Special Issue on “Sports Performance and Health”

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Sports performance is primarily perceived to be associated with elite sport, where athletes strive for a place on the podium, with the most prestigious result probably being an Olympic gold medal. On the other hand, recreational athletes are increasingly attempting to emulate top athletes by pushing their limits and setting their ambitions ever higher. As such, both elite and recreational athletes are seeking to optimize their performance.

Performance optimization is distinctly multidisciplinary. “Internal” performance optimization includes all of the athlete’s technical to tactical skills, which depend heavily on the pillars of his or her physical and mental capabilities. “External” performance optimization, on the other hand, involves the development of innovative sports equipment and adjusting it to the athlete and the current conditions in which the equipment is used.

To improve both internal and/or external performance, optimized training concepts and incorporating state-of-the-art technologies are key. Besides a better understanding of human physical and mental performance and the possibilities to improve it, nowadays miniature and wearable sensors and advanced data processing approaches can also be supportive. Such technological advances can provide new real-time feedback opportunities and, when combined with artificial intelligence, may even allow the prediction/optimization of current performance enhancement strategies.

However, despite or even because of such possibilities for improvement, sports performance enhancement is in a permanent trade-off with the protection of athletes’ health. Regardless of the well-known positive effects of physical activity on health, the prevention and management of sports injuries remain major challenges that need to be addressed. The treatment of sports injuries is often difficult, expensive and time-consuming, so preventive strategies and activities are justified for both medical and economic reasons. Moreover, improved physiological and psychological understanding of the factors influencing/protecting health, as well recent technological advances, could help to monitor and counteract injuries and their risk factors, and thus promote safe participation in sport.

Accordingly, this Special Issue on “Sports Performance and Health” was open (but not limited) to submissions from the following areas: (i) benefits of sport for health, (ii) tradeoffs between sports performance and health, (iii) optimization of sports performance by training, (iv) technique and/or tactics enhancements, prevention and management of sports injuries, (v) optimization of sports equipment to increase performance and/or decrease the risk of injury, and (vi) innovations for sports performance, health, and load monitoring. Covering such a wide range of sports performance and health-related aspects, this Special Issue contains 19 scientific contributions, 17 of which are original research papers, one review paper, and one commentary.

Two factors equally important to sports performance and health, and addressed by a total of five articles within this issue are fatigue and motion asymmetries. With respect to the first, the study by Du and Fan [1] investigated the effects of fatigue on the kinematics

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and kinetics of lunging maneuvers. Results showed that the initial contact angles, peak angles, moments, power, and time needed to reach the peak angles at the hip, knee, and ankle in the sagittal plane all decreased post-fatigue. Accordingly, with respect to preventing fatigue-induced injuries, the authors suggested focusing particularly on the muscular strengthening of the knee and hip extensors. A second study by Zorko et al. [2] examined the influence of fatigue and ski waist-width on knee-joint stability and skier's balance. They demonstrated that the skiers' knee-joint kinematics and balance were hampered in the state of fatigue, as well as when using skis with a large waist-width. They suggested avoiding the fatigue state and the use of skis with a large waist-width while skiing on hard surfaces to decrease the risk of injury.

Concerning motion asymmetries, two studies in this Special Issue examined potential relationships with performance. Ujakovič and Šarabon [3] reported asymmetries in jumping ability and hip and trunk strength to influence the change of direction performance in elite basketball players. Furthermore, as the magnitudes of asymmetry revealed to be highly dependent on the specific movement, test and parameter, the authors suggested not to use uniform asymmetry thresholds, such as <10%, when deciding on athletes' return to sport or when planning counteractive training interventions. Supej et al. [4] investigated whether asymmetries in the technique and acting ground reaction forces (GRF) associated with left and right turns influence the asymmetries in the performance of elite slalom skiers. They found that although slalom skiers moved their bodies in a quite symmetrical fashion, asymmetry in their skiing technique and GRF influenced variables related to asymmetries in performance. Finally, the third study on motion asymmetries by Stodółka et al. [5] investigated the asymmetry between the right and left foot center of pressure (COP) trajectory. Strong positive correlations were observed between the right and left foot anteroposterior COP displacement trajectory, while in the mediolateral direction, moderate to strong negative correlations were present. However, according to the authors, additional investigations are warranted to better understand the causes of COP asymmetry and to help clinicians with the diagnosis of posture-related pathologies.

Concerning the submission area (iii), i.e., the optimization of sports performance by training, technique and/or tactics enhancements, the study by Smajla et al. [6] investigated elbow extensors and volar flexors strength in basketball players, and demonstrated significant associations between strength and shooting performance, particularly for long-distance shooting. Havolli et al. [7] reported the anthropometric characteristics, maximal isokinetic strength and selected handball power as indicators that are specific to playing position in elite Kosovan handball players. In fact, the study found that shooting success is largely determined by the player's height, weight, muscle strength and power, while it seems that anthropometric characteristics and physical performance are closely related to the game demands of each playing position. A commentary by Patterson and Raschner [8] introduced an Intelligent Motion Lifter (IML) that allows safe supramaximal eccentric loads training with a free barbell and no spotters. The IML was suggested to be used for free barbell training: a spotter for normal training, eccentric only, concentric only, and squat jumps. Along with the introduction of the IML concept, the commentary addressed the necessity of eccentric training for elite alpine ski racers. The study by Bugaj et al. [9] explored the effects of a 7-week training period on changes in skin NADH Fluorescence in highly trained athletes and concluded that physical training results in an increase in the skin NADH fluorescence levels at rest and after exercise in athletes. The effect of the environment on training was investigated by Hagiwara et al. [10]. They examined the subjective and objective arousal of elite swimmers during physical training under positive and negative ion environments. Their analysis of the change in the arousal level at rest and during training revealed that both subjective and objective arousal levels were significantly higher in the positive and negative ion environments than in the control environment. Based on the fact that the average training performance scores were also significantly higher in the positive and negative ion environments, the authors concluded that such conditions have a positive effect on sports training.

Regarding the optimization of sports performance by technique and/or tactics enhancements Sánchez-Alcaraz et al. [11] analyzed the serve and return statistics in elite padel players regarding courtside and gender. They found female players to execute more backhand and cross-court returns and to use more lobbs than men. The presented results appear particularly useful to develop appropriate game strategies and to design specific training exercises. The study by Čoh et al. [12] compared the biomechanical parameters of the hurdle clearance technique of the fifth hurdle in the 110 m hurdle race of Colin Jackson and Dayron Robles, two world record holders. The authors demonstrated differences in temporal parameters, as well as in the center-of-mass flight trajectory of the hurdle clearance. Finally, Wong et al. [13] conducted a systematic scoping review to present the available evidence on the biomechanics of table-tennis strokes. They summarized current trends, categorized research foci, and biomechanical outcomes regarding various movement maneuvers and playing levels. Most notably, their review uncovered that there is a lack of studies that investigated backspin maneuvers, longline maneuvers, strikes against sidespin, and pen-hold players. Meanwhile, higher-level players were found to be able to better utilize the joint power of the shoulder and wrist joints through the full-body kinetic chain.

With regard to the submission area (iv), i.e., prevention and management of sports injuries, the study by Carraro et al. [14] assessed the lower back complaints in adolescent competitive alpine skiers in view of sex, category, discipline preference, and training attributes. Particularly noteworthy is their finding that the characteristic pain intensity was found to be significantly related to the skiers' years of sports participation, the number of competitions/season, and the number of skiing days/season. Furthermore, this study showed a relatively high magnitude of lower back-related pain in adolescent competitive alpine skiers and that training attributes are a key driver for such complaints. In a second study addressing this submission area, Liu et al. [15] investigated the effects of backpack loads on leg muscle activation during slope walking. Their results implied that the hip and knee muscles play an important role during slope walking with loads. They interpreted their findings as being useful for designing assistant devices, such as exoskeleton robots, to enhance hikers' and soldiers' walking abilities.

The submission area (v) related to the optimization of sports equipment to increase performance and/or decrease the risk of injury was addressed by three papers. Romero-Morales et al. [16] investigated the effectiveness of ankle taping in elite soccer and basketball players and found a decrease in the ROM of ankle dorsiflexion as a reason why taping may be considered a useful prophylactic approach for the prevention of ankle sprain injuries. The study by Wong et al. [17] examined the effects of wearing upper-, lower- and full-body compression garments on basketball free-throw shooting accuracy, consistency and the range of motion of body joints. Overall, they demonstrated that upper-body or full-body compression garments constrained the range of motion and resulted in an improvement in shooting accuracy. In the context of football, Tang et al. [18] studied the effect of football shoe collar type on ankle biomechanics and dynamic stability during anterior and lateral single-leg jump landings. They found that medial-lateral stability was significantly improved with the high collar, compared to the low collar and that, during the lateral single-leg jump landing, ankle inversion ROM and total ankle frontal ROM were significantly smaller for the high collar, compared to the elastic collar. Accordingly, high collar shoes may be effective in decreasing the ROM and increasing dynamic stability, leading to high ankle joint stiffness. Overall, various equipment in sports can be used to improve performance or decrease the risk of injury. In this context, the designers, researchers and producing companies may still significantly contribute to the developments of sports and safety.

Last, but not least, one paper addressed the submission area (vi), i.e., innovations for sports performance, health, and load monitoring. Here, the study by Bogataj et al. [19] aimed to examine the reliability, validity, and usefulness of the smartphone-based application "My Jump 2". They showed that My Jump 2 is a valid, reliable, and useful tool for measuring vertical jump in recreationally active adults. Moreover, the authors concluded

that, due to its simplicity and practicality, it can be used by practitioners, coaches, and recreationally active adults to measure vertical jump performance.

In summary, the current Special Issue provided several new insights and multidisciplinary perspectives on sports performance and health, and emphasized the ongoing challenges within this field. However, since the outbreak of the COVID 19 pandemic in early 2020, additional new issues emerged, such as the impact of COVID-19-related restrictions on performance and health in elite sports, the implications for mental and physical health in the general population, and the challenges related to the management of COVID-19 infection-related long-term sports performance and health consequences. Thus, there is an evident need to address such issues and fill our current large knowledge gaps through joint upcoming research efforts.

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