Injuries from slip-induced fall accidents represent a significant burden to aging population. Existing evidence has identified several aging effects related to slip and fall accidents, yet has not explained determining causes of older adults' higher likelihood of these accidents. Previous studies suggest that explosive strength generation and the ability to attenuate fast, large-scale lower extremity motions are critical in determining whether or not an elderly individual can respond appropriately to gait perturbations such as a slip. However, considering the phase-dependent modulation of response evident in aging adults, it is expected that control of foot placement strategies in terms of timely and sufficient muscle activation pattern/torque production would be equally important in successful recovery process. As such, the objective of the current study was to investigate the aging effect on lower extremity muscle activation characteristics during unexpected slip-induced fall accidents. More specifically, temporal characteristics of slip-initiation (i.e., muscle activation times after slip perturbation), and torque generating capabilities of young and old adults during fall-recovery process were investigated. An empirical study was conducted on 10 young and 8 old healthy participants. Participants' dynamic balance was challenged when exposed to unexpected slippery floor surface condition after their normal walking. Kinematics, kinetics and EMG measures were obtained, respectively. EMG parameters (activation time, relative peak) were then derived from gastrocnemius, rectus femoris, and hamstrings on both legs. Sagittal joint moments at ankle and knee joints were estimated via inverse dynamics. Two-way repeated-measure ANOVA was employed to test the aging effect (young and old) and condition effect (normal, reactive-recovery, and fall). Further results indicated that the muscles in both recovery and fall conditions were activated about 100 to 150 ms after slip initiation. And relative muscle activation magnitude (comparing to normal walking) of the hamstrings muscle was considerably larger than gastrocnemius and rectus femoris after slip-initiation. Further results including age-related differences in joint torque generation pattern during slip-recovery will be discussed.

Identification of high-risk fallers by force capacity measures in the elderly
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For effective fall prevention in the elderly, training programs should focus on high-risk fallers. From experimental studies on tripping reactions, we found that older fallers showed lower maximum moments around the ankle and adapted moments around all lower extremity joints at a lower rate during the push-off phase of balance recovery. During the landing phase, lower knee extension moments were generated. The aim of this study was to search for force generating capacity measures that can predict fall outcome in older adults. Seventeen healthy older adults (10 women, mean age 71±4.5 years) participated. First, subjects' capacity to recover balance after tripping was measured experimentally. In about 5 of 40 walking trials, they were tripped over an obstacle that suddenly appeared from the floor. Subjects wore a safety harness and were classified as fallers based on full use of the harness in at least 2 tripping trials. Next, maximum force generating capacity (maximum force and rate of force development) was measured statically (planar flexion and knee extension in a dynamometer) and dynamically (push-off during jumping and in a leg-press fitness apparatus). A statistical stepwise discriminant analysis was used to find the best predictor(s) for falls and to quantify the predictive value. Seven older fallers were classified as fallers. They were limited in their balance recovery by the rate of force generation in all joints during push-off. In the ankle, the tripping moments were larger and faster than the voluntary values measured in the dynamometer. Although all force producing capacity measures were strongly correlated, the maximum force by the whole leg produced on the leg press was the variable that discriminated best between fallers and non-fallers. Based on whole leg capacity measure, 100% of the fallers and 90% of the non-fallers were classified correctly.

Effects of aging on lower extremity joint torque and muscle activation patterns during slip-induced falls
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The extent to which aging affects the ability to concurrently restore control of the slipping foot, the trunk, and placement of the recovery foot on the ground after a slip-induced during locomotion was characterized. Thirty-five young adults and 21 healthy older adults (age: 70.9±5.1 years) were subjected to an a slip induced during locomotion was characterized. Thirty-five young adults and 21 healthy older adults (age: 70.9±5.1 years) were subjected to an

Concurrent control of multiple segments is required to avoid falling due to a slip induced during locomotion
K.L. Troy, S.J. Donovan, J. Marone, M.L. Bareither, M.D. Grabiner. Department of Movement Sciences, University of Illinois at Chicago, Chicago, USA

The extent to which aging affects the ability to concurrently restore control of the slipping foot, the trunk, and placement of the recovery foot on the ground after a slip-induced during locomotion was characterized. Thirty-five young adults and 21 healthy older adults (age: 70.9±5.1 years) were subjected to an unexpected and unrestricted slip using artificial ice. The falls of 18 older adults were compared to the successful recoveries of 33 younger adults. Kinematic variables reflecting the states of the slipping limb, the trunk and the recovery limb during the recovery phase of the response, and for which between-group (reaction time) and within-group (amplitude) differences were significant, were entered into a stepwise multivariable discriminant analysis that correctly classified 93.8% of the young and older adult subjects. The discriminant variables selected were the lateral displacement of the recovery foot relative to the center of mass, the difference between the velocity of the slipping foot and that of the center of mass at the instant at which the recovery foot was placed on the ground, the peak anteriorly-directed velocity of the slipping foot, and the trunk extension velocity at the endpoint of the analysis that preceded the engagement of the safety harness (p<0.001; Wlik’s λ=0.299). Failure to restore control of the slipping limb and trunk appeared consistent with the delayed activation of key lower extremity and abdominal muscles. The results demonstrate the collective and concurrent importance of temporal and spatial control of lower extremities and trunk underlying successful performance of this complex motor task.

Choice stepping response and transfer times: effects of age, fall risk and secondary tasks
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As people age they experience a decline in factors that contribute to stable posture and gait, including sensory acuity, reaction time and lower limb

3.2. Locomotion and Falls – Mechanisms, Injuries and Interventions

Track 3. Musculoskeletal systems and Performance – Joint ISB/ESB Track

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