Sports Medicine (2023) 53:1103–1105
https://doi.org/10.1007/s40279-023-01809-0

LETTER TO THE EDITOR

Comment on "Running-Related Biomechanical Risk Factors for Overuse Injuries in Distance Runners: A Systematic Review Considering Injury Specificity and the Potentials for Future Research"

José Roberto de Souza Júnior[1,2] · Logan Walter Gaudette[1] · Adam S. Tenforde[1]

Accepted: 3 January 2023 / Published online: 21 January 2023

Dear Editor,

We enjoyed reading the systematic review by Willwacher and colleagues [1] that aims to characterize biomechanical risk factors for running overuse injuries (ROIs). Previous systematic reviews found that a history of injury and training variables contribute to running-related injuries [2, 3]. More recent studies evaluated the association of biomechanical variables with ROIs [4, 5] and lower limb tendinopathies [6]. The innovation of the present review comes from evaluating the association of kinematic and kinetic aspects in eight of the most common ROI in distance runners. Developing this review was presumably a challenge considering the differences in the definition of injury, type of runners, populations, study designs, data collection methods, outcomes, and follow-up period. Therefore, we would like to congratulate the authors [1] on this outstanding work and contributions to advancing the field of running medicine.

The authors [1] concluded that different biomechanical risk factors are associated with different ROIs. In particular, moderate evidence supported a higher eversion time during stance and peak contralateral pelvic drop as risk factors for medial tibial stress syndrome, higher average and instantaneous loading rates in plantar fasciitis, and reduced braking ground reaction force impulse and longer contact time for individuals with patellofemoral pain syndrome. Identifying different biomechanical variables by ROI suggests the importance of evaluating and addressing risk factors with an individualized gait retraining program within the injured runner.

The review demonstrates the limited high-quality prospective studies that currently exist to characterize biomechanical risk factors for ROIs. Notably, few prospective studies were identified among the 66 studies that met criteria for inclusion; the condition with the most prospective studies performed was the ROI patellofemoral pain syndrome. No prospective studies were identified for tibial stress fracture, despite this ROI being among the most common bone stress injury with a high rate of reoccurrence and extended time lost from sport [7]. In addition, one prospective study characterized risk factors for medial tibial stress syndrome, which is a common injury in both athletes and the general population [8]. The limited number of studies identified highlights the challenges of performing prospective studies to characterize biomechanical risk factors for ROIs, and reflects the value for the future development of prospective studies investigating the association of biomechanical risk factors for advancing the science of understanding ROIs.

More than 300 biomechanical aspects were identified in this review [1]; yet limited risk factors were considered relevant (conflicting to moderate evidence) for ROIs according to the pre-determined criteria of differences between injured and uninjured in one prospective or two retrospective studies. Six aspects were found to have moderate evidence as a biomechanical risk factor for ROIs. These results suggest that previous studies had difficulties in identifying biomechanical variables that can lead to an increased risk of specific injuries. Future studies should use models (e.g., classification and regression tree analysis) that can capture non-linear multifactorial interactions between a variety of variable types including descriptive aspects of anthropometrics, age, and sex, along with physiological,

This comment refers to the article available online at https://doi.org/10.1007/s40279-022-01666-3.

✉ José Roberto de Souza Júnior
JDESOUZAJUNIOR@mgh.harvard.edu

[1] Department of Physical Medicine and Rehabilitation, Spaulding Rehabilitation Hospital, Spaulding National Running Center, Harvard Medical School, Boston, MA, USA

[2] Graduate Program of Sciences and Technologies in Health, University of Brasília, Brasília, DF, Brazil

psychological, behavioral, and biomechanical risk factors for injury [9, 10]. The inclusion of non-biomechanical variables with biomechanical variables is important, as variables such as anthropometric characteristics, mental health, and sleep habits have presented associations with ROIs [11].

The findings from this review [1] of biomechanical variables for ROIs highlight another concern: most risk factors were assessed with motion capture systems using either force plates or instrumented treadmills, all of which have limited availability outside of a lab environment. Of the main aspects identified, fewer than ten could be reliably assessed in a clinician routine, and of the six aspects that presented moderate evidence with specific running injuries only peak contralateral pelvic drop could be easily evaluated with a simple video capture. These results may suggest a financial barrier in the identification of risk factors in clinical practice using these technologies. The use of accessible technologies to provide information, especially on kinetic aspects of running, is another field that must be targeted by future research.

Wearable sensors such as accelerometers may represent a solution. Excellent within-session reliability and acceptable measurement error values were found for treadmill and overground running [12]. In addition, a moderate-to-strong correlation between vertical tibial acceleration and loading rates in healthy and injured runners has been reported [13, 14]. Future studies are required as a limited number of variables assessed by commercially available wearable sensors are valid [15]. Of the studies that have examined the relationship between tibial acceleration and specific ROIs, only one, which focused on tibial stress fractures, found significantly higher tibial accelerations in the injured group compared with healthy controls. Therefore, further investigations to determine the potential of this variable in predicting specific ROIs must be carried out.

A logical extension of this review [1] is to create targeted interventions to address biomechanical risk factors for ROIs. However, limited prospective studies have been performed that attempt to modify biomechanical risk factors within runners as a form of targeted intervention to prevent future injury. The adoption of a non-rearfoot strike has been suggested to reduce injury rates, although others have challenged the limited evidence to support this approach [16, 17]. In addition, only one longitudinal study supports that landing softly has the potential to reduce injury occurrence in runners through decreasing loading rates [18]. With a better comprehension of risk profiles for specific injuries, we will be able to identify biomechanical aspects to address and be more assertive about individualized interventions to reduce injury rates.

Research characterizing biomechanical variables that may be related to specific ROIs has grown and makes the current review highly relevant. However, key barriers persist including implementation science to apply this knowledge for the injured runner. Practically speaking, this review [1] supports taking an individualized approach to providing care for the injured runner, and we hope our commentary sparks further interest to advance future work on this topic.

Declarations

Funding No funding has been received for the preparation of this article.

Conflict of interest José Roberto de Souza Júnior, Logan Walter Gaudette, and Adam S. Tenforde have no conflicts of interest that are directly relevant to the content of this article.

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Data availability Not applicable.

Code availability Not applicable.

Author contributions Each named author has substantially contributed to conducting the underlying research and drafting this manuscript. All authors read and approved the final version.

References

1. Willwacher S, Kurz M, Robbin J, Thelen M, Hamill J, Kelly L, et al. Running-related biomechanical risk factors for overuse injuries in distance runners: a systematic review considering injury specificity and the potentials for future research. Sports Med. 2022;52:1863–77.
2. Saragiotto BT, Yamato TP, Hespanhol Junior LC, Rainbow MJ, Davis IS, Lopes AD. What are the main risk factors for running-related injuries? Sports Med. 2014;44:1153–63.
3. 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: e0114937.
4. Ceyssens L, Vanelderen R, Barton C, Malliaras P, Dingenen B. Biomechanical risk factors associated with running-related injuries: a systematic review. Sports Med. 2019;49:1095–115.
5. Vannatta CN, Heinert BL, Kernozek TW. Biomechanical risk factors for running-related injury differ by sample population: a systematic review and meta-analysis. Clin Biomech. 2020;75: 104991.
6. Mousavi SH, Hijmans JM, Rajabi R, Diercks R, Zwerver J, van der Worp H. Kinematic risk factors for lower limb tendinopathy in distance runners: a systematic review and meta-analysis. Gait Posture. 2019;69:13–24.
7. Rizzone KH, Ackerman KE, Roos KG, Dompier TP, Kerr ZY. The epidemiology of stress fractures in collegiate student-athletes, 2004–2005 through 2013–2014 academic years. J Athl Train. 2017;52:966–75.

8. Lopes AD, Hespanhol LC, Yeung SS, Costa LOP. What are the main running-related musculoskeletal injuries? Sports Med. 2012;42:891–905.
9. Ferreira VMLM, Oliveira RR, Nazareno TS, Freitas LV, Mendonça LD. Interaction of foot and hip factors identifies Achilles tendinopathy occurrence in recreational runners. Phys Ther Sport. 2020;45:111–9.
10. Bittencourt NFN, Meeuwisse WH, Mendonça LD, Nettel-Aguirre A, Ocarino JM, Fonseca ST. Complex systems approach for sports injuries: moving from risk factor identification to injury pattern recognition: narrative review and new concept. Br J Sports Med. 2016;50:1309–14.
11. Mousavi SH, Hijmans JM, Minoonejad H, Rajabi R, Zwerver J. Factors associated with lower limb injuries in recreational runners: a cross-sectional survey including mental aspects and sleep quality. J Sports Sci Med. 2021;20:204–15.
12. Aubol KG, Hawkins JL, Milner CE. Tibial acceleration reliability and minimal detectable difference during overground and treadmill running. J Appl Biomech. 2020. https://doi.org/10.1123/jab.2019-0272.
13. Van den Berghe P, Six J, Gerlo J, Leman M, De Clercq D. Validity and reliability of peak tibial accelerations as real-time measure of impact loading during over-ground rearfoot running at different speeds. J Biomech. 2019;27(86):238–42.
14. Tenforde AS, Hayano T, Jamison ST, Outerleys J, Davis IS. Tibial acceleration measured from wearable sensors is associated with loading rates in injured runners. PM R. 2020;12:679–84.
15. De Fontenay BP, Roy JS, Dubois B, Bouyer L, Esculier JF. Validating commercial wearable sensors for running gait parameters estimation. IEEE Sensors J. 2020;20:7783–91.
16. Daoud AI, Geissler GJ, Wang F, Saretsky J, Daoud YA, Lieberman DE. Foot strike and injury rates in endurance runners: a retrospective study. Med Sci Sports Exerc. 2012;44:1325–34.
17. Anderson LM, Bonanno DR, Hart HF, Barton CJ. What are the benefits and risks associated with changing foot strike pattern during running? A systematic review and meta-analysis of injury, running economy, and biomechanics. Sports Med. 2020;50:885–917.
18. Chan ZYS, Zhang JH, Au IPH, An WW, Shum GLK, Ng GYF, et al. Gait retraining for the reduction of injury occurrence in novice distance runners: 1-year follow-up of a randomized controlled trial. Am J Sport Med. 2017;46:388–95.