EFFECTS OF AGE AND OBESITY ON RISK OF TRIPPING DURING LEVEL WALKING

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INTRODUCTION:

Fall-related injuries are a major public health concern, and two major demographic trends in the United States threaten to exacerbate this problem: an increase in the older adult population and an increase in the prevalence of obesity. In 2009-2010, over one-third of adults were considered obese, and the likelihood of obesity increased with age [1]. Given these trends, it is important to understand how an individual's risk of tripping is affected by age and obesity.

The purpose of the study was to investigate the effects of age, obesity, and their interaction on the risk of tripping while walking over level ground. This risk was assessed by measuring minimum foot clearance (MFC) during the swing phase of normal gait.

METHODS

Four gender-balanced groups, comprised of 20 participants each, completed this study (Table 1). All participants were required to pass a screening designed to exclude participants with self-reported medical conditions, such as musculoskeletal, neurological, or balance disorders, that could impact the validity of the results.

Table 1: Participant demographics

Group	Age (y)	BMI (kg/m^2)
Young Healthy Weight	24±3.3	22.3± 2.2
Young Obese	23.1±3.0	33.4±3.3
Older Healthy Weight	62.4±8.2	24.2±1.8
Older Obese	64.1±9.8	32.7±3.0

Participants walked along a 10 m walkway at two speeds: a self-selected gait speed and a hurried speed of 1.9 m/s. Eight successful trials at each speed were completed, and each trial included the swing phase of both the dominant and non-dominant lower limbs. Thus, foot clearance from 16 swing phases for each participant was analyzed.

All participants wore the same brand of athletic shoes, to which were attached three reflective markers. A Vicon MX T10 motion analysis system (Vicon Motion Systems Inc., LA, CA) was used to sample marker positions at 100 Hz.

MFC was determined using a method adopted from Startzell et al [2]. A pointer with markers attached was used to define an average of 16 points on the sole of each shoe with respect to a shoe-fixed reference frame. MFC was defined as the lowest of all the points on the sole of the shoe during mid-swing. For each participant, the median MFC and MFC interquartile range (IQR) were determined. A lower median MFC and higher MFC IQR imply a greater risk of tripping [3]. A five-way, mixed-factor analysis of covariance was performed for median MFC and MFC IQR using JMP v7 (Cary, North Carolina, USA) with a significance level of $p<0.05$. Independent variables were age, obesity, gait speed, gender, and leg dominance; all two-way interactions were included, along with stature as a covariate

RESULTS AND DISCUSSION:

For median MFC, no two-way interactions were statistically significant. Median MFC was higher among older adults, higher at the hurried gait speed, higher for males, and higher for the non-dominant limb ($p<0.05$; Figure 1). Median MFC was also positively associated with stature ($p<0.05$).

MFC IQR was significantly affected by an age x speed interaction, in that IQR only increased with age at the hurried speed, and only increased with speed among older adults ($p<0.05$; Figure 2). In addition, MFC IQR increased for the non-dominant limb ($p<0.05$).

Participants who were obese exhibited a slower self-selected gait speed relative to the healthy weight participants (p<0.05).

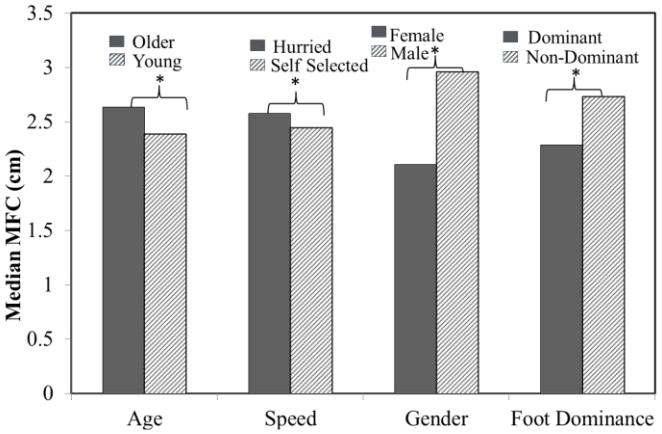

Figure 1: Median MFC values showing all significant main effects. * indicates p<0.05

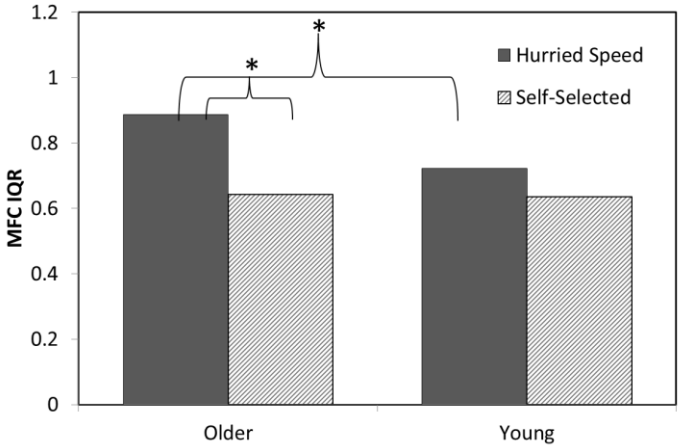

Figure 2: MFC IQR values showing significant age by speed interaction. * indicates p<0.05

The age by gait speed interaction effect on MFC IQR suggests that the older group, when walking at higher speeds, may have a higher risk of tripping due to greater variability in MFC. Conversely, the older adults showed a larger median MFC, and median MFC increased at the hurried gait speed, both of which suggest a decrease in risk of tripping. This increase in median MFC with age during overground walking has been previously reported [4] and could be a safety adaptation this group uses to compensate for sensory deficits that come with age. A potential cause for greater median MFC at higher gait speeds could be an adaptation used to offset greater MFC IQR at higher gait speeds.

Several studies have reported increased IQR with age during treadmill walking [5], however there was no significant main effect for age found here (p=0.08). It is possible that the effect of age on MFC IQR is reduced when walking overground as opposed to treadmill walking. Future work is needed to whether and under what conditions age influences MFC IQR.

There were no significant effects of obesity on median MFC or MFC IQR. Although obesity has been associated with alterations in temporal and angular components of gait (such as slower gait speed, smaller stride length, and larger stride width [6]) our results indicate that these alterations do not result in a greater risk of tripping.

CONCLUSIONS

Obesity was not found to substantially affect the risk of tripping, at least under the conditions examined here. Older adults at a hurried walking speed showed a greater risk of tripping, based on an increased MFC IQR. However, median MFC results indicated a decreased risk of tripping for older adults in addition to a decreased risk of tripping at hurried gait speeds. Potentially offsetting effects appear to be present when examining the risk of tripping among older adults, and these should be examined more closely in future work.

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ACKNOWLEDGMENTS

This material is based upon work supported by the National Science Foundation Graduate Research Fellowship (to CMR), and 5R01OH009880.