Does Exercise Offset Age-Related Decline in Ankle Function? A Biomechanical Analysis of Older Adults during Preferred-Speed Walking

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Summary

This study explored the biomechanical differences in ankle function during preferred-speed walking between young adults and older adults who maintain regular exercise habits. The findings indicate that while regular exercise helps preserve walking speed, it does not fully mitigate age-related declines in ankle function, highlighting the need for targeted interventions to enhance gait performance and stability.

Introduction

The ankle joint plays a crucial role in limb propulsion during walking [1]. However, aging is often associated with decreased joint mobility and a reduced ability to generate joint power, which can negatively impact walking performance [2]. These age-related changes may also alter mechanical energy utilization in the lower limbs [3]. Although many studies have investigated age-related changes in gait, few have focused on older adults with regular exercise habits, who may exhibit distinct biomechanical adaptations. This study aims to investigate the differences in biomechanical characteristics of ankle joints between young adults and older adults who exercise regularly during preferred-speed walking.

Methods

Twenty healthy young (23.0 ± 2.2 years) and twenty healthy older adults with regular exercise (69.1 ± 4.3 years, engaging in either 150 minutes of moderate-intensity exercise or 75 minutes of high-intensity exercise per week), all capable of independently performing daily activities, were recruited in this study. Participants were asked to walk at their preferred speed while kinematic and ground reaction force data were synchronously recorded at a 100 Hz sampling rate using the Vicon motion capture system and three force plates. Joint kinetics, kinematics, and mechanical energy flow during walking were analyzed. Visualized mechanical energy flow diagrams were generated at the instant of peak ankle power generation. An independent t-test was conducted to compare the results between the younger and older adults.

Results and Discussion

No significant difference in preferred walking speed was observed between young adults (1.1 ± 0.2 m/s) and older adults (1.1 ± 0.1 m/s, $p = 0.76$). Older adults exhibited a significantly lower peak ankle plantarflexion (12.9 ± 4.4°) compared to young adults (17.1 ± 4.4°, $p < 0.01$). The peak ankle joint positive power was reduced in older adults (2.5 ± 0.6 J/kg) compared to young adults (4.1 ± 1.8 J/kg, $p < 0.01$). Mechanical energy flow diagrams revealed insufficient energy generation at the ankle joint in older adults compared to young adults. Accordingly, increased energy absorption at the knee joint may act as a compensatory mechanism to maintain stability. This compensation could lead to a decline in walking performance and potentially increase the risk of falls in older adults. Furthermore, reduced energy transfer from the trailing limb to the pelvis, coupled with increased energy transfer to the leading limb, suggests that older adults exert greater effort to stabilize the lower limbs during weight transfer of the gait cycle (Figure 1).

Conclusions

These findings provide valuable insights into the effects of regular exercise on gait in older adults. Although exercise helps maintain walking speed, it does not counteract age-related gait alterations regarding ankle function. These aging changes could still affect walking efficiency and long-term gait stability. Increased knee energy absorption and greater energy transfer to the leading limb may serve as a compensatory mechanism. However, targeted interventions are needed to improve ankle mobility and power generation ability for normal gait performance.

Acknowledgments

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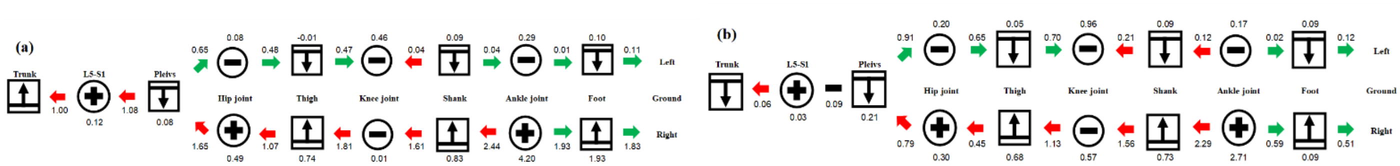

Figure 1: The mechanical energy flow diagrams for (a) young adults and (b) older adults at the instant of peak ankle power generation.