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Biomechanics: Movement, Health, Technology, and Aging

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Introduction

This review synthesized findings on how different foot strike patterns in running, like heel strike versus forefoot strike, affect lower limb biomechanics. It highlighted the utility of wearable sensors in capturing these nuances, showing potential for injury prevention and performance optimization through tailored running techniques[1].

This systematic review synthesized current understanding of shoulder joint kinematics during common daily activities in healthy adults. It highlighted variability in motion patterns and the importance of precise 3D kinematic data for understanding normal function, which is crucial for developing effective rehabilitation strategies after injury[2].

This review explored the application of computational fluid dynamics (CFD) in cardiovascular biomechanics, highlighting its role in understanding blood flow patterns, vessel wall stress, and disease progression. It emphasized how CFD models help predict clinical outcomes and design medical devices, showcasing its diagnostic and prognostic potential[3].

This systematic review and meta-analysis identified key biomechanical risk factors associated with running-related injuries. It highlighted aspects like ground reaction forces, joint kinematics, and muscle activation patterns that contribute to injury susceptibility, offering valuable insights for developing targeted prevention strategies for runners[4].

This review explores the intricate relationship between mechanical forces and the biological processes within cartilage, focusing on its role in maintaining homeostasis and contributing to osteoarthritis development. It highlights how mechanotransduction pathways influence cellular behavior and offers insights into potential therapeutic targets[5].

This systematic review assessed the efficacy of wearable robotics in upper-extremity rehabilitation, focusing on how these devices enhance motor recovery and provide biomechanical assistance. It underlined their potential in improving patient engagement and delivering precise, repetitive training, which are critical for functional restoration[6].

This systematic review examined how different footwear influences running biomechanics and overall performance. It highlighted changes in ground reaction forces, joint angles, and muscle activity depending on shoe type, offering insights for athletes and manufacturers aiming to optimize design for injury prevention and enhanced efficiency[7].

This systematic review explored the current and emerging applications of wearable sensor technology in sport biomechanics. It highlighted how these devices provide real-time data on movement patterns, performance metrics, and injury risk, demonstrating their value for athlete monitoring, coaching, and personalized training interventions[8].

This systematic review examined recent advances in applying Finite Element Analysis (FEA) to orthopedic biomechanics. It detailed how FEA models simulate complex mechanical behaviors of bone and joint structures under various loads, improving understanding of fracture mechanics, implant design, and personalized treatment planning[9].

This systematic review investigated the impact of aging on muscle biomechanics and motor control. It highlighted changes in muscle strength, power, stiffness, and coordination patterns with age, emphasizing their implications for functional decline and increased fall risk. Understanding these changes is vital for developing effective interventions for older adults[10].

Description

Studies frequently examine running biomechanics, including how different foot strike patterns affect lower limb mechanics. Wearable sensors are key to capturing these nuances, with the potential for injury prevention and performance optimization through tailored techniques[1]. Similarly, researchers identify crucial biomechanical risk factors for running-related injuries, like ground reaction forces, joint kinematics, and muscle activation patterns, which helps develop targeted prevention strategies for runners[4]. Furthermore, the impact of various footwear on running biomechanics and performance is assessed, revealing how shoe types alter ground reaction forces, joint angles, and muscle activity. This offers valuable insights for athletes and manufacturers aiming to optimize design for injury prevention and enhanced efficiency[7].

Understanding human movement extends to shoulder joint kinematics during common daily activities in healthy adults. Identifying variability in motion patterns and precise 3D kinematic data is crucial for comprehending normal function, which is vital for designing effective rehabilitation strategies after injury[2]. In sport, wearable sensor technology shows promise for real-time data on movement patterns, performance metrics, and injury risk, proving valuable for athlete monitoring, coaching, and personalized training interventions[8].

Advanced computational methods are also pivotal in biomechanics. Computational Fluid Dynamics (CFD) finds application in cardiovascular biomechanics, clarifying blood flow patterns, vessel wall stress, and disease progression. CFD models predict clinical outcomes and aid in designing medical devices, showcasing significant diagnostic and prognostic potential[3]. In orthopedic biomechanics, Finite Element Analysis (FEA) has seen recent advances. FEA models simulate the complex mechanical behaviors of bone and joint structures under various loads, enhancing understanding of fracture mechanics, implant design, and personalized treatment planning[9].

The intricate relationship between mechanical forces and biological processes within cartilage is explored, focusing on its role in maintaining homeostasis and contributing to osteoarthritis development. Mechanotransduction pathways, influencing cellular behavior, offer insights into potential therapeutic targets[5]. Moreover, research investigates the impact of aging on muscle biomechanics and motor control, highlighting changes in muscle strength, power, stiffness, and coordination patterns. Understanding these age-related changes is crucial for developing effective interventions to address functional decline and increased fall risk in older adults[10].

Wearable robotics are effectively assessed for upper-extremity rehabilitation. These devices enhance motor recovery and provide biomechanical assistance, improving patient engagement and delivering precise, repetitive training essential for functional restoration[6].

Conclusion

Recent biomechanics research highlights several key areas. Studies on running mechanics, including foot strike patterns and footwear, leverage wearable sensors to understand lower limb biomechanics, aiming for injury prevention and performance optimization. Researchers also identify biomechanical risk factors for running-related injuries, focusing on ground reaction forces, joint kinematics, and muscle activation to inform prevention strategies.

Understanding human movement extends to shoulder joint kinematics during daily activities, crucial for rehabilitation. Computational Fluid Dynamics (CFD) is a powerful tool in cardiovascular biomechanics, elucidating blood flow patterns and disease progression for diagnostic and prognostic applications. Finite Element Analysis (FEA) further contributes to orthopedic biomechanics by simulating bone and joint behaviors under load, aiding fracture mechanics, implant design, and treatment planning.

Wearable technology plays a significant role in both sport biomechanics and rehabilitation. Wearable sensors offer real-time data for athlete monitoring and personalized training, while wearable robotics enhances upper-extremity motor recovery through precise, repetitive training. Finally, research delves into mechanobiology, exploring mechanical forces in cartilage homeostasis and osteoarthritis development, alongside investigating age-related changes in muscle biomechanics and motor control to address functional decline and fall risk in older adults.

Acknowledgement

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Conflict of Interest

None.

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