IFSPT International Perspective

The Prevention and Treatment of Running Injuries: A State of the Art

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Despite decades of efforts, running injury prevention programs continue to fall short of achieving a reduction in running injury rates[1] and most running injuries are notorious for their high recurrence.[2] Prevention and treatment efforts often focus on a sole factor, such as muscle strengthening or biomechanics, despite the multifactorial nature of running injuries. Additional emphasis on low-value interventions such as footwear to prevent injury often detracts from more effective prevention strategies.[3] Not surprisingly, most running injury prevention programs fail to reduce running injury rates and, in the case of advising on running biomechanics, may actually increase the risk of running injury.[1] The purpose of this international perspective is to describe how a causal framework approach can help to prevent and treat running injuries.

Causal frameworks provide an important path forward for running injury prevention and treatment efforts by considering how training loads interact with modifiers (i.e., risk factors). Bertelsen et al[4] introduced a causal framework for the aetiology of running injuries that identified the complex interplay of training load (i.e., number of running steps) with the distribution of biomechanical loading across anatomical structures, magnitude of internal biomechanical loads, and an anatomical structure's capacity to tolerate the load. For instance, male masters runners have an elevated risk for Achilles tendinopathy due in large part to age-related reductions in Achilles tendon stiffness.[5] Rapid increases in hill running or speedwork distribute a greater degree of biomechanical loads on the Achilles tendon, potentially resulting in an injurious training load in the masters runner. Importantly, runners who are not at-risk for Achilles tendinopathy, such as adolescent runners, may not experience the same injury under similar training loads. A critical concept in Bertelsen's causal framework is that a runner's biomechanics distributes the loads to various structures, but an injury will not result without a training load error coupled with a compromised load capacity of the anatomical structure.

More recently, Kalkhoven et al[6] provided an important update to the Bertelsen framework by incorporating the tissue-specific microdamage that occurs from biomechanical loading and the ability of the athlete's underlying physiology to support tissue adaptation. The Kalkhoven framework applies an important concept long-known in tissue mechanics: cumulative biomechanical loads have a non-linear relationship with cumulative tissue damage. For instance, a 10% increase in tissue stress/strain magnitudes results in a 50% reduction in the number of loading cycles (i.e., steps) before tissue failure.[7] This key, non-linear relationship may explain how a sudden addition of speedwork, for instance, can result in injury even if weekly running volume remains unchanged.[8] Yet, running injury prevention programs often view added training load as a linear issue, focusing more on training volume than loading magnitude.

Since tissue is not an inert structure, consideration of the ability of the athlete's physiology to support tissue adaptation in response to loading is a critical component in understanding running injuries. Important physiological concepts, namely Relative Energy Deficiency in Sport (RED-S), have not had enough focus in prevention and treatment programs. The treatment of bone stress injuries in runners is emblematic of the problem of concentrating on an isolated risk factor (e.g., biomechanics) while ignoring other keystone contributors, such as energy availability. If energy availability is insufficient to support bone remodeling, addressing biomechanics or prescribing targeted bone loading exercises will likely have minimal therapeutic effect.[9]

Adopting a causal framework can greatly inform injury prevention and treatment efforts by tailoring a program to the runner's risk profile and recent training loads. Enhancing pre-run load capacity of the athlete via consistent, progressive loading (progressive strengthening, minimizing training spikes), addressing psychological stressors, and optimizing a runner's physiology is the first step. Second, considering the attributes of the individual runner (i.e., masters male vs adolescent female) and the ability of the athlete's physiology to support tissue remodeling will help inform physiological interventions and training load pre-

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scription. Tailoring training load prescription to address structure-specific cumulative microdamage should also be specific to past injuries or anatomical structures that are more likely to experience injury in specific sub-populations. For example, those recovering from, or at-risk for, Achilles tendinopathy should add speedwork into a training program judiciously, whereas downhill running should be added in slowly if recovering from, or at-risk for, patellofemoral pain. Wearable technologies can monitor injury-specific training loads (i.e., number of steps) while performing activities known to increase loading on injury-susceptible tissues, helping inform the need for recovery days to restore pre-run load capacity and support tissue adaptation. Lastly, clinicians should adopt routine screening for RED-S and other physiological conditions known to reduce tissue adaptability and refer out for specialized care when indicated.

We believe that by employing a causal framework of running injury aetiology that considers current theory in tissue mechanics and physiology, and by following general principles of injury risk management, the puzzle of running injury prevention and treatment has potential to be solved.

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