Does a 30 Minute Treadmill Walk Result in a Distal to Proximal Shift in Older Adults?

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Summary

The effects of a 30-minute treadmill walk (30MTW) on knee extensor muscle fatigue and gait mechanics were quantified in healthy young and older adults. Older were weaker at baseline, but not more fatigable than Young following the 30MTW. Associations between muscle fatigue (fall of peak muscle power) and changes in hip relative work suggest a reduced reliance on the hip after a treadmill walk.

Introduction

Older adults exhibit hallmark differences in gait mechanics that may have consequences for mobility. A reported gait adaptation in older age is a "distal-to-proximal" shift of joint power and work [1]. Prior work found that the knee extensor (KE) muscles of adults aged 55-70 yr and young adults fatigued to a similar extent in response to a 30MTW. However, only the older adults experienced a decrease in ankle moment following the 30MTW, suggesting that KE fatigue exacerbates the distal-to-proximal shift with age [2]. Adults >70 yr may experience greater KE fatigue with a 30MTW [3], due partly to muscle weakness leading to a greater functional demand, resulting in larger gait changes. Our purpose was to compare the impact of a 30MTW on KE muscle fatigue and gait mechanics in young and older adults.

Methods

Fifteen young and 16 older adults (Table 1) participated in this study after providing informed consent. All participants completed an advanced Short Physical Performance Battery (SPPB-A), gait analysis with a marker-based motion capture system (Qualisys Inc, Sweden; AMTI, USA) for five overground walking trials at preferred walking speed (PWS), and isokinetic KE power testing at 240°·s^{-1} (Biodex Med. Sys., USA) before and after a 30MTW. The 30MTW was completed at the PWS determined by a 400-m walk test and included challenge periods at a 3% incline at minutes 7, 17, and 27 [3]. Joint kinematics and kinetics (externally referenced) were calculated [2]. Ankle and hip relative positive joint work was calculated as joint work divided by total limb positive work. Post 30MTW, KE power as a % baseline quantified fatigue. A 2×2 ANOVA tested for effects of age and timepoint (pre-, post- 30MTW) for hip and ankle kinematics and kinetics, and peak KE power. Pearson's correlation coefficients were calculated for KE fatigue vs. relative positive work at the hip and ankle.

Results and Discussion

Older produced less KE power at baseline than Young ($p<0.01$). KE muscle fatigue was not different by group with the 30MTW ($p=0.07$). A lack of fatigue may be attributed to the relatively slow PWS compared with prior work [2, 3]. At baseline, Older walked with greater hip flexion at heel strike and hip ROM, but lower peak hip positive power ($p\leq0.05$) than Young, suggesting the lack of a proximal gait shift in Older. There were no changes in gait in either group after the 30MTW. Changes in relative positive ankle work were not associated with KE fatigue ($r=-0.22$, $p=0.22$; Fig.1A), but KE fatigue was associated with Δhip relative positive work ($p=0.02$) for all participants combined, and for Young only ($p=0.02$), with no association for Older only ($r=0.21$, $p=0.42$), Fig. 1B. In contrast to prior work [2], these associations suggest those who fatigued reduced, rather than increased, their reliance on the hip joint. Quantifying fatigue in other muscles may provide additional insights.

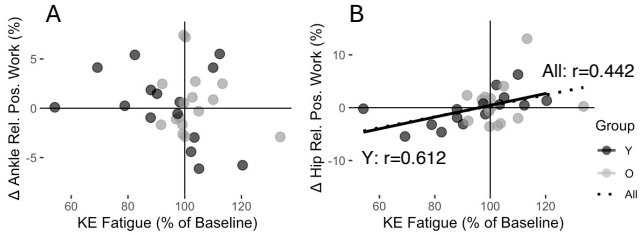

Figure 1: Associations between knee extensor (KE) fatigue and changes in relative positive work at the ankle (A) and hip (B).

Conclusions

Despite Older being weaker than Young, they did not have greater muscle fatigue with the 30MTW. The identified associations suggest that KE fatigue with a prolonged walk may decrease, rather than increase, the contribution of the hip joint to support and propulsion in gait, particularly at slower gait speeds.

Acknowledgments

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References

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Table 1: Group characteristics, reported as mean (SD). * $p<0.05$

Group	n (# male)	Age (yr)*	Height (cm)	Mass (kg)	BMI (kg·m^{-2})	SPPB-A*	PWS (m·s^{-1})	Baseline Power (W)*	KE Fatigue (%)
Young	15 (5)	34.7 (3.4)	167.7 (5.7)	68.9 (11.3)	24.4 (3.2)	2.8 (0.2)	1.10 (0.13)	390.4 (148.1)	93.3 (17.4)
Older	16 (4)	73.3 (2.4)	167.3 (8.5)	73.1 (14.0)	26.1 (4.4)	2.4 (0.4)	1.09 (0.13)	249.8 (86.6)	102.8 (9.9)