INTRODUCTION
The control of mediolateral (ML) dynamic stability during stepping tasks is particularly important for older adults, given the association with lateral falls and hip fracture [1]. Despite our understanding of the mechanisms for ML stabilisation during step initiation, there is a need to better understand the origins of age-related decline in ML stability, which can manifest during the restabilisation phase, after foot contact.

We previously [2] characterised whole body centre of mass (COM) kinematics among younger adults during the restabilisation phase of volitional stepping and revealed COM incongruity (i.e. overshoot of the final COM position) to be common and potentially beneficial for simplifying ML stability control. The present study sought to extend this work to examine age-related differences in ML dynamic stability control. In contrast to young adults, we hypothesized that older adults would reduce average ML COM incongruity, but exhibit increased intertrial variability of incongruity. We believed that such age-related differences may be related to the regulation of whole body angular momentum during the restabilisation phase. As such, we analysed the waveform representing the divergence between the inclination angles of the net ground reaction force ($\theta_{GRF_{net}}$) and COP-COM ($\theta_{COP-COM}$) (Fig. 1). We expected older adults to exhibit difficulty directing the net GRF at the COM, as quantified by an increased root mean square error (RMSE) between $\theta_{GRF_{net}}$ and $\theta_{COP-COM}$.

METHODS
A motion analysis system (Vicon, CA, USA) and four force plates (AMTI, MA, USA) were used to record 3D kinematic data, reaction forces and moments. A whole body kinematic model was used to calculate the COM position. Starting from a standardized parallel stance position [3], healthy younger (n=20) and older adults (n=20) performed 10 self-selected speed, single step trials with the preferred limb (PREF). To vary the challenge to control, participants also performed rapid step trials with preferred (PREF_RAPID) and narrow step width (ML_RAPID), cued by an auditory tone. Participants were asked to maintain a stable final position for 10 seconds, after step contact. Task condition order was randomized. ML COM incongruity (peak - final COM position), intertrial variability (within-condition standard deviation), and RMSE values were calculated. Each dependent variable was analysed with a 2-factor ANOVA (age*step), with a repeated measure. Only the age-related differences are reported below.

RESULTS
Contrary to our hypotheses, older adults exhibited greater COM incongruity and reduced RMSE of the net GRF than did younger adults. Older adults, however, exhibited increased intertrial variability of incongruity. Given the unexpected results, secondary analyses were used to further understand the data. Due to the ML anticipatory postural adjustment, older adults exhibited larger COM displacement toward the stance limb during step initiation and, hence, exhibited reduced ML COM velocity at foot contact. Analysis of the waveform representing the divergence between $\theta_{GRF_{net}}$ and $\theta_{COP-COM}$ revealed that older adults exhibited an increased latency in reorienting the net GRF to oppose the angular momentum that developed during the stepping phase (P2, Fig. 1).

DISCUSSION & CONCLUSIONS
The present results suggest that while COM overshoot may aid in the simplification of stability control, increased overshoot among older adults may arise from difficulty in reactive control during the restabilisation phase. Specifically, such age-related differences may be linked to the latency in active reorientation of the GRFnet after foot-contact. We propose that the magnitude and timing of reorientation are likely modulated by sensory information regarding the state of the COM at the onset of, and during, the restabilisation phase. Interestingly, healthy older adults may attempt to offset such instability by modifying the COM trajectory in an anticipatory manner, prior to step-onset, which may minimize the development of ML instability during the stepping phase, prior to foot contact.

REFERENCES

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