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Paper Title:	Quantifying the Impact of Passive Ankle Foot Orthosis Stiffness on Ankle and Subtalar Joint Mechanics During Healthy Running: A Biomechanical Analysis
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Abstract

Passive-dynamic ankle-foot orthoses (AFOs) are frequently prescribed to enhance gait and functional outcomes. While most research on AFOs has focused on walking, there is an increasing interest in the capacity of AFOs to support higher intensity activities such as running. Changes in AFO stiffness and alignment have shown to alter gait parameters, such as footstrike angles and knee extensor moments. Nevertheless, existing studies predominantly focus on patient populations, highlighting a critical need to explore how passive AFOs affect healthy running biomechanics comprehensively. Moreover, a significant gap exists in the literature to evaluate effects of passive AFO stiffness on the subtalar kinematics, moment and muscle forces. This study addressed this gap by systematically analyzing the effects of passive AFO translational stiffness on kinematics, muscle forces, and joint moments at the ankle and subtalar joints during normal, healthy running at 4m/s. Using a modified musculoskeletal model with adjustable AFO stiffnessvalues ranging from 10,000 Nm to 50,000 Nm and OpenSim 4.4 for biomechanical simulations, the study found that both AFO weight and stiffness significantly impacted running dynamics.Despite the weight of the AFO increasing the peak ankle plantarflexion and subtalar eversion angles, the AFO reduced the peak dorsiflexion, plantarflexion, and inversion moments during stance. On the contrary, use of AFO increased the eversion moment during swing. The AFO's assistance led to reduced dorsiflexor and plantarflexor muscle forces from mid stance to mid-swing, yet caused a substantial rise in peroneus muscle forces (peroneus brevis and longus) during the swing phase. Notably, the 3 kg weight of the AFO resulted in only minor kinematic changes, with variations of 3 degrees at the ankle and 1.5 degrees at the subtalar joint. This research recommends a translational stiffness of under 30,000 Nm for optimal running support, highlighting the importance of using lightweight materials in AFO construction to minimize negative impacts on foot kinematics and kinetics.