Movement Objectives of Young and Older Adults in Overground Walking

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Summary

Previous research suggests that the CNS aims to minimize the metabolic cost of transport, a theory supported by numerous studies. However, how movement objectives change with aging remains unclear. This research, using controlled overground conditions and a range of speeds, examines metabolic cost, head movements, and arm movements to explore age-related gait adaptations. The findings challenge assumptions about age-related walking efficiency, suggesting stability plays a key role in gait optimization for older adults. Further research is needed to understand the mechanisms driving these adaptations.

Introduction

The optimal control principle states that humans move optimally to achieve a certain objective function. The optimization criteria for gait have been studied in relation to factors like walking speed, step frequency, and head accelerations. However, most research has focused on younger adults and primarily examined preferred walking speed (PWS) or subjective speeds (e.g. "fast"), mostly using treadmills. Since treadmill locomotion differs from natural overground walking, overground trials are necessary to accurately examine natural locomotion patterns. Additionally, studies suggest that arm swing velocity decreases with age, but this relationship has not been thoroughly investigated. This study aimed to analyze overground walking in young and older adults at eight different speeds, including PWS, predetermined speeds, and relative PWS variations. We monitored metabolic cost, walking speed, step frequency, step length, head accelerations, and arm swing to determine age-related differences in movement objectives.

Methods

Twenty participants (10 older adults (OA) [age: 74.1 ± 3.4, sex: 6F, 4M], 10 younger adults (YA) [age: 25.5 ± 2.9, sex: 4F, 6M]) completed eight 6-minute overground walking trials on an outdoor flat and straight pavement. The first trial was conducted at PWS, followed by trials at predetermined speeds of 0.8 m/s, 1.2 m/s, and 1.6 m/s, and personalized speeds of PWS±5% and PWS±10%. The metabolic rate was measured (COSMED K5), and IMU sensors were attached to the center of the forehead, the middle of the right dorsal forearm, and the right tibia. The Gross Cost of Walking (GCoW) and Net CoW (J/kg*m) were determined.

Results and Discussion

The PWS of YA and OA showed no statistically significant difference ($p=0.11$) (consistent with [1]). Similarly, no significant differences were found in GCoW ($p=0.33$) or NCoW ($p=0.87$) between YA and OA at PWS, consistent with [1]. Nor were there differences in GCoW or NCoW at the predetermined speeds. This suggests that OA had a similar metabolic cost of walking as YA at the same velocities, contradicting numerous treadmill-based studies that report higher metabolic costs for OA. The discrepancy likely arises from OA experiencing a higher CoW on a treadmill compared to overground, while YA do not [1], possibly due to greater emphasis on stability [2]. Notably, the PWS did not correspond to the speed that minimized the NCoW in either age group ($p<0.01$) or GCoW in OA ($p=0.02$); in contrast, YA's PWS closely matched the speed minimizing GCoW ($p=0.99$).

No significant differences were found in maximum arm swing velocities between YA and OA across trials ($p>0.05$), reinforcing that previously reported differences are likely due to variations in walking speed rather than inherent age-related changes in arm movement.

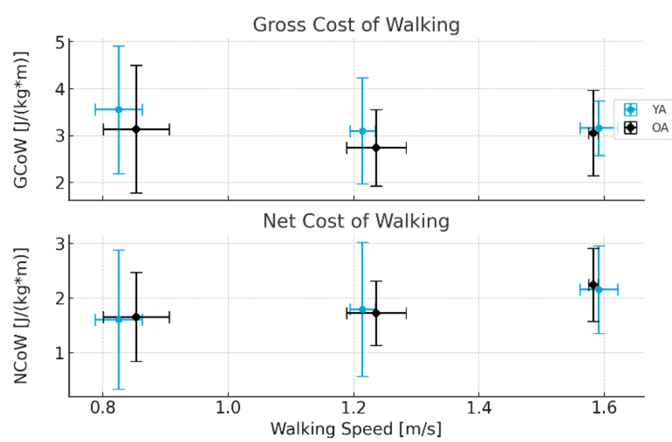

Figure 1: Gross and Net Metabolic Cost of Walking.

Conclusions

Older adults did not exhibit a higher metabolic cost of walking compared to young adults during overground gait across different velocities, nor were there differences in maximum arm swing velocities. The PWS did correspond to the minimum metabolic cost in young adults, but not in older adults.

Acknowledgments

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References

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