



Sex-specific differences in gait patterns of healthy older adults: Results from the Baltimore Longitudinal Study of Aging

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ABSTRACT

The effects of normal aging and orthopedic conditions on gait patterns during customary walking have been extensively investigated. Empirical evidence supports the notion that sex differences exist in the gait patterns of young adults but it is unclear as to whether sex differences exist in older adults. The aim of this study was to investigate sex-specific differences in gait among older adults. Study participants were 336 adults (50–96 years; 162 women) enrolled in the Baltimore Longitudinal Study of Aging (BLSA) who completed walking tasks at self-selected speed without assistance. After adjusting for significant covariates, women walked with higher cadence ($p=0.01$) and shorter stride length ($p=0.006$) compared to men, while gait speed was not significantly related to sex. Women also had less hip range of motion (ROM; $p=0.004$) and greater ankle ROM ($p<0.001$) in the sagittal-plane, and greater hip ROM ($p=0.004$) in the frontal-plane. Hip absorptive mechanical work expenditure (MWE) of the women was greater in the sagittal-plane ($p<0.001$) and lower in the frontal-plane ($p<0.001$), compared to men. In summary, women's gait is characterized by greater ankle ROM than men while men tend to have greater hip ROM than women. Characterizing unique gait patterns of women and men with aging may be beneficial for detecting the early stages of gait abnormalities that may lead to pathology.

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1. Introduction

Walking is one of the most important activities that healthy adults perform every day. The effects of normal aging and orthopedic conditions on customary walking patterns have been investigated extensively (Beauchet et al., 2009; Cho et al., 2004; DeVita and Hortobagyi, 2000; Kerrigan et al., 2001; Ko et al., 2009; McGibbon and Krebs, 2004; Srygley et al., 2009; Winter et al., 1990). In many of these studies, the effect of sex on gait patterns was accounted for in the statistical analysis, therefore hiding any possible difference in gait between men and women. However, understanding differences in gait between older men and women is important to start discriminating normal sex related patterns from early pathologic changes.

Previous studies revealed sex differences in gait patterns among young adults. When walking at a self-selected speed, young healthy women tend to have shorter stride length and slower gait speed compared to healthy young men, mostly due to a shorter height (Cho et al., 2004). Moreover, healthy young women tend to generate greater mechanical joint power from the hip and knee joints during late stance compared to healthy

young men (Kerrigan et al., 1998). However, it is unclear whether such differences in gait parameters between young men and women are retained in the older populations. Clarifying this issue is important because older adults have higher prevalence of pathologies that affect gait performance and increase the likelihood of mobility disability (Helbostad et al., 2007; Simonsick et al., 2008). Although there is evidence that older women tend to walk at slower speed than men of similar age (Oberg et al., 1993; Samson et al., 2001), it is still unknown whether sex differences also exist in the other kinetic and kinematic gait patterns.

Full three dimensional (3D) gait analysis has recently emerged as an excellent method of assessing gait performance (McGibbon and Krebs, 2004; Teixeira-Salmela et al., 2008) as it provides both kinetic and kinematic measures as well as basic spatiotemporal gait parameters. By collecting simultaneous information of kinematics and kinetics, mechanical work expenditures (MWE) in the generative and absorptive phases (Ko et al., 2010), can estimate the size and direction for the muscle loading during walking, thus providing information essential to evaluate performance and energetics in gait analysis.

This study investigated sex differences in the basic spatiotemporal gait parameters, angular kinematics, and joint mechanical work in an adult population. The goal of the present study was to investigate sex-differences in the general gait patterns and also in the age-association of gait patterns among older adults using a

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