

OBESITY INCREASES FALL RATE FOLLOWING A LABORATORY-INDUCED TRIP

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INTRODUCTION

Tripping accounts for an estimated 53% of falls among adults aged 65 and older [1]. A common strategy to prevent a fall after tripping is to step to extend the base of support anteriorly, and thereby provide vertical and posterior ground reaction forces that can help arrest the forward momentum of the trunk [2]. As such, stepping characteristics and trunk kinematics are critically important during trip recovery.

Obese adults exhibit a higher rate of falls than those who are normal-weight [3], but the reason for this higher rate is unclear. The purpose of this study was to investigate: 1) obesity- and age-related differences in trip recovery, and 2) differences between successful and failed recoveries. Dependent variables included measures of fall rate, stepping characteristics, and trunk kinematics.

METHODS

Participants included 10 young (age 18-30 years) normal-weight (body mass index, BMI, of 18-24.9 kg/m²) adults, 10 young obese adults (BMI over 30 kg/m²), 10 older (age 60-70 years) normal-weight adults, and 10 older obese adults. Participants were tripped near mid-swing using a 7-cm-high obstacle while walking at a speed of 1.4-1.6 m/s. Forces applied to a safety harness were sampled from a load cell (Cooper Instruments and Systems, Warrenton, VA) at 1000 Hz and low-pass filtered at 20 Hz (eighth-order, zero-phase-shift Butterworth filter). Kinematic data using a modified Helen Hayes marker set were collected at 100 Hz with a 6-camera motion analysis system (MX-T10, Vicon Motion Systems Inc., L.A, CA) and low-pass filtered at 5 Hz (8th-order, zero-phase-shift Butterworth filter).

Harness load was used to classify trip recovery outcome as either a recovery (peak load less than 30% body weight), a harness-assisted recovery (peak load 30-50% body weight), or a fall (peak load exceeded 50% of body weight). Trials classified as harness assisted were removed from further analysis.

Logistic regression analyses were used to investigate the effects of obesity and age on fall rate and stepping strategy (elevating or lowering). A three-way analysis of variance was used to investigate the effects of obesity, age, and trip recovery outcome on recovery step time and length, and peak trunk angle and angular velocity. All statistical analyses were performed using JMP 10 (SAS Institute Inc., Cary, NC) with a significance level of $p \leq 0.05$.

RESULTS AND DISCUSSION

Obesity affected several aspects of trip recovery. Fall rate was 52% among obese adults and 22% among normal-weight adults, with an odds ratio indicating obese adults were 8.79 (C.I.: 4.62, 394.8; $p=0.026$) times more likely to fall when adjusting for age and gender. Stepping strategy ($p=0.151$), recovery step time ($p=0.499$), and recovery step length ($p=0.854$) did not differ between obesity groups. Peak trunk angle was 13 degrees higher among obese adults ($p=0.046$) (Figure 1). Peak trunk angular velocity was affected by an obesity level x age interaction ($p=0.038$; Figure 1). Peak trunk angular velocity was 216 degrees/s higher among obese older adults compared to normal-weight older adults ($p=0.012$), and 245 degree/s higher among obese older adults compared to obese young adults ($p=0.005$).

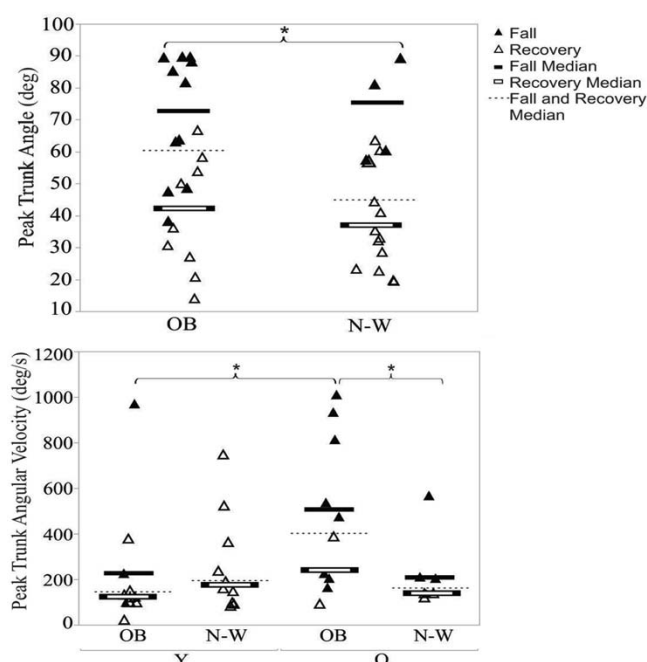


Figure 1: Peak trunk angle (top) and peak trunk angular velocity (bottom) separated by obesity group, and obesity and age group. Brackets indicate significant differences between groups. Note: OB=obese, N-W=normal-weight, Y=young, O=older.

Comparing dependent variables between falls and recoveries also revealed several differences. A lowering strategy was used during 73% of falls and 25% of recoveries with odds ratios indicating users of a lowering strategy were 8.25 (C.I.: 2.03; 40.18; $p=0.003$) times more likely to fall. Recovery step time and length did not differ between falls and recoveries ($p=0.541$ and $p=0.758$). Peak trunk angle was 32 degrees higher during falls ($p<0.001$), and peak trunk angular velocity was 287 degrees/second higher during falls ($p=0.027$).

The higher rate of falls among obese adults may have resulted from differing trunk kinematics, and three intrinsic factors associated with obesity could be responsible for these differences. First, an anterior shift of the trunk COM among obese adults [4] could increase the gravitational moment that rotates the body forward after tripping. Second, greater trunk mass would increase trunk momentum that needs to be decelerated through trunk and lower extremity muscle exertions [5]. Third, reduced relative strength

among obese adults could reduce the ability to decelerate trunk momentum.

Although recovery step time and length were not affected by obesity or trip recovery outcome, the success of trip recovery was dependent upon the choice of stepping strategy. Other studies have reported a higher prevalence of a lowering strategy among obese adult fallers [6]. For older adults it has been shown that practicing balance recovery from a simulated trip improves recovery kinematics following an actual trip [7]. This training may be effective in promoting more frequent use of the elevating strategy during mid-swing trips, and may help improve the success of trip recovery.

In conclusion, obese adults exhibited a higher fall rate after tripping. This higher fall rate was not due to altered stepping characteristics, but appeared to be related to trunk kinematics. These results suggest the higher rate of falls among obese adults reported elsewhere may be due to impaired trip recovery, and support the use of interventions to improve trip recovery capability to help prevent falls among obese adults.

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