 [LOE 2]
37. Rauh MJ, Koepsell TD, Rivara FP, et al. Quadriceps angle and risk of injury among high school cross-country runners. *J Orthop Sports Phys Ther* 2007;37(12):725-33. doi: 10.2519/jospt.2007.2453 [published Online First: 2007/08/29] [LOE 2]
38. Rauh MJ. LEG-LENGTH INEQUALITY AND RUNNING-RELATED INJURY AMONG HIGH SCHOOL RUNNERS. *Int J Sports Phys Ther* 2018;13(4):643-51. [LOE 2]
39. Luedke LE, Heiderscheit BC, Williams DS, et al. ASSOCIATION OF ISOMETRIC STRENGTH OF HIP AND KNEE MUSCLES WITH INJURY RISK IN HIGH SCHOOL CROSS COUNTRY RUNNERS. *Int J Sports Phys Ther* 2015;10(6):868-76.[LOE 2]
40. Finnoff JT, Hall MM, Kyle K, et al. Hip strength and knee pain in high school runners: a prospective study. *PM R* 2011;3(9):792-801. doi: 10.1016/j.pmrj.2011.04.007 [published Online First: 2011/08/06] [LOE2]

TABLE 6 - BONE STRESS INJURY

Author (Year)	Study Design	No. of Subjects	Population Age Range	Population Sex	Outcome Measure	Summary	Level of Evidence
Tenforde 2013[17]	Prospective Cohort	748	13-18 yr	442 F / 306 M high school	Stress fractures	• Prospective stress fractures in 5.4% of girls (n = 23) and 4.0% of boys (n = 11). • Tibial stress fractures were most common in girls, and the metatarsus was most frequently fractured in boys. • Independent risk factors for stress fractures in girls included: prior fracture (HR 5.83, 95% CI: 2.32, 14.67), body mass index < 19 kg/m2, (HR 2.67, 95% CI: 1.11, 6.41) late menarche (age menarche ≥15 yr), (HR 2.49, 95% CI: 1.01, 6.17) and previous participation in gymnastics or dance (HR 3.13, 95% CI: 1.20, 9.15). • Independent risk factors for stress fractures in boys included prior fracture (HR 5.73, 95% CI: 1.52, 21.67) and increased number of seasons (HR 2.35, 95% CI: 1.12, 5.00).	2
Changstrom 2015[23]	Descriptive Epidemiology	389	13-19 yr	210 F / 179 M high school athletes	Stress fractures	• Overall stress fracture injury rate of 1.54/100,000 AE. • The most commonly injured sites were the lower leg (40.3% of all stress fractures), foot (34.9%), and lower back/lumbar spine/pelvis (15.2%). • Stress fracture injury rates were 10.62/100,000 AE for girls' cross country and 5.42/100,000 for boys' cross country. • Girls sustained more stress fractures (63.3%) than boys (36.7%) and had higher rates of stress fracture (2.22 vs 1.27; rate ratio, 1.75; 95% CI: 1.38, 2.23).	4
Field 2011[44]	Prospective Cohort	6831	9-15 yr	6831 F adolescents	Stress fractures	• During seven years of follow-up, 267 females (3.9%) developed a stress fracture. • Hours per week of running (RR=1.13, 95% CI: 1.04, 1.23), basketball (RR=1.12, 95% CI 1.03, 1.22) and cheerleading and gymnastics (RR=1.12, 95% CI 1.02, 1.23) were significant predictors of developing a stress fracture independent of age, age at menarche, family history of fracture, and hours per week of low- and moderate-impact activity.	2

BMD, bone mineral density; RR, relative risk; HR, hazard ratio; CI, confidence interval; AE = athletic exposure

REFERENCES: TABLE 6 - BONE STRESS INJURY

17. Tenforde AS, Sayres LC, McCurdy ML, et al. Identifying sex-specific risk factors for stress fractures in adolescent runners. *Med Sci Sports Exerc* 2013;45(10):1843-51. doi: 10.1249/MSS.0b013e3182963d75 [LOE 2]
23. Changstrom BG, Brou L, Khodaee M, et al. 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 [published Online First: 2014/12/05] [LOE 4]
44. Field AE, Gordon CM, Pierce LM, et al. Prospective study of physical activity and risk of developing a stress fracture among preadolescent and adolescent girls. *Arch Pediatr Adolesc Med* 2011;165(8):723-8. doi: 10.1001/archpediatrics.2011.34 [published Online First: 2011/04/04] [LOE 2]

TABLE 7 - LOW BMD and MENSTRUAL DYSFUNCTION

Author (Year)	Study Design	No. of Subjects	Population Age Range	Population Sex	Outcome Measures	Summary	Level of Evidence
Rauh 2014[45]	Prospective Cohort	89	13-18 yr	89 F high school cross country and track	Musculoskeletal injuries	• Low BMD relative to age (BMD Z-score of ≤ -1SD) was significantly associated (adjusted OR=4.6, 95% CI: 1.5, 13.3) with increased injury occurrence. • Among those with BMD Z-score of ≤ -2SD, a history of oligo/amenorrhea was significantly associated (adjusted OR=4.1, 95% CI: 1.2, 13.5) with increased injury occurrence.	2
Barrack 2017[47]	Cross-sectional	69	13-19 yr	51 M athletes	Low BMD (BMD Z-score ≤ -1.0)	• Single risk factors of low BMD included <85% expected weight (OR=5.6, 95% CI: 1.4, 22.5) and average weekly mileage >30 in the past year (OR=6.4, 95% CI: 1.5, 27.1). • The strongest two-variable and three-variable risk factors included weekly mileage >30 + stress fracture history (OR=17.3, 95% CI: 1.6, 185.6) and weekly mileage >30 + <85% expected weight + stress fracture history (OR=17.3, 95% CI: 1.6, 185.6), respectively. • Risk factors were cumulative when predicting low BMD (including <85% expected weight, weekly mileage >30, stress fracture history and <1 serving of calcium-rich food/day): 0-1 risk factors (11.1%), 2 risk factors (42.9%), or 3-4 risk factors (80.0%)).	4
Tenforde 2015[48]	Cross-sectional	136	13-19 yr	94 F / 42 M high school runners	BMD Z-score	• In girls, risk factors for lower lumbar BMD Z-scores included: lower android-to-gynoid fat mass ratio (β=0.49), higher fat mass (β=-0.30), being shorter (β=0.33), and the interaction between current menstrual irregularity and a history of fracture (β=-1.18). • In girls, risk factors for lower total body less head BMD Z-scores included: later age of menarche (β=-0.26), lower android-to-gynoid fat mass ratio (β=0.17), lower lean mass (β=0.33), and drinking less milk (β=0.19). • In boys, risk factors for lower lumbar BMD Z-scores included: lower BMI Z-score (β=0.57) and the belief that being thinner improves performance (β=-0.90). • In boys, risk factors for lower total body less head BMD Z-scores included: lower BMI Z-score (β=0.60) and the belief that being thinner improves performance (β=-0.46), and lower android-to-gynoid fat mass ratio (β=0.25)	2

						• Girls with a BMI ≤17.5 kg/m^2 or both menstrual irregularity and a history of fracture more frequently had BMD Z-score ≤ -1.0. • Boys with a BMI ≤17.5 kg/m^2 and belief that thinness improves performance more frequently had BMD Z-score ≤ -1.0.	
Barrack 2014[50]	Prospective Cohort	259	13-29 yr	56 F (age < 18 yr) athletes	Bone stress injury	• 28 participants (10.8%) developed a bone stress injury. • Single factors associated with the development of bone stress injury included ≥12 h/wk of purposeful exercise (OR=4.9; 95% CI: 1.4, 16.9), BMI <21.0 kg/m^2 (OR=2.4; 95% CI: 1.0, 5.3), and BMD Z score <-1.0 (OR=3.2; 95% CI: 1.4, 7.2). • The strongest 2- and 3-variable combined risk factors for bone stress injury were low BMD (Z score <-1.0) + ≥12 h/wk of exercise (OR=5.1; 95% CI: 2.2, 12.1) and ≥12 h/wk of exercise + leanness sport/activity + dietary restraint (OR, 8.7; 95% CI: 2.7, 28.3).	2

BMI, body mass index; BMD, bone mineral density; OR, odds ratio; β=beta coefficient; CI, confidence interval

REFERENCES: TABLE 7 - LOW BMD and MENSTRUAL DYSFUNCTION

45. Rauh MJ, Barrack M, Nichols JF. Associations between the female athlete triad and injury among high school runners. *Int J Sports Phys Ther* 2014;9(7):948-58. [LOE 2]
47. Barrack MT, Fredericson M, Tenforde AS, et al. Evidence of a cumulative effect for risk factors predicting low bone mass among male adolescent athletes. *Br J Sports Med* 2017;51(3):200-05. doi: 10.1136/bjsports-2016-096698 [LOE 4]
48. Tenforde AS, Fredericson M, Sayres LC, et al. Identifying sex-specific risk factors for low bone mineral density in adolescent runners. *Am J Sports Med* 2015;43(6):1494-504. doi: 10.1177/0363546515572142 [published Online First: 2015/03/06] [LOE 2]
50. 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):949-58. doi: 10.1177/0363546513520295 [published Online First: 2014/02/24] [LOE 2]

TABLE 8 – TRAINING

Author (Year)	Study Design	No. of Subjects	Population Age Range	Population Sex	Outcome Measure	Summary	Level of Evidence
Rauh 2006[14]	Prospective Cohort	421	14-18 yr	186 F / 235 M high school cross country	Injuries	• No association to injury risk for: running experience, pre-season number of weeks, pre-season frequency d/wk, pre-season average weekly distance, training pace, training surface or terrain.	2
Rauh 2014[19]	Prospective Cohort	421	14-18 yr	186 F / 235 M high school cross country	Injuries	• Runners who ran <8 wks during summer had higher odds of incurring injury during first month of season (OR=2.7, 95% CI 1.2, 5.8). • Runners who only alternated mileage 25% or less during summer had higher odds of incurring injury during the first month of season (OR=3.0, 95% CI 1.4, 6.4). • Runners who ran predominantly on hills >33% each run (OR=12.3, 95% CI: 2.9, 52.5) or flat irregular terrains >33% each run (OR=12.3, 95% CI: 2.2, 6.2) had higher odds of incurring an injury during first month of season for girl runners only.	2
Huxley 2014[21]	Prospective Cohort	103	13-17 yr	66 F / 34 M / 3 Unidentified Elite track and field	Injuries	• Injured athletes trained at a higher intensity at 13-14 years, completed more high-intensity training sessions at 13-14 years and 15-16 years, and had a higher yearly training load at 13-14 years.	4
Luedke 2016[51]	Prospective Cohort	68	13-18 yrs	47 F / 20 M high school cross country	Injuries	• Runners with step rate < 166 steps/min at self-selected running speed were at greater odds of incurring a shin injury (OR=5.85, 95% CI: 1.1-32.1). • Runners with step rate $\leq$ 164 steps /min at fixed running speed (3.3 m/s) were more likely to incur shin injury (OR=6.67, 95% CI: 1.2-36.7).	2
Timpka 2015[52]	Prospective Cohort	110	mean age =17 yrs	64 F / 46 M Swedish track and field	Overuse injuries	• In assessing training load index (reported intensity x minutes of training per week), athletes in the third quartile (HR=1.76, 95% CI: 1.13-2.76, p=0.013) and fourth quartile (HR=1.81, 95% CI 1.18-2.80. p=0.007) had almost twice the risk of overuse injury compared to their peers in in the first quartile.	4
Tenforde 2011[53]	Retrospective Cohort	748	13-18 yrs	442 F / 306 M high school cross country & track and field	Overuse injuries	• Compared to girls with no injury, girls with previous injury reported a greater percentage of miles on pavement (55% vs 49%). • Compared to boys with no injury, boys with previous injury reported greater average weekly miles over past year (17.1±11.9 vs 14.1 ± 11.5 miles).	3

CI, confidence interval; OR, odds ratio; HR, hazard ratio

REFERENCES: TABLE 8 – TRAINING

14. Rauh MJ, Koepsell TD, Rivara FP, et al. Epidemiology of musculoskeletal injuries among high school cross-country runners. *Am J Epidemiol* 2006;163(2):151-9. doi: 10.1093/aje/kwj022 [published Online First: 2005/11/23] [LOE 2]
19. Rauh MJ. Summer training factors and risk of musculoskeletal injury among high school cross-country runners. *J Orthop Sports Phys Ther* 2014;44(10):793-804. doi: 10.2519/jospt.2014.5378 [published Online First: 2014/09/05] [LOE 2]
21. Huxley DJ, O'Connor D, Healey PA. An examination of the training profiles and injuries in elite youth track and field athletes. *Eur J Sport Sci* 2014;14(2):185-92. doi: 10.1080/17461391.2013.809153 [published Online First: 2013/06/19] [LOE 4]
51. Luedke LE, Heiderscheit BC, Williams DS, et al. Influence of Step Rate on Shin Injury and Anterior Knee Pain in High School Runners. *Med Sci Sports Exerc* 2016;48(7):1244-50. doi: 10.1249/MSS.0000000000000890 [LOE 2]
52. Timpka T, Jacobsson J, Dahlström Ö, et al. The psychological factor 'self-blame' predicts overuse injury among top-level Swedish track and field athletes: a 12-month cohort study. *Br J Sports Med* 2015;49(22):1472-7. doi: 10.1136/bjsports-2015-094622 [published Online First: 2015/09/15] [LOE 4]
53. Tenforde AS, Sayres LC, McCurdy ML, et al. Overuse injuries in high school runners: lifetime prevalence and prevention strategies. *PMR* 2011;3(2):125-31; quiz 31. doi: 10.1016/j.pmrj.2010.09.009 [LOE 3]

TABLE 9 – FOOTWEAR and FOOTSTRIKE

Author (Year)	Study Design	No. of Subjects	Population Age Range	Population Sex	Outcome Measure	Summary	Level of Evidence
Aibast 2017[57]	Observational	76	12-18 yr	38 F / 38 M adolescents	Injuries	• Lower-limb injury prevalence was 8% in habitually barefoot and 61% in habitually shod participants ($p = 0.01$). • Habitually barefoot participants spent more time engaged in moderate to vigorous physical activity compared to habitually shod subjects (60±26 min/d vs 31±13 min/d; $p< 0.001$)	3
Hollander 2018[62]	Cross-sectional observational	678	6-18 yr	335 F / 343 M children	Rearfoot strike pattern	• Habitually barefoot children showed a higher probability of using a rearfoot strike than habitually shod children ($p < 0.001$). • The probability of rearfoot strike decreased in habitually barefoot children with age ($OR_{barefoot\text{-}jogging}$ =0.82, 95% CI: 0.71, 0.96; $OR_{barefoot\text{-}running}$ =0.58, 95% CI: 0.50, 0.67; $OR_{shod\text{-}running}$ =0.68, 95% CI, 0.59, 0.79). • In habitually shod children, the probability of rearfoot strike increased during shod jogging (OR=1.19, 95% CI: 1.05, 1.35).	3

OR, odds ratio; CI, confidence interval

REFERENCES: TABLE 9 – FOOTWEAR and FOOTSTRIKE

57. Aibast H, Okutoyi P, Sigei T, et al. Foot Structure and Function in Habitually Barefoot and Shod Adolescents in Kenya. *Curr Sports Med Rep* 2017;16(6):448-58. doi: 10.1249/JSR.0000000000000431 [LOE 3]
62. Hollander K, de Villiers JE, Venter R, et al. Foot Strike Patterns Differ Between Children and Adolescents Growing up Barefoot vs. Shod. *Int J Sports Med* 2018;39(2):97-103. doi: 10.1055/s-0043-120344 [published Online First: 2017/11/16] [LOE 3]