Evidence-Based Practice Group
Answers to Clinical Questions

Association Between Wearing Orthosis and Developing Metatarsal Stress Fractures

A Rapid Systematic Review

Prepared by	Dr. Craig Martin Manager Medical Services, Evidence-Based Practice Group
Date	October 2023

WorkSafeBC

About this report

Association Between Wearing Orthosis and Developing Metatarsal Stress Fractures

Published: October 2023

About the Evidence-Based Practice Group

The Evidence-Based Practice Group was established to address the many medical and policy issues that WorkSafeBC officers deal with on a regular basis. Members apply established techniques of critical appraisal and evidence-based review of topics solicited from both WorkSafeBC staff and other interested parties such as surgeons, medical specialists, and rehabilitation providers.

Suggested citation

WorkSafeBC Evidence-Based Practice Group, Martin CW. Association Between Wearing Orthosis and Developing Metatarsal Stress Fractures. Richmond, BC: WorkSafeBC Evidence-Based Practice Group; October 2023.

Contact information

Address	Evidence-Based Practice Group WorkSafeBC PO Box 5350 Stn Terminal Vancouver BC V6B 5L5
Email	craig.martin@worksafebc.com
Phone	604 279-7417
Toll-free	1 888 967-5377 ext 7417

View other systematic reviews by the EBPG online at: http://worksafebc.com/evidence

Objectives

- To determine if there is any evidence that wearing orthosis may cause foot metatarsal stress fractures, especially among those already diagnosed with osteoporosis.

Methods

- A comprehensive and systematic literature search was conducted on October 4, 2023.
- The search was done on commercial databases, including Cochrane Database of Systematic Reviews (2005 to September 27, 2023), ACP Journal Club (1991 to September 2023), York University UK Database of Abstracts of Reviews of Effects (1st Quarter 2016), Cochrane Clinical Answers (September 2023), Cochrane Central Register of Controlled Trials (August 2023), UK NHS Health Technology Assessment (4th Quarter 2016), UK NHS Economic Evaluation Database (1st Quarter 2016), BIOSIS Previews (1969 to 2008), Embase (1974 to 2023 October 03>, Medline Epub Ahead of Print, Medline In-Process, In-Data-Review & Other Non-Indexed Citations, Medline Daily and Medline (1946 to October 03, 2023), Joanna Briggs Institute Evidence Based Practice Database (Current to September 27, 2023), that are available through Ovid platform.
- A combination of keywords were employed in these searches. These keywords include:

  metatarsal AND ((stress fracture*) OR (fatigue fracture*) OR microfracture*) AND (orthotic OR orthosis OR orthoses)

- No limitation, such as on the language or date of publication, was implemented in any of these searches.
- A manual search on the references of the articles that were retrieved in full was planned.

Results

- Search results:
  - Sixty[1-60] published studies were identified through our literature search.
  - Upon examination of the titles and abstracts of these sixty[1-60] studies, eight[1,13,29,35,37,45,55,59] studies were thought to be relevant and were retrieved in full for further appraisal. Two[61,62] more studies were retrieved as the result of manual searches. Overall, there were ten[1,13,29,35,37,45,55,59,61,62] studies retrieved in full for further appraisal in this systematic review.
- Of the ten[1,13,29,35,37,45,55,59,61,62] studies that were retrieved in full, none provided any data showing that wearing orthoses caused metatarsal stress fracture. In fact, some of these studies, in the form of good quality systematic reviews[37,61] (clear objective translated into clear literature search followed by robust critical appraisal and clear presentation) as well as one unclear quality (presented as an abstract only) systematic review[35] (level of evidence 1. Appendix 1), and a medium quality large size (total n=2774) controlled trial[29] (clear criteria of intervention and controls, clear data analysis, clear presentation) (level of evidence 2. Appendix 1) provided some evidence for the protective effect of wearing orthoses in the incidence of metatarsal stress fractures, especially among military personnel.

Summary

- At present, there is no data to show that wearing orthoses increases the incidence of metatarsal stress fractures.
- At present, there is some data to show that wearing orthoses provides a protective effect towards the incidence of metatarsal stress fractures.

References

1. Anderson E.G. Fatigue fractures of the foot. Injury. 21(5) (pp 275-279), 1990. Date of Publication: 1990.; ISSN: 0020-1383.
2. Armstrong, G. and Carmont M.R. Does stud design predispose to metatarsal refracture?. Foot. and Ankle Surgery. 12(1) (pp 55), 2006. Date of Publication: 2006.; ISSN: 1268-7731.
3. Aronow M.S. Fifth metatarsal Jones and proximal diaphyseal stress fractures in the cavovarus foot. Techniques. in Orthopaedics. 27(2) (pp 102-117), 2012. Date of Publication: June 2012.; ISSN: 0885-9698.
4. Aweid, B.; Aweid, O.; Talibi, S., and Porter, K. Stress fractures. Trauma. (United Kingdom). 15(4) (pp 308-321), 2013. Date of Publication: October 2013.; ISSN: 1460-4086.
5. Benazzo, F.; Zanon, G.; Todesca, A.; Moreno, J., and Fischetto, G. Stress fractures of the foot in Italian national track and field athletes: Diagnosis, incidence and treatment. Journal. of Sports Traumatology and Related Research. 21(3) (pp 178-186), 1999. Date of Publication: 1999.; ISSN: 1120-3137.
6. Berkson D.A.; Cabry, R., and Shiple, B. Freiberg's infraction in an adolescent dancer: Condition often mistaken for a stress fracture. Physician. and Sportsmedicine. 33(3) (pp 42-46), 2005. Date of Publication: March 2005.; ISSN: 0091-3847.
7. Bischof J.E.; Defrate L.E.; Queen R.M., and Nunley, I. I. J.A. Bilateral Jones fractures in two elite soccer players. Foot. and Ankle International. 31(5) (pp 441-447), 2010. Date of Publication: May 2010.; ISSN: 1071-1007.
8. Boike, A.; Schnirring-Judge, M., and McMillin, S. Sesamoid disorders of the first metatarsophalangeal joint. Clinics. in Podiatric Medicine and Surgery. 28(2) (pp 269-285), 2011. Date of Publication: April 2011.; ISSN: 0891-8422.
9. Burns Joshua; Landorf, Karl B.; Ryan, Monique M.; Crosbie Jack, and Ouvrier, Robert A. Interventions for the prevention and treatment of pes cavus [Systematic Review]. Cochrane. 2010; (12).
10. Campbell, Mark T.; Ghaedi Bahareh; Tanjong Ghogomu Elizabeth; Ramsay Timothy, and Welch Vivian. Shoe and heel lifts for leg length inequality in adults with musculoskeletal conditions [Protocol]. Cochrane. 2021; (12).
11. Carmont M.R.; Chaudhry, S., and McBride D.J. Clutch foot stress fracture: Another complication of commuting?. Foot. and Ankle Surgery. 10(3) (pp 159-162), 2004. Date of Publication: 2004.; ISSN: 1268-7731.
12. Casillas M.M. and Ortiz N.F. Fifth metatarsal fractures. Current. Orthopaedic Practice. 20(2) (pp 140-145), 2009. Date of Publication: April 2009.; ISSN: 1940-7041.
13. Centre for Reviews and Dissemination. Does shoe insole modification prevent stress fractures? A systematic review (Structured abstract). Database. 2015; (2).
14. Coady C.M.; Gow, N., and Stanish, W. Foot problems in middle-aged patients: Keeping active people up to speed. Physician. and Sportsmedicine. 26(5) (pp 31-42), 1998. Date of Publication: 1998.; ISSN: 0091-3847.

15. Darabos, N.; Obrovac, K.; Knez, N.; Darabos, A.; Hudetz, D., and Elabjer, E. Combined surgical therapy and orthotic management of stress and tuberosity avulsion fracture of the fifth metatarsal bone. Journal. of the American Podiatric Medical Association. 99(6) (pp 529-535), 2009. Date of Publication: November-December 2009.; ISSN: 8750-7315.
16. Desai S.N.; Grierson, R., and Manoli, A. The cavus foot in athletes: Fundamentals of examination and treatment. Operative. Techniques in Sports Medicine. 18(1) (pp 27-33), 2010. Date of Publication: March 2010.; ISSN: 1060-1872.
17. Edenfield K.M.; Michaudet, C.; Nicolette G.W., and Carek P.J. Foot and Ankle Conditions: Midfoot and Forefoot Conditions. FP. essentials. 465 (pp 30-34), 2018. Date of Publication: 01 Feb 2018.; ISSN: 2159-3000.
18. Eulry, F. Static metatarsalgia. [French]. Revue. du Praticien. 47(1) (pp 37-42), 1997. Date of Publication: 01 Jan 1997.; ISSN: 0035-2640.
19. Evans, Angela M.; Rome Keith; Carroll Matthew, and Hawke Fiona. Foot orthoses for treating paediatric flat feet [Systematic Review]. Cochrane. 2022; (1).
20. Faber, F. W.; te Slaa, R. L., and Nollen, A. J. [Pain in the forefoot: a support sole is no panacea]. [Dutch]. Nederlands. Tijdschrift voor Geneeskunde. 136. 1(41):2029-32, 1992 Oct 10.; ISSN: 0028-2162.
21. Fenton, P.; Bali, N., and Meda K.P. (ii) The cavo-varus foot. Orthopaedics. and Trauma. 28(1) (pp 13-17), 2014. Date of Publication: February 2014.; ISSN: 1877-1327.
22. Friend, G. Sequential metatarsal stress fractures after Keller arthroplasty with implant. Journal. of Foot Surgery. 20(4) (pp 227-231), 1981. Date of Publication: 1981.; ISSN: 0449-2544.
23. Fujioka, H.; Kokubu, T.; Makino, T.; Hirata, H.; Nagura, I.; Inui, A.; Tanaka, J.; Yoshiya, S., and Kurosaka, M. Stress fracture of the fifth metatarsal bone as a late complication of total knee arthroplasty. Kobe. Journal of Medical Sciences. 55(4) (pp E93-E97), 2009. Date of Publication: 2009.; ISSN: 0023-2513.
24. Guettler J.H.; Ruskan G.J.; Bytomski J.R.; Brown C.R.; Richardson J.K., and Moorman 3rd. C.T. Fifth metatarsal stress fractures in elite basketball players: evaluation of forces acting on the fifth metatarsal. American. journal of orthopedics (Belle Mead, N.J.). 35(11) (pp 532-536), 2006. Date of Publication: Nov 2006.; ISSN: 1078-4519.
25. Hatch R.L.; Alsobrook J.A., and Clugston J.R. Diagnosis and management of metatarsal fractures. American. Family Physician. 76(6) (pp 817-826), 2007. Date of Publication: 15 Sep 2007.; ISSN: 0002-838X.
26. Hetsroni, I.; Mann, G.; Dolev, E.; Morgenstern, D., and Nyska, M. Base of fourth metatarsal stress fracture: tendency for prolonged healing. [Review] [10 refs]. Clinical. Journal of Sport Medicine. 15. 1(3):186-8, 2005 May.; ISSN: 1050-642X.
27. Hockenbury R.T. Forefoot problems in athletes. Medicine. and Science in Sports and Exercise. 31(7 SUPPL.) (pp S448-S458), 1999. Date of Publication: 1999.; ISSN: 0195-9131.
28. Hoffman J.W.; Bitar R.C.; Williams, N.; Steineman B.D.; Sturnick D.R.; Garrison G.W.; Demetracopoulos C.A.; Drakos M.C., and O'Malley M.J. Orthosis and Foot Structure Affect the Fifth Metatarsal Principal Strains During Simulated Level Walking. The. American

journal of sports medicine. 50(6) (pp 1659-1667), 2022. Date of Publication: 01 May 2022.; ISSN: 1552-3365 (electronic).
29. House, C.; Reece, A., and Roiz de Sa, D. Shock-absorbing insoles reduce the incidence of lower limb overuse injuries sustained during Royal Marine training. Military. medicine. 178(6) (pp 683-689), 2013. Date of Publication: Jun 2013.; ISSN: 1930-613X (electronic).
30. Japjec, M.; Staresinic, M.; Starjacki, M.; Zgaljardic, I.; Stivicic, J., and Sebecic, B. Treatment of proximal fifth metatarsal bone fractures in athletes. Injury. 46 (pp S134-S136), 2015. Date of Publication: 01 Nov 2015.; ISSN: 0020-1383.
31. Kadel, N. J.; Goldstein, J.; Newberg, A. H., and Trepman, E. Salter-Harris III stress fracture of the proximal first metatarsal: a case report. Foot. & Ankle International. 22. 1(3):252-5, 2001 Mar.; ISSN: 1071-1007.
32. Karnovsky S.C.; Rosenbaum A.J.; DeSandis, B.; Johnson, C.; Murphy C.I.; Warren R.F.; Taylor S.A., and Drakos M.C. Radiographic Analysis of National Football League Players' Fifth Metatarsal Morphology Relationship to Proximal Fifth Metatarsal Fracture Risk. Foot. and Ankle International. 40(3) (pp 318-322), 2019. Date of Publication: 01 Mar 2019.; ISSN: 1071-1007.
33. Kennedy J.G.; Knowles, B.; Dolan, M., and Bohne, W. Foot and ankle injuries in the adolescent runner. Current. Opinion in Pediatrics. 17(1) (pp 34-42), 2005. Date of Publication: February 2005.; ISSN: 1040-8703.
34. Laker, S. R.; Saint-Phard, D.; Tyburski, M., and Van Dorsten, B. Stress fractures in elite cross-country athletes. Orthopedics. 30. 1(4):313-5, 2007 04.; ISSN: 0147-7447.
35. Lavigne, A.; Chicoine, D.; Esculier J.-D.; Desmeules, F.; Fremont, P., and Dubois, B. Preventing Stress Fractures of the Lower Extremity with Physical Interventions: A Systematic Review and Meta-Analysis. Clinical. Journal of Sport Medicine. Conference: Annual Symposium Canadian Academy of Sport and Exercise Medicine, CASEM 2022. Quebec City, QC Canada. 32(3) (pp e334), 2022. Date of Publication: May 2022.; ISSN: 1536-3724.
36. Lavigne, A.; Chicoine, D.; Esculier J.-D.; Desmeules, F.; Fremont, P., and Dubois, B. Preventing stress fractures of the lower extremity with physical interventions. Clinical. Journal of Sport Medicine. Conference: Annual Meeting American Medical Society for Sports Medicine, AMSSM 2022. Colorado Springs, CO United States. 32(2) (pp 200), 2022. Date of Publication: March 2022.; ISSN: 1536-3724.
37. Lavigne, A.; Chicoine, D.; Esculier, J. F.; Desmeules, F.; Fremont, P., and Dubois, B. The Role of Footwear, Foot Orthosis, and Training-Related Strategies in the Prevention of Bone Stress Injuries: A Systematic Review and Meta-Analysis. [Review]. International. Journal of Exercise Science. 16. 1(3):721-743, 2023.; ISSN: 1939-795X.
38. Manoli, A. and Graham, B. Clinical and new aspects of the subtle cavus foot: A review of an additional twelve year experience. Fuss. und Sprunggelenk. 16(1) (pp 3-29), 2018. Date of Publication: March 2018.; ISSN: 1619-9987.
39. Manusov E.G.; Lillegard W.A.; Raspa R.F., and Epperly T.D. Evaluation of pediatric foot problems: Part I. The forefoot and the midfoot. American. Family Physician. 54(2) (pp 592-610), 1996. Date of Publication: August 1996.; ISSN: 0002-838X.

40. Matthews, Barry G.; Thomson, Colin E.; McKinley, John C.; Harding, Michael P., and Ware, Robert S. Treatments for Morton's neuroma [Protocol]. Cochrane. 2021; (7).
41. Mazur, F.; Swoboda, B.; Carl H.D.; Lutter, C.; Engelhardt, M.; Hoppe M.W.; Hotfiel, T., and Grim, C. Plantar pressure changes in hindfoot relief devices of different designs. Journal. of Experimental Orthopaedics. 6(1) (no pagination), 2019. Article Number: 7. Date of Publication: 01 Dec 2019.; ISSN: 2197-1153 (electronic).
42. McPoil T.G. and Cornwall M.W. Rigid versus soft foot orthoses. A single subject design. Journal. of the American Podiatric Medical Association. 81(12) (pp 638-642), 1991. Date of Publication: Dec 1991.; ISSN: 8750-7315.
43. Meardon S.A.; Brent Edwards, W.; Ward, E., and Derrick T.R. Effects of custom and semi-custom foot orthotics on second metatarsal bone strain during dynamic gait simulation. Foot. and Ankle International. 30(10) (pp 998-1004), 2009. Date of Publication: October 2009.; ISSN: 1071-1007.
44. Micheli, L. J.; Sohn, R. S., and Solomon, R. Stress fractures of the second metatarsal involving Lisfranc's joint in ballet dancers. A new overuse injury of the foot. Journal. of Bone & Joint Surgery - American Volume. 67. 1(9):1372-5, 1985 Dec.; ISSN: 0021-9355.
45. Milgrom, C.; Giladi, M., and Kashtan, H. A prospective study of the effect of a schock-absorbing orthotic device on the incidence of stress fractures in military recruits. Foot. and Ankle. 6(2) (pp 101-104), 1985. Date of Publication: 1985.; ISSN: 0198-0211.
46. Moul, J. L. and Massey, A. N. Recurrent metatarsal stress fractures in a college football lineman. Journal. of Athletic Training. 30. 1(1):72-4, 1995 Mar.; ISSN: 1062-6050.
47. Omey M.L. and Micheli L.J. Foot and ankle problems in the young athlete. Medicine. and Science in Sports and Exercise. 31(7 SUPPL.) (pp S470-S486), 1999. Date of Publication: 1999.; ISSN: 0195-9131.
48. Osborne, M. D. [Reprint author]. Foot pain - female soccer player. Medicine. & Science in Sports & Exercise. 31(5 SUPPL.):S88, May, 1999.; ISSN: 0195-9131.
49. Pecina, M.; Bojanic, I.; Smoljanovic, T.; Ivkovic, A.; Mirkovic, M., and Jelic, M. Surgical treatment of diaphyseal stress fractures of the fifth metatarsal in competitive athletes: Long-term follow-up and computerized pedobarographic analysis. Journal. of the American Podiatric Medical Association. 101(6) (pp 517-522), 2011. Date of Publication: November/December 2011.; ISSN: 8750-7315.
50. Pegrum, J.; Dixit, V.; Padhiar, N., and Nugent, I. The pathophysiology, diagnosis, and management of foot stress fractures. Physician. and Sportsmedicine. 42(4) (pp 87-99), 2014. Date of Publication: 2014.; ISSN: 0091-3847.
51. Porter D.A.; Foulk D.M., and Rund A.M. Intramedullary screw fixation for chronic proximal fourth metatarsal stress fractures: A new technique for the fourth metatarsal "Jones". Techniques. in Foot and Ankle Surgery. 9(3) (pp 147-153), 2010. Date of Publication: September 2010.; ISSN: 1536-0644.
52. Queen R.M.; Abbey A.N.; Verma, R.; Butler R.J., and Nunley J.A. Plantar loading during cutting while wearing a rigid carbon fiber insert. Journal. of athletic training. 49(3) (pp 297-303), 2014. Date of Publication: 01 May 2014.; ISSN: 1938-162X (electronic).

53. Queen R.M.; Crowder T.T.; Johnson, H.; Ozumba, D., and Toth A.P. Treatment of metatarsal stress fractures: Case reports. Foot. and Ankle International. 28(4) (pp 506-510), 2007. Date of Publication: April 2007.; ISSN: 1071-1007.
54. Riehl, J.; Tomaszewski, D., and Cush, G. Midfoot arthritis: Evaluation and treatment, surgical and nonsurgical. Current. Orthopaedic Practice. 19(3) (pp 249-252), 2008. Date of Publication: May 2008.; ISSN: 1940-7041.
55. Rome Keith; Handoll, H. G. Helen, and Ashford, Robert L. Interventions for preventing and treating stress fractures and stress reactions of bone of the lower limbs in young adults [Systematic Review]. Cochrane. 2009; (1).
56. Saxena, A. and Cheung, S. Pushing the envelope: Case studies on how fast you can and cannot return the elite athlete to running. Clinics. in Podiatric Medicine and Surgery. 18(2) (pp 319-328), 2001. Date of Publication: 2001.; ISSN: 0891-8422.
57. Simkin, A.; Leichter, I.; Giladi, M.; Stein, M., and Milgrom, C. Combined effect of foot arch structure and an orthotic device on stress fractures. Foot. and Ankle. 10(1) (pp 25-29), 1989. Date of Publication: 1989.; ISSN: 0198-0211.
58. Zechman, J. S. Stress fracture of the second metatarsal after Keller bunionectomy. Journal. of Foot Surgery. 23. 1(1):63-5, 1984 Jan-Feb.; ISSN: 0449-2544.
59. Zukas, R.; Sloat, N., and Wright, P. Are soft in-soles or orthotics better than no insoles to prevent stress fractures of the lower extremity in adults?. The. Journal of the Oklahoma State Medical Association. 106(3) (pp 81-82), 2013. Date of Publication: Mar 2013.; ISSN: 0030-1876.
60. Zwipp, H.; Borrmann, M., and Walter, E. [Experience with the Hind Foot Relaxation Boot]. [German]. Zeitschrift. fur Orthopadie & Unfallchirurgie. 155. 1(3):333-339, 2017 Jun.
61. Snyder RA, DeAngelis JP, Koester MC, Spindler KP, Dunn WR. Does shoe insole modification prevent stress fractures? A systematic review. HSS J. 2009 Sep;5(2):92-8.
62. Bonanno DR, Landorf KB, Munteanu SE, et al Effectiveness of foot orthoses and shock-absorbing insoles for the prevention of injury: a systematic review and meta-analysis. British Journal of Sports Medicine 2017;51:86-96.

Appendix 1

WorkSafeBC — Evidence-Based Practice Group levels of evidence (adapted from 1-6)

1	Experimental, randomized controlled trial (RCT), systematic review RTCs with or without meta-analysis.
2	Evidence from controlled trials without randomization (quasi-experimental studies) or systematic reviews of observational studies.
3	Evidence from cohort or case-control analytic studies, preferably from more than 1 centre or research group.
4	Evidence from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments.
5	Opinions of respected authorities, based on clinical experience, descriptive studies or reports of expert committees based on scientific evidence.

References

1. Canadian Task Force on the Periodic Health Examination: The periodic health examination. CMAJ. 1979;121:1193-1254.
2. Houston TP, Elster AB, Davis RM et al. The US Preventive Services Task Force Guide to Clinical Preventive Services, Second Edition. AMA Council on Scientific Affairs. American Journal of Preventive Medicine. May 1998;14(4):374-376.
3. Scottish Intercollegiate Guidelines Network (2001). SIGN 50: a guideline developers' handbook. SIGN. Edinburgh.
4. Canadian Task Force on Preventive Health Care. New grades for recommendations from the Canadian Task Force on Preventive Health Care. CMAJ. Aug 5, 2003;169(3):207-208.
5. (2014). Canadian task force on preventive health care procedure manual. Downloaded from https://canadiantaskforce.ca/methods/ in May 12, 2022.
6. (2021). US Preventive Services Task Force. Procedure Manual. Downloaded from https://www.uspreventiveservicestaskforce.org/uspstf/about-uspstf/methods-and-processes/procedure-manual , in May 12 2022.