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STRATEGIES TO REGAIN BALANCE IN RESPONSE TO A CONTROLLED DYNAMIC PERTURBATION IN ELDERLY WITH AND WITHOUT FALL HISTORY

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SUMMARY
This study aimed to compare strategies applied to regain balance after a controlled perturbation in elderly with and without fall history. Frequency and cause (tripping vs slipping) of falls were analyzed. Thirty-one subjects were randomized into two groups according to their history of falls in the last 12 months. The Fallers (FG; n=13; 69.1 ± 6.57 years, 72.5 ± 11.7 kg) and the non-fallers group (CG; n=18; 71.5 ± 7.45 years; 70.9 ± 9.3 kg) were requested to stand on a movable platform. A controlled perturbation was applied by moving the platform in the posterior direction. Surface electromyography (EMG) was collected to determine latency, activation rate, activity level and muscle activation sequence from vastus lateralis (VL), tibialis anterioris (TA), biceps femoris (BF) and gastrocnemius medialis (GM) of the dominant limb. The U Mann-Whitney test was applied. EMG differences were not observed between the FG and CG. The GM was the first recruited muscle (95% of the cases), irrespective of fall history. Within the FG a greater activation rate of the TA ($p<0.01$) and BF ($p<0.05$) of the recurrent fallers was detected in comparison with those only one fall. A shorter latency was identified in the VL ($p<0.05$), BF ($p<0.03$) and GM ($p<0.02$) of the participants who referred slipping as the cause of the fall in comparison with those who tripped. FG and CG presented the same strategies to regain balance after a dynamic perturbation. Muscle activation latency differed in fallers that had slipping as the main cause of falling.

INTRODUCTION
Decrease in muscular strength [2,3], reduction in bone mass [4], loss of flexibility [5] and diminished sensorial system capacity [6] have been described as phenomena that accompany ageing. The deterioration of postural stability leads to greater risk of falling [7]. Such changes may impact on elderly's functional capacity and increase fall susceptibility, especially during locomotion [8,9]. Approximately 20 to 30% of the elderly [6,10,11] suffer from some type of fall each year and this number may rise up to 40% in those older than 80 years [12]. In fact, 60% of falls occur after balance loss caused by trips [13,14]. Balance recovery requires a rapid repositioning of the limb on the ground and is described as a determining factor [15]. However, it is not clear whether the differences in the timing and the peaks of muscle activation while responding to a disturbance differ between the elderly with and without fall history. The aim of this study was to compare the strategies used to regain balance after a controlled perturbation taking into account fall history. Frequency and cause of the falls (tripping vs slipping) were also analyzed.

METHODS
Thirty-one subjects were assigned into a group that experienced one or more falls in the last 12 months (FG; n=13; 69.1 ± 6.57 years, 72.5 ± 11.7 kg) and a group with no fall history (CG; n=18; 71.5 ± 7.45 years; 70.9 ± 9.3 kg). Ethical approval was granted from the Federal University of Paraná Ethics Committee prior to data collection CEP/SD: 1107.032.11.04 CAAE: 030.0.091.000-11.
A movable platform (figure 1) was used to apply a controlled perturbation. The platform was mounted onto a wheeled frame placed on a set o rails to allow translational movements in the anterior-posterior direction. The frame was pulled by a constant tension applied by weight that corresponded to 10% BW. The disturb was applied by releasing an electromagnetic system that allowed the weight to pull the system. Surface electromyography (EMG) was collected from vastus lateralis (VL), tibialis anterioris (TA), biceps femoris (BF) and gastrocnemius medialis (GM) of the dominant limb a wireless system (Delsys Trigno™, Boston, USA) sampling at 4000 Hz. A triaxial wireless accelerometer (Delsys Trigno™, Boston, USA) was firmly secured in the platform and allowed to identify the disturb onset. The latency, activation rate, activity level and muscle activation sequence were determined.
During data collection, participants were instructed to stand still on the force platform with their feet parallel and slightly apart, arms hanging loose at side of the body, head straight and open eyes. Participants were unaware of the disturb instant which was applied 4.5cm backwards and imposed a simulated tripping stimulus.
The "U" Mann-Whitney Test was applied to determine differences between for a) history of falls, b) leading causes of falls and c) frequency of falls. The Kruskal-Wallis Test was used to compare variables with more than two factors: a) frequency of falls and b) the main cause of fall. The Chi-Square Test was used to determine the relationship between variables. When the Chi-Square resulted in 2x2 tables, was considered the value of the Fisher Test. Statistical tests were

performed with SPSS 13.0 for Windows software with a significance level of $p < 0.05$.

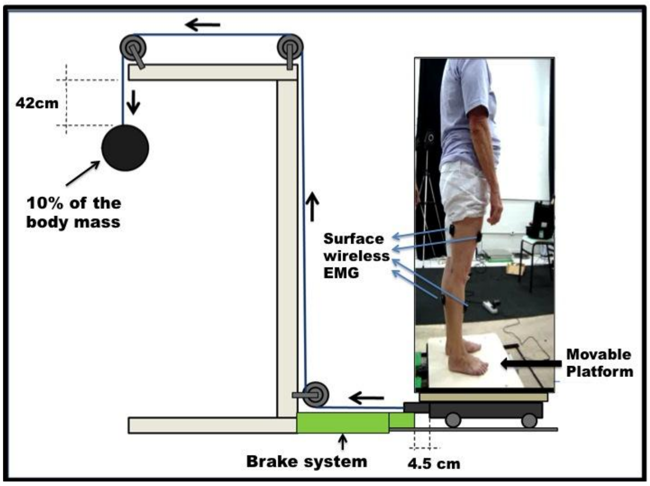

Figure 1: Experimental setup.

RESULTS AND DISCUSSION

Tripping was the main fall cause [13,14], but causes (tripping, slipping and others) did not differ between one-time fallers and others that reported two or more falls per year [13]. These findings reinforce the arguments that falls causes do not allow one to identify one-time fallers from recurrent fallers.

EMG differences were not observed between the FG and CG as also shown in balance static tests [16]. The hypothesis that fallers present lower activation times when compared to their non-fallers counterparts was rejected. Irrespective to fall history, the GM was the first recruited muscle (95% of the cases) as an attempt to reduce the forward motion of the body. Fallers with more than one fall showed greater activation rate of the TA ($p<0.01$) and BF ($p=0.05$) in comparison to the one-time fallers. A shorter latency was identified in the VL ($p<0.05$), BF ($p<0.03$) and GM ($p<0.02$) of the participants who referred slipping as main cause of the fall in comparison to those who reported a trip as a fall cause. Others have reported the importance of short latency of GM and BF when tripping [17,18,19,20,21,22]. FG and CG presented the same strategies to regain balance after a dynamic perturbation. Muscle activation latency differed in fallers that had slipping as the main cause of falling.

CONCLUSIONS

In conclusion, both groups presented the same pattern to regain balance after a dynamic disturb. When fall cause and frequency were considered different reaction times were found.

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