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Biomechanics of Running – Implications for Running-Related Injuries and Future Areas for Research

Biomechanik des Laufens – Implikationen für laufbedingte Verletzungen und zukünftige Forschungsfelder

EDITORIAL

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Running has been one of the most popular sports practiced worldwide for many years. According to current estimates, almost 18 million people in Germany run regularly. Besides the joy of exercise and nature, most runners mention an improvement in fitness and health as motivation. Increasing physical performance is also a priority for many runners, which is why there are continuously high numbers of participants and finishers at running events such as the major city marathons in Berlin, Frankfurt and Hamburg.

In addition to the numerous and well-studied benefits of running on general health, high rates of running-related injuries are regularly reported. Depending on the population and time period studied, the prevalence rate varies between 20 and 80% (20). The most frequent diagnoses are iliotibial band syndromes, tendinopathies of the Achilles tendon and plantar fascia, patellofemoral pain syndromes and stress fractures of the tibia and metatarsalia (17).

The etiology of running-related injuries is multifactorial and risk factors can be divided into modifiable and non-modifiable (13). Besides good evidence for a high running distance (>60km/week) and a running related injury in the history as independent risk factors, there are numerous studies on anthropometric, anatomical and training-related parameters that could be associated to a running-related injury (13). Biomechanical parameters are also part of several scientific studies, although the general evidence is not yet sufficiently clear (3).

Focus of Biomechanical Research: Running Footwear

Not least because of the first marathon under 2 hours run by Eliud Kipchoge under laboratory-like conditions on October 12, 2019 in Vienna, running footwear is in the focus of biomechanical research. Besides the current discussion about the benefits of footwear on running economy and performance (11, 12, 16) the running shoe is also central in the debate about running-related injuries. Although numerous innovations, such as new damping systems or pronation elements, have come onto the market since the 1970s, no reduction in the number of injuries has been recorded (20). Nigg et al. (2015) (20) are therefore advocating a paradigm shift away from strong cushioning, corrective shoe elements and blanket insoles towards a „natural“ and self-chosen movement pattern. Since the publication of Lieberman and colleagues‘ article on Kenyan barefoot runners in the journal „Nature“(15), over the past 10 years, numerous scientific papers have dealt with the topic of (simulated) barefoot locomotion and there are now many models from different manufacturers on the market that are designed to replicate the biomechanics of barefoot walking (4, 6, 21). One focus of current research in this area concerns the potential of altered kinematics in the upper ankle joint (forefoot stike) and a reduced cadence with associated lower ground reaction forces (10, 24). These have been suspected for years of being associated with certain injuries even though the current evidence is not yet sufficient (3, 5). Future research in this area should focus on the long-term effects of (simulated) barefoot walking and prospective studies are necessary (9).

New Technical Innovations: Inertial Sensor Technology and Artificial Intelligence

Current technical developments in the field of wearables (23) now enable the investigation of biomechanical variables outside the biomechanics laboratories, which otherwise often have to be operated with great technical and personnel effort. Inertial Measurement Units (IMUs), which contain acceleration, rotation and magnetic sensors, can be used to continuously measure kinematic data during a training session or competition (7, 8, 14). In addition, ground reaction forces can be indirectly estimated from the acceleration of the tibia (14, 22). Research in this area is expected to increase significantly in the coming years and must currently still undergo sufficient validation for the various parameters and research questions to be measured (18). Overall, this research area has great potential for application, especially in the field of „Citizen Science“, as many watches and almost all smartphones are now equipped with an IMU.

A further research area with high potential involves modern methods of „artificial intelligence“ and „big data (2, 19). In this context, machine learning is to be emphasized, which aims at recognizing patterns and regularities from arbitrary data sets. Machine learning offers possibilities in the processing of large biomechanical data ›

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sets as well as in the analysis of the multifactorial genesis of running-related injuries with the aim of predicting these (1, 2). Prediction of injuries is a very challenging and important component in injury prevention.

In consideration of these future research areas, the interdisciplinary nature of sports medicine is once again in demand and cooperation with the fields of sports science, physiotherapy, orthopedics/traumatology, biomechanics, engineering, computer science and statistics is essential.

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