KNEE STRENGTH AND SLIP SEVERITY IN YOUNG AND OLDER ADULTS

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INTRODUCTION
Falls initiated by slips are a major cause of serious injury in the elderly population (Moyer, 2005). Studies have shown a possible correlation between lower extremity muscle strength, which decreases with age, and slip severity (Lockhart, 2005). However, these studies did not focus on the knee, which plays an important role in slip-recovery attempts (Moyer, 2005/2006). Thus, the goal of this study was to investigate the relationship between knee flexion/extension (KF/KE) strength and slip severity in young and older adults.

METHODS
Ten young (Y) (24 ± 3.0 yrs) and ten older subjects (O) (57 ± 5.1 yrs), screened for neurological and orthopedic abnormalities, participated. In Visit 1, isometric KF and KE strength was collected at 1000 Hz using a Biodex AP System 2. Subjects were instructed to contract for five seconds then relax for ten seconds over three repetitions. In Visit 2, subjects were instructed to walk at a self-selected pace across a vinyl tile walkway. Whole body motion data was recorded at 120 Hz using a Vicon 612 motion capture system. After two to three baseline dry trials, the left force plate was covered with a glycerol-water solution (75:25%) without the subject’s knowledge, creating an unexpected slippery condition.

Strength data of the left/stance (slipping) leg was lowpass filtered at 20 Hz using a fourth-order zero phase Butterworth filter (Winter, 1990). Peak torque and rate of force development (RFD), defined as the slope of the torque-time curve, were determined for each repetition. RFD was calculated in incrementing time periods of 0-10, 0-20,..., 0-300 ms from the onset of the contraction (Andersen, 2006). Repetition was determined to be insignificant; therefore, the mean value of across each repetition was used for this analysis.

Slip trials were categorized as non-hazardous (NH) and hazardous (H) by considering the peak slip velocity (PSV) of the heel during a slip. PSV was identified as the first local maximum of horizontal heel velocity after 50 ms from heel strike using the velocity of the left heel marker. Hazardous slips were defined as having a PSV of greater than 1.0 m/s (Moyer, 2005). To achieve the goal of this study, linear ANOVA models were used to compare differences in knee strength characteristics (peak torque magnitude and RFD) between 2 fixed effects and their interactions, i.e. slip severity (NH/H) and age (Y/O). A significance level of p<0.05 was used.

RESULTS AND DISCUSSION
Peak isometric strength was not different between H/NH slips across both age groups (Table 1). This is somewhat expected, as exerting peak strength is not required when reacting to an unexpected slip.

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<th></th>
<th>Young</th>
<th></th>
<th>Older</th>
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<tr>
<td></td>
<td>NH</td>
<td>H</td>
<td>NH</td>
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<tr>
<td>KF</td>
<td>63.84 (21.73)</td>
<td>65.82 (22.08)</td>
<td>57.73 (24.38)</td>
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<tr>
<td>KE</td>
<td>98.69 (20.44)</td>
<td>90.13 (36.82)</td>
<td>73.98 (19.31)</td>
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Table 1: Peak Torque Mean (Std Dev)
A significant NH/H x age interaction effect was noted for KF RFD from 0-100 to 0-180 ms (Figure 1). KE RFD demonstrated near significant interaction effects later, between 0-140 and 0-250 ms (Figure 2). These effects were due to young adults who experienced H slips having lower RFD values than those who experienced NH slips. RFD in older adults did not affect slip severity. This may be attributed to older adults generally adopting “safer” gait styles, while younger adults must overcome initial conditions with quick, powerful reactions to reduce slip severity. Initial reaction to a slip consists of a KF moment, 120 ms, followed by a KE moment, 180 ms (Moyer, 2005/2006). These temporal reactions correspond to the RFD time intervals reported here that significantly impacted slip severity. The RFD intervals are also equivalent to the time span during which responses to a slip occur (Andersen, 2006; Moyer, 2006).

**Figure 1:** RFD of NH (gray) and H (black) from 0-120 ms for Y/O. Interaction effects are shown in the upper right corner.

**Figure 2:** RFD for NH (gray) and H (black) from 0-190 ms for Y/O. Interaction effects are shown in the upper right corner.

**SUMMARY/CONCLUSIONS**

In summary, RFD, and not peak torque, at the knee was noted to be an important factor in slip severity. The temporal aspects of RFD were determined critical at the same time as corrective reactions to slips and suggest that age-related strength differences may impact slip severity.

**REFERENCES**


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