Elderly adults perform less limb work during walking

Justus Ortega and Claire Farley
Locomotion Laboratory, Department of Integrative Physiology
University of Colorado, Boulder, CO, USA
E-mail: Justus.Ortega@colorado.edu

INTRODUCTION

Elderly adults consume more metabolic energy for walking than young adults across a range of speeds (3). It has been hypothesized that the mechanical work performed by the limbs, including the simultaneous positive and negative work by the two limbs during double support, is an important determinant of the metabolic cost of walking (2). This study tests the hypothesis that walking is more metabolically expensive for elderly adults because they perform more mechanical work with their limbs than young adults.

METHODS

Ten young (25 ± 5 yrs, mean ± SD) and ten elderly (75 ± 5 yrs) adults walked at five speeds on a treadmill and on a 40 m walkway with imbedded force platforms. Subjects performed one seven-minute trial at each speed on the treadmill and three trials at each speed on the walkway.

Metabolic cost was determined using indirect calorimetry (1) during the last two minutes of each treadmill trial. We calculated net metabolic cost of transport by subtracting standing metabolic power from gross metabolic power and dividing by body mass and speed.

We measured ground reaction force (GRF) under each limb on the walkway and subsequently calculated individual limb mechanical work (ILW) from the dot product of the GRF and the center of mass (COM) velocity (2). ILW exceeds the traditionally calculated external work because it includes the simultaneous opposing work performed by the two limbs during double support (2).

RESULTS AND DISCUSSION

Despite consuming 20% more metabolic energy (p=0.010; Figure 1), elderly adults perform about 7% less limb work to travel a meter than young adults (p=0.028; Figure 2). This difference is mainly due to the elderly subjects performing about 14% less positive limb work during double support than young adults.

The reason why elderly adults perform less individual limb work may be that they take shorter steps at a faster stride frequency. By taking shorter steps, elderly adults exert lower peak propulsive GRF and reduce the vertical excursion of the COM. Both of these factors reduce the mechanical work needed to redirect the COM when it transitions from arcing over one stance limb to arcing over the next stance limb (2).

Elderly adults have a faster stride frequency than young adults primarily because they spend less time in the single limb

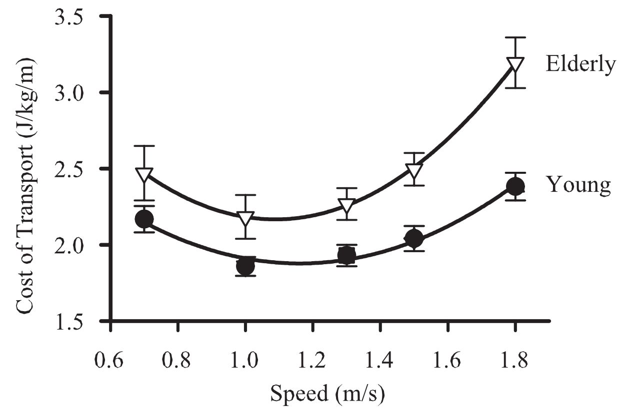

Figure 1: Net metabolic cost of transport (mean ± SEM) versus speed.

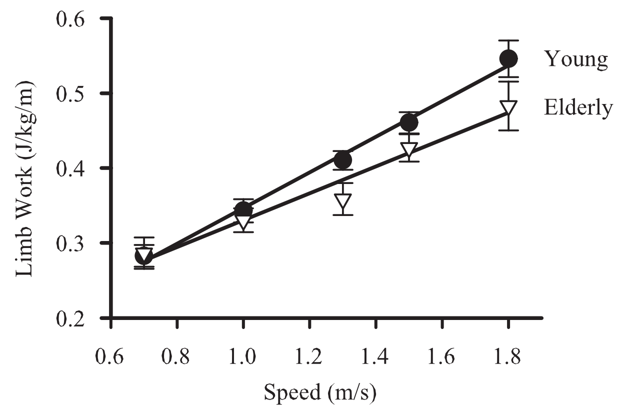

Figure 2: Positive limb work (mean ± SEM) versus speed.

support phase. It seems likely that the single support phase is the least stable part of a stride, and therefore, shortening this phase may be a response to reduced stability with aging.

CONCLUSIONS

Although elderly adults consume more metabolic energy to travel a meter than young adults, they perform less limb work than young adults. Although the shorter stride length of elderly adults may partly explain the difference in step-to-step transition work, the high metabolic cost of walking in elderly adults is likely due to other factors, such as greater muscle force generation for stabilization.

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ACKNOWLEDGEMENTS

NIH Grants- AG 00279, M01 RR00051