Review Article

Acute Ankle Injuries and Achilles Tendon Rupture in Adolescent Recreational Sports: Risk Factors and Prevention Strategies

Aw-Zien Toh[1], Chya-Wei Wong[2,3,4], Rou-Chen Jee[5], Teck-Hock[6]

Author's Affiliation:
1- London North West University Healthcare Trust, England, United Kingdom
2- KPJ Sibu Specialist Medical Centre, Sibu, Sarawak, Malaysia
3- Special Olympics Malaysia, Kuala Lumpur, Malaysia
4- Faculty of Medicine, Nursing & Health Sciences, SEGi University, Kota Damansara, Selangor, Malaysia
5- Department of Rehabilitation Medicine, Sibu Hospital, Ministry of Health Malaysia, Sibu, Sarawak, Malaysia
6- Department of Paediatrics & Clinical Research Centre, Sibu Hospital, Ministry of Health Malaysia, Sibu, Sarawak, Malaysia

Correspondence:
Toh Teck Hock, Email: tohth@moh.gov.my

Received on: 24-Jun-2026 Accepted for Publication: 30-Jun-2026

ABSTRACT

Background: Acute ankle injuries, including Achilles tendon ruptures, are increasingly recognized among recreational athletes participating in sports that involve jumping, sprinting and rapid directional changes. As sports participation is promoted for obesity management, awareness of these potentially preventable injuries becomes increasingly important.

Aims: This review examines the current evidence regarding the clinical presentation, biomechanics, risk factors, and prevention of acute ankle injuries in adolescents, and discusses the role of healthcare professionals in promoting safe sports participation and reducing injury incidence.

Results: Multiple intrinsic and extrinsic factors, including obesity, contribute to acute ankle injuries in adolescents. Early recognition of serious injuries such as fractures and Achilles tendon rupture is essential to improve outcomes, while imaging helps confirm diagnoses and guide management. Effective preventive strategies include structured warm-up and conditioning programs, load management, appropriate footwear selection, fatigue recognition, and early identification of high-risk individuals. A multi-disciplinary approach involving pediatricians, primary care providers, and educators is necessary to promote injury prevention and safe sports participation.

Conclusion: Acute ankle injuries in adolescents result from a complex interplay of biomechanical, intrinsic, and extrinsic risk factors. Early recognition and appropriate clinical assessment to improve outcomes. Pediatric and primary healthcare professionals play a crucial role in risk identification, preventive education, and supporting safe sports participation through evidence-based injury prevention strategies.

Clinical significance: While sports are important for obesity management, evidence-based preventive approaches and public health education are essential for reducing the burden of acute ankle injuries and improving long-term musculoskeletal health among at-risk adolescents.

Keywords Acute ankle injury, Achilles tendon rupture, sports injuries, adolescents, injury prevention

Introduction

Childhood obesity has emerged as a major global public health challenge, with rising prevalence observed across both high-income and low- and middle-income countries.[1] In response, sports participation and regular physical activity have become increasingly important components of weight management and the promotion of overall

physical and psychosocial health in children and adolescents. Regular participation in sports and physical activities has been associated with improved body composition, contributes to energy balance, improves cardiovascular fitness, enhances musculoskeletal fitness, and supports mental well-being in children and young people.[2,3] Consequently, physical activity is recognized as a key strategy for preventing excessive weight gain and promoting lifelong health in the pediatric population.[4]

Despite the benefits of sports participation for obesity management and healthy development, it also carries certain risks. Children and adolescents who take part in sports are at increased risk of sustaining musculoskeletal injuries, particularly those affecting the lower limbs.[5,6]

Acute ankle injuries represent the most common musculoskeletal injuries among children and adolescents participating in sports, particularly in activities involving sudden acceleration and change of direction, such as jumping and sprinting in badminton, basketball, and football.[7] These injuries account for a significant proportion of emergency department visits, interruption in sports participation, and may result in long-term functional impairment if not promptly recognized and managed.[7] Although Achilles tendon rupture has historically been associated with middle-aged recreational male athletes, the growing participation of younger individuals in competitive and recreational sports has increased awareness of Achilles tendon rupture in adolescents and young adults.[5,8]

With the continued global rise in childhood obesity rates, the implementation of effective injury prevention strategies and the promotion of safe sports participation are increasingly important for reducing the burden of acute ankle injuries in children and adolescents.[1]

This narrative review examines current evidence regarding the clinical presentation, biomechanics, risk factors, diagnosis, and prevention of acute ankle injuries, including Achilles tendon rupture, among adolescents. In addition, the review highlights the role of pediatricians and primary healthcare professionals in promoting safe sports participation and reducing injury incidence within the pediatric population.

Clinical Presentation and Diagnosis

The scenario in Box 1 demonstrates a common mechanism of acute ankle injury among adolescents participating in recreational sports. In this context, the presentation raises the possibility of Achilles tendon rupture, which typically occurs after a sudden, violent dorsiflexion of the plantarflexed foot during landing or push-off activities.[5] At the time of injury, patients often report hearing or feeling a sudden, loud "pop" at the back of the ankle, a hallmark feature of a tendon rupture.[5,9] This is usually followed by immediate pain, difficulty walking, and a sensation of being struck or kicked from behind. Inability or marked weakness in plantarflexion of the foot strongly suggests a disruption in the tendon's continuity. Swelling over the posterior aspect of the ankle further supports a diagnosis of Achilles tendon rupture.

The Simmonds test, also known as the Thompson or Simmonds-Thompson test, is a simple, reliable, and widely used bedside examination for assessing the integrity of the Achilles tendon (Fig 2). The patient lies prone, with the feet hanging freely over the edge of the examination couch while the calf muscles remain relaxed. Gentle compression of the calf normally produces passive plantarflexion of the foot. An absence of foot plantarflexion during calf compression is a positive sign and is highly suggestive of a complete Achilles tendon rupture.[9] When performed correctly, the test has high sensitivity and remains an important component of the clinical assessment.

In the pediatric population, true Achilles tendon ruptures are relatively uncommon compared to adults because the immature physis is biomechanically weaker than surrounding tendons and ligaments. Consequently, children and adolescents are more likely to sustain physeal (growth plate) injuries or avulsion fractures rather than complete tendon ruptures following similar mechanisms of injury.[10] Other important differential diagnoses in children and adolescents presenting with similar mechanisms of injury include plantaris tendon rupture, peroneal tendon injury, posterior tibial tendon dysfunction, ligamentous ankle sprains, subtalar injury, and other soft-tissue injuries.

A case scenario involves an adolescent with obesity who participated in a recreational badminton game without performing an adequate warm-up. The adolescent wore badminton-specific footwear designed primarily to maximize agility and speed (Fig. 1). After several consecutive games, he became increasingly fatigued. During an attempt to reach for a shuttlecock, the adolescent landed forcefully on one foot and immediately experienced a sudden "pop" sound at the back of his ankle. This was followed by severe pain and difficulty walking. The lower leg and ankle were significantly swollen. Although he remained able to partially bear weight, he had marked difficulty pushing off and lifting the foot from the ground, resulting in significant impairment of mobility.

Box 1: A common case scenario for acute ankle injuries among recreational sports

Differentiating Achilles tendon rupture from other acute ankle injuries can be challenging, as clinical presentations are often nonspecific and include pain, swelling, and difficulty bearing weight. Fractures should be suspected when there is significant focal bony tenderness, visible deformity, inability to bear weight immediately after injury, or pain localized over the malleoli, calcaneus, or growth plate regions. In contrast, soft-tissue injuries such as ligament sprains, muscle strains, or tendon injuries typically present with diffuse swelling, preserved bone alignment, and pain aggravated by movement or stretching rather than direct bony palpation.[11] Maintaining a high index of suspicion and conducting a careful clinical assessment are essential, particularly in active adolescents presenting with acute ankle pain following sports participation.

Radiographic evaluation remains the first-line imaging modality in suspected fractures and may be guided by clinical decision tools such as the Ottawa Ankle Rules, which have demonstrated high sensitivity in children.[12] Ultrasonography and magnetic resonance imaging may assist in assessing tendon integrity and soft

tissue injuries.[13,14] Early imaging and specialist referral are important to avoid missed growth plate injuries and possible long-term functional complications in the pediatric population.[10,12]

Fig. 1: Badminton-specific footwear designed to prioritize agility and speed using more lightweight materials. Such footwear is well-suited for rapid multi-directional movements in elite players but may offer less structural support and stability for ankles and knees, particularly for recreational athletes with obesity, poor conditioning, or underlying biomechanical risk factors. This image was generated using OpenAI's DALL·E 3 model (via ChatGPT) using prompts designed by the authors for illustrative purposes.

Risk Factors for Acute Ankle Injuries and Achilles Tendon Rupture

Numerous risk factors have been associated with acute ankle injuries and Achilles tendon rupture. These risk factors can be classified into intrinsic, extrinsic, and behavioral categories, each contributing individually or jointly to risk. Intrinsic risk factors are inherent to the individual. These include increasing age, elevated body mass index (BMI, >30 kg/m^2), anatomical and biomechanical abnormalities, chronic Achilles tendinopathy, previous musculoskeletal injury, and regular participation in high-intensity athletic activities. Several underlying medical conditions have also been associated with increased susceptibility to tendon injury, including diabetes mellitus, hyperparathyroidism, and chronic renal failure. Furthermore, genetic predisposition may play a role, particularly through polymorphisms in genes involved in collagen synthesis, tendon structure, and extracellular matrix remodeling, which may affect tendon strength and resilience. Exposure to certain drugs, including corticosteroids, quinolones, and oral bisphosphonates, has also been linked to tendon degeneration and an increased risk of rupture.[5-9,15,16]

Obesity and physical deconditioning are particularly important considerations in pediatric and adolescent populations. Increased body weight results in greater mechanical loading across the ankle joint and Achilles tendon during activities such as running, jumping, and landing.[5,6] Excessive loading can accelerate tendon microtrauma

and increase susceptibility to acute injury. Additionally, many adolescents with obesity exhibit lower baseline fitness, reduced muscular strength, impaired balance, and poorer neuromuscular control, all of which may negatively influence movement patterns during sports participation. As childhood obesity rates continue to rise globally, these factors are likely to contribute increasingly to the burden of sports-related ankle injuries.[1]

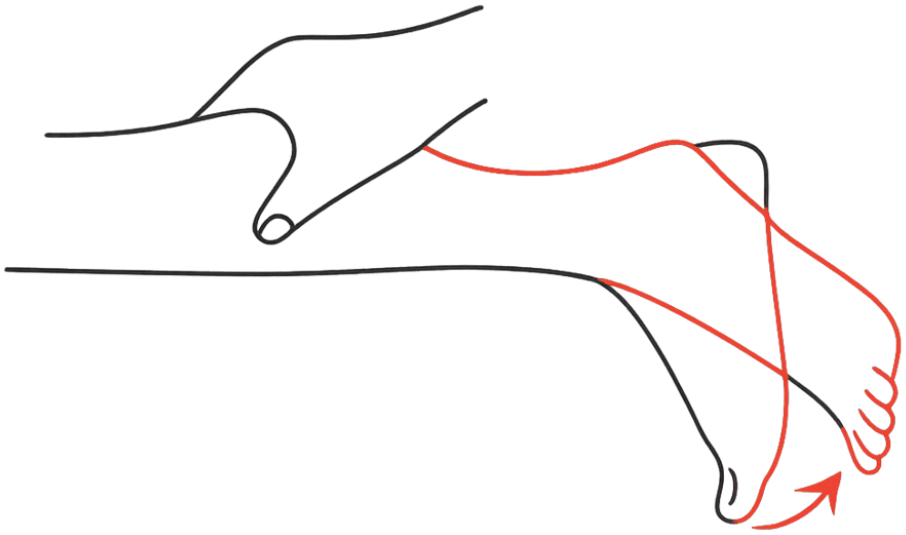

Fig. 2: Demonstration of Simmonds Test for assessment of Achilles tendon integrity. Plantar flexion of the foot (red arrow) after calf compression indicates a negative test result and an intact Achilles tendon. Illustration by Yiting Xia, reproduced with permission.

Extrinsic risk factors would relate to environmental and equipment-related influences. These include inappropriate footwear, poorly maintained playing surfaces, inadequate sporting facilities, and unsuitable training environments. Similarly, uneven or slippery playing surfaces may increase the likelihood of falls, awkward landings, and excessive stress on the ankle complex.

Behavioral risk factors are particularly important because they are often modifiable. Inadequate warm-up and cool-down routines, failure to recognize early signs of fatigue, poor training techniques, and excessive training loads are significant in increasing the incidence of injuries among recreational athletes.[5-9,15,16]

A structured warm-up and cool-down routine is one of the most important strategies for injury prevention, but is often neglected.[5,17] Dynamic stretches and low-intensity preparatory exercises improve blood circulation, enhance muscle and tendon flexibility, enhance neuro-muscular activation, and prepare the body for more intense activity.[5,7] As in the case illustrated in Box 1, inadequate warm-up may have left the tendon insufficiently prepared for sudden mechanical stresses, consequently adding to the likelihood of injury. Sports education programs should therefore emphasize evidence-based warm-up and cool-down protocols across all levels of participation, from recreational to competitive sports.

Fatigue is a significant contributor to injury risk. Physical fatigue impairs coordination, reaction time, balance, proprioception, and neuromuscular control, leading to less efficient movement patterns and suboptimal landing

mechanics.[7] Athletes who continue intense play despite obvious fatigue may place excessive stress on the Achilles tendon and surrounding structures, thereby increasing the likelihood of acute injury. Recognizing and appropriately responding to fatigue should be considered as an essential aspect of safe sports participation. From both sporting and public health perspectives, there is a need to shift cultural attitudes that perceive rest as a sign of weakness, lack of commitment, or poor performance. Adequate recovery should instead be recognized as a fundamental component of responsible sportsmanship, optimal performance, and long-term musculoskeletal health.

Fig. 3: Example of badminton-specific footwear designed to provide greater ankle support and stability. Such footwear is typically more bulky and rigid, incorporates more sturdy materials to enhance protection, improves stability during multidirectional movements, and reduces the risk of injury. This image was generated using OpenAI's DALL·E 3 model (via ChatGPT) using prompts designed by the authors for illustrative purposes.

Appropriate Footwears in Sports Participation

Footwear lacking adequate support, cushioning, traction, or stability can alter lower limb biomechanics and increase the risk of ankle sprains, tendon overload, and other musculoskeletal injuries. Proper footwear tailored to an individual's biomechanics and specific sporting activity is necessary for preventing acute ankle injuries and Achilles tendon rupture.[5,18] In the case illustrated in Box 1, the player wore badminton-specific footwear designed primarily for agility and speed, which is more appropriate for elite players. Such footwear typically incorporates lightweight materials and flexible soles, which are ideal for rapid multidirectional movements, sudden directional changes, jumps, and sprints (Fig. 2). However, these designs may offer less structural support for the ankles and Achilles tendon, particularly among recreational athletes with obesity, poor conditioning, or underlying biomechanical abnormalities.[19]

Selection of sports footwear should be individualized, as no single design is suitable for all athletes. While elite players may benefit from lightweight, responsive designs that maximize speed and agility, recreational athletes often require footwear that prioritizes stability, cushioning, and ankle support. Furthermore, the interaction

between footwear characteristics and individual biomechanics is particularly relevant for adolescents with obesity or poor physical conditioning. Increased body weight can lead to higher ground reaction forces during landing and push-off, thereby amplifying stress on the Achilles tendon. In these cases, footwear lacking adequate cushioning or support may not sufficiently absorb impact forces, increasing the risk of injury. The mismatch between footwear features and individual biomechanical needs can elevate mechanical strain on the Achilles tendon and surrounding structures during high-impact activities.

The use of inappropriate footwear, such as running shoes for court-based sports, may also increase injury risk. Running shoes are designed primarily for repetitive forward linear motion and sagittal-plane shock absorption, but they often provide inadequate lateral stability for sports requiring rapid side-to-side directional changes, pivoting, and jumping. Consequently, inappropriate footwear may predispose athletes to ankle sprains, tendon overload, and instability during sports participation.[18,19,20] Consultation with sports medicine specialists, podiatrists, physiotherapists, or trained sports store staff can help ensure proper footwear selection (Fig. 3), reducing injury risk and optimizing performance.

Participation in high-impact sports such as badminton, basketball, and football, whether barefoot or with inadequate foot protection, should also be discouraged. Similarly, these activities involve repetitive jumping, sprinting, rapid changes in direction, and forceful landings that generate substantial mechanical loads across the foot and ankle. The absence of appropriate footwear may reduce shock absorption and expose the foot and ankle to greater mechanical stress during jumping and landing. The absence of adequate cushioning, heel support, and traction may further increase the risk of acute ankle injuries, especially on hard playing surfaces. This issue is particularly relevant among children and adolescents participating in informal recreational sports without proper supervision or access to suitable sports equipment.[21]

Role of Pediatricians and Primary Healthcare Professionals

Pediatricians and primary healthcare professionals play an important role in integrating injury prevention into routine care and pre-sports evaluations to identify risks and recommend tailored measures.[22] Pre-participation evaluations provide a valuable opportunity to identify modifiable risk factors, such as obesity, physical deconditioning, previous injuries, inappropriate footwear, and excessive training loads. Early recognition of these factors enables healthcare professionals to provide targeted guidance to children and caregivers, thereby reducing injury risk prior to sports participation.

Preventive strategies that incorporate such assessments are supported by evidence demonstrating that injury-prevention programs can significantly reduce the incidence of lower-limb injuries among youth athletes.[23] Accordingly, clinicians should promote evidence-based preventive measures, including neuromuscular training, gradual conditioning, adequate rest, and proper warm-up routines.

Healthcare professionals also have an important role in addressing health inequities that may influence injury risk. The balance between cost and safety must be acknowledged, as access to high-quality sport-specific footwear and

organized sports facilities may be limited for some families because of financial constraints. Consequently, children may use worn-out footwear, improperly fitted shoes, or footwear intended for other sports due to economic limitations and rapid growth during adolescence.[24] Public health initiatives, schools, and community sports programs should therefore prioritize practical and affordable injury-prevention strategies, including education on appropriate footwear selection, timely replacement of excessively worn shoes, and avoidance of unsafe barefoot participation in high-impact sports. While elite-level footwear is not necessary for all recreational athletes, ensuring adequate fit, stability, grip, and sport-specific support remains essential for reducing injury risk and promoting safer sports participation.

Socioeconomic factors may affect access to safe training environments, coaching, and organized sports programs, thereby contributing to disparities in injury incidence and outcomes. By recognizing these barriers, clinicians can provide pragmatic, and context-specific advice that supports inclusive, and safer sports participation within the community.[25]

Integration of targeted screening for modifiable risk factors into routine clinic consultations may further strengthen preventive efforts. Brief anticipatory guidance addressing obesity, fatigue, inadequate conditioning, inappropriate footwear, and excessive training may help identify at-risk individuals early and reinforce preventive behaviors, particularly when aligned with community-based and school-based programs.

Greater collaboration among healthcare providers, schools, sports organizations, and community leaders is also required to establish practical, and evidence-based guidelines for safe sports participation among children and adolescents. Existing evidence suggests that school-based injury prevention policies are often inconsistent and not fully evidence-based, highlighting the need for more robust, standardized frameworks.[26]

Interventions incorporating psychological and behavioral components within school-based programs have demonstrated reductions in sports injury incidence, suggesting an important role for integrated and multidisciplinary prevention approaches. Embedding injury prevention education within school curricula and public health initiatives may help foster a culture of safe sports participation and long-term musculoskeletal health from an early age.[23]

Future Directions

Future research should prioritize pediatric-specific data on acute ankle injuries and Achilles tendon rupture among children and adolescents, as much of the current evidence is extrapolated from adult populations. Prospective studies are needed to better characterize injury patterns, biomechanical differences, and long-term outcomes in children and adolescents, particularly in relation to growth plate vulnerability and developmental physiology. Existing literature highlights that pediatric injury-prevention research remains limited and often lacks age-specific guidance, indicating the need for more targeted studies.[25]

There is a need to evaluate the effectiveness and real-world implementation of structured injury-prevention programs in school and community settings. Neuromuscular training and structured warm-up protocols have demonstrated significant reductions in lower extremity injuries among youth athletes in randomized trials and systematic reviews.[27] However, challenges related to program adherence, implementation, and long-term sustainability remain, particularly in non-elite and recreational settings.[25]

Digital health platforms may offer promising opportunities to extend preventive strategies beyond the clinic. Emerging evidence suggests that digital health interventions, including online education platforms for coaches and parents, may markedly reduce injury incidence and improve preventive health behaviors. Furthermore, digital tools are increasingly recognized for their potential to enhance the delivery of preventive healthcare services in adolescents, although integration into routine clinical practice requires further evaluation.[17,28]

Finally, future research should explore behavioral and cultural factors influencing injury risk among children and adolescents, including attitudes towards fatigue, rest, pain tolerance, and early symptom reporting. Understanding these factors may help inform more effective and culturally sensitive injury-prevention strategies.

Conclusion

Participation in sports plays an important role in obesity management programs and in overall health promotion among children and adolescents. However, participation in sports must be accompanied by appropriate injury-prevention strategies to minimize the risk of acute ankle injuries and Achilles tendon ruptures. Many of these injuries are preventable with proper preparation, adequate warm-up, suitable footwear, safe training practices, and respect for physical limitations.

Addressing modifiable risk factors, increasing public health awareness, and integrating injury prevention into healthcare, school, and community programs may substantially reduce the burden of sports-related ankle injuries among children and adolescents. Collaboration among healthcare providers, educators, sports organizations, caregivers, and community leaders remains essential in fostering a culture of safe sports participation and empowering young athletes to remain physically active while minimizing injury risk. As sports and the child grow, prioritizing a culture of safety becomes increasingly vital.

Acknowledgments

We would like to thank the Director General of Health, Malaysia, for his approval in publishing this article. The authors thank Ms Yiting Xia for preparing the original illustration used in Figure 1.

Author Contributions

AZT and THT conceived and designed the article, and AZT drafted the first manuscript. CWW and RCJ advised on the contents of the manuscript. All authors critically revised, read and approved the final manuscript. All authors have full access to the article and have final responsibility for the decision to submit it for publication.

Conflicts of Interest

All authors declare no potential conflicts of interest.

Funding

No honorarium, grant, or other form of payment was given to anyone to produce the article..

References

1. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in underweight and obesity from 1990 to 2022: A pooled analysis of 3663 population-representative studies with 222 million children, adolescents, and adults. *Lancet*. 2024 Mar 16;403(10431):1027-50. doi:10.1016/S0140-6736(23)02750-2.
2. Poitras VJ, Gray CE, Borghese MM, Carson V, Chaput JP, Janssen I, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Appl Physiol Nutr Metab*. 2016 Jun;41(6 Suppl 3):S197-239. doi:10.1139/apnm-2015-0663.
3. World Health Organization. WHO guidelines on physical activity and sedentary behaviour. Geneva: World Health Organization; November 25, 2020. Available at: https://www.who.int/publications/i/item/9789240015128. Accessed June 1, 2026.
4. Wyszyńska J, Ring-Dimitriou S, Thivel D, Weghuber D, Hadjipanayis A, Grossman Z, et al. Physical activity in the prevention of childhood obesity: The Position of the European Childhood Obesity Group and the European Academy of Pediatrics. *Front Pediatr*. 2020 Nov 5;8:535705. doi:10.3389/fped.2020.535705. .
5. Hess GW. Achilles tendon rupture: a review of etiology, population, anatomy, risk factors, and injury prevention. *Foot Ankle Spec*. 2010 Feb;3(1):29-32. doi:10.1177/1938640009355191.
6. Xergia SA, Tsarbou C, Liveris NI, Hadjithoma M, Tzanetakou IP. Risk factors for Achilles tendon rupture: an updated systematic review. Phys Sportsmed. 2023 Dec;51(6):506-16. doi:10.1080/00913847.2022.2085505..
7. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train*. 2007 Apr-Jun;42(2):311-9.
8. Lemme NJ, Li NY, DeFroda SF, Kleiner J, Owens BD. Epidemiology of Achilles tendon ruptures in the United States: Athletic and nonathletic injuries from 2012 to 2016. *Orthop J Sports Med*. 2018 Nov 26;6(11):2325967118808238. doi:10.1177/2325967118808238.
9. Apley AG, Solomon L. Chapter 21: The ankle and foot; in Concise system of orthopaedics and fractures, 2nd Edition (1994). Butterworth Heinemann Ltd, United Kingdom. ISBN: 0750617675. p. 209-23.

10. Houghton KM. Review for the generalist: evaluation of pediatric foot and ankle pain. *Pediatr Rheumatol Online J*. 2008 Apr 9;6:6. doi:10.1186/1546-0096-6-6.
11. Du P, Chen K, Patterson D, Ranade S. The pediatric ankle and foot: a review of common injuries in the pediatric athlete and their treatments. *Ann Joint*. 2018;3:24. doi:10.21037/aoj.2018.02.02
12. Dowling S, Spooner CH, Liang Y, Dryden DM, Friesen C, Klassen TP, et al. Accuracy of Ottawa Ankle Rules to exclude fractures of the ankle and midfoot in children: A meta-analysis. *Acad Emerg Med*. 2009 Apr;16(4):277-87. doi:10.1111/j.1553-2712.2008.00333.x.
13. Aminlari A, Stone J, McKee R, Subramony R, Nadolski A, Tolia V, et al. Diagnosing Achilles Tendon Rupture with Ultrasound in Patients Treated Surgically: A Systematic Review and Meta-Analysis. *J Emerg Med*. 2021 Nov;61(5):558-67. doi:10.1016/j.jemermed.2021.09.008.
14. Dams OC, Reininga IHF, Gielen JL, van den Akker-Scheek I, Zwerver J. Imaging modalities in the diagnosis and monitoring of Achilles tendon ruptures: A systematic review. *Injury*. 2017 Nov;48(11):2383-99. doi:10.1016/j.injury.2017.09.013.
15. Gianakos AL, Hartman H, Kerkhoffs GMMJ, Calder J, Kennedy JG. Sex differences in biomechanical properties of the Achilles tendon may predispose men to higher risk of injury: A systematic review. *J ISAKOS*. 2024 Apr;9(2):184-91. doi:10.1016/j.jisako.2023.11.001.
16. Raikin SM, Garras DN, Krapchev PV. Achilles tendon injuries in a United States population. *Foot Ankle Int*. 2013 Apr;34(4):475-80. doi:10.1177/1071100713477621.
17. Olsen OE, Myklebust G, Engebretsen L, Holme I, Bahr R. Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial. *BMJ*. 2005 Feb 26;330(7489):449. doi:10.1136/bmj.38330.632801.8F.
18. Barton CJ, Bonanno D, Menz HB. Development and evaluation of a tool for the assessment of footwear characteristics. *J Foot Ankle Res*. 2009 Apr 23;2:10. doi:10.1186/1757-1146-2-10.
19. Kuntze G, Mansfield N, Sellers W. A biomechanical analysis of common lunge tasks in badminton. *J Sports Sci*. 2010 Jan;28(2):183-91. doi:10.1080/02640410903428533.
20. Sun X, Lam WK, Zhang X, Wang J, Fu W. Systematic review of the role of footwear constructions in running biomechanics: Implications for running-related injury and performance. *J Sports Sci Med*. 2020 Feb 24;19(1):20-37.
21. Hollander K, de Villiers JE, Sehner S, Wegscheider K, Braumann KM, Venter R, et al. Growing-up (habitually) barefoot influences the development of foot and arch morphology in children and adolescents. *Sci Rep*. 2017 Aug 14;7(1):8079. doi:10.1038/s41598-017-07868-4.
22. Hergenroeder AC. Prevention of sports injuries. *Pediatrics*. 1998 Jun;101(6):1057-63. doi:10.1542/peds.101.6.1057.
23. Jacobsson J, Kowalski J, Timpka T, Hansson PO, Spreco A, Dahlstrom O. Universal prevention through a digital health platform reduces injury incidence in youth athletics (track and field): a cluster randomised controlled trial. *Br J Sports Med*. 2023 Mar;57(6):364-70. doi:10.1136/bjsports-2021-105332.

24. Robbins S, Waked E, Gouw GJ, McClaran J. Athletic footwear affects balance in men. *Br J Sports Med.* 1994 Jun;28(2):117-22. doi:10.1136/bjsm.28.2.117.
25. Nauta J, van Mechelen W, Otten RH, Verhagen EA. A systematic review on the effectiveness of school and community-based injury prevention programmes on risk behaviour and injury risk in 8–12-year-old children. *J Sci Med Sport.* 2014 Mar;17(2):165-72. doi:10.1016/j.jsams.2013.07.011.
26. Göpfert A, Van Hove M, Emond A, Mytton J. Prevention of sports injuries in children at school: a systematic review of policies. *BMJ Open Sport Exerc Med.* 2018 Jun 4;4(1):e000346. doi:10.1136/bmjsem-2018-000346.
27. Ding L, Luo J, Smith DM, Mackey M, Fu H, Davis M, Hu Y. Effectiveness of warm-up intervention programs to prevent sports injuries among children and adolescents: A systematic review and meta-analysis. *Int J Environ Res Public Health.* 2022 May 23;19(10):6336. doi:10.3390/ijerph19106336.
28. Lutz D, van den Berg C, Räisänen AM, Shill IJ, Kim J, Vaandering K, et al. Best practices for the dissemination and implementation of neuromuscular training injury prevention warm-ups in youth team sport: A systematic review. *Br J Sports Med.* 2024 May 28;58(11):615-25. doi:10.1136/bjsports-2023-106906.