IMPACTS OF ADDED TORSO MASS ON REACTIVE BALANCE CONTROL: IMPLICATIONS FOR STABILITY IN PREGNANCY

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Introduction: Pregnant women fall at a similar rate as women over the age of 65 [1, 2]. Despite their prevalence, the cause of falls during pregnancy remains poorly understood, in part due to the vast array of contributing factors such as the influence of hormones on tissue properties [3, 4, 5], the exacerbation of previously minor gait asymmetries [6] and the change of center of mass (COM) location due to added mass [7, 8, 9].

Isolating the effects of added mass on instability in pregnancy is an essential step to teasing apart the influence of each of these variables on falls and balance in pregnant women. While other changes are difficult to separate, the use of a weight vest on non-pregnant women allows for a straightforward investigation of the short-term effects of added mass on balance control.

Here, we preliminarily tested the effect of altering mass and mass distribution during standing balance perturbations in a non-pregnant female participant. We predict that front-loaded mass would result in less COM movement during forward support-surface perturbations that send the COM backward, as it acts as a counterweight; and greater COM movement in backward support-surface perturbations (Fig 1A). We predicted the opposite results for back-loaded mass.

Methods: One healthy young adult (25 year-old female) stood with arms crossed during forward and backward support-surface perturbations of 12.6 cm over 500 ms (Fig. 1A) while wearing a weight vest in four conditions: no added mass (black/gray), 24 lbs- evenly-distributed (purple), front-loaded (red), or back-loaded (blue). The participant was outfitted with a full-body motion capture marker set (Vicon). We quantified the peak change in COM displacement relative to the feet, after each ramp perturbation ("peak COM excursion") and at 2.5 s (just before the platform returned to its home position) ("COM return") (Fig. 1B).

Results & Discussion: Adding mass increased COM excursion in both forward and backward perturbations when mass was added evenly (Fig 1C, purple). However, back- and front-loaded mass reduced COM excursion in forward perturbations, but increased COM excursion in backward perturbations (Fig. 1C, red, blue). Future analysis will investigate whether participant posture at the time of perturbation onset explains the unexpected reduced COM excursion in forward perturbations. COM return was greater than 0 cm in all conditions for both perturbation directions and did not correspond with that of peak COM excursion. This suggests that longer pauses before resetting the platform to its home position will provide further information about the effect of added mass on the ability to regain stability following a perturbation.

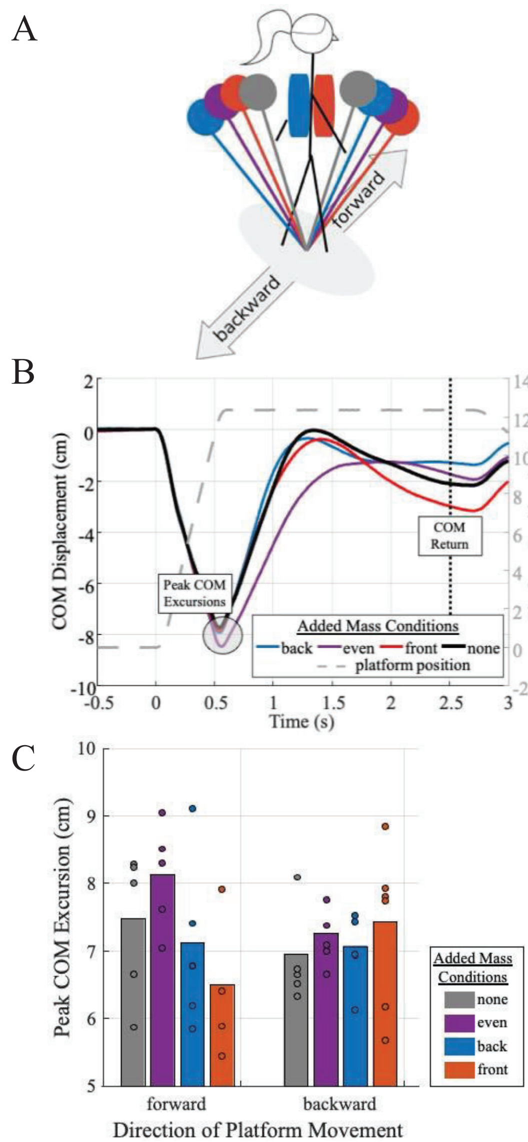

Figure 1: (A) Experimental set-up with added mass worn on perturbation platform. Colorful projections indicate hypothesized response to perturbations by condition. (B) Example of COM displacement during one forward perturbation. (C) Peak COM excursions for all four conditions after forward and backward perturbations.

Significance: The unexpected results in response to forward perturbations indicate a need to repeat this experiment with the starting COM position and joint angles more carefully controlled. If maintaining consistent COM starting positions and joint angles across weighted conditions impacts the response to perturbations significantly, this information could be valuable to understanding what postures reduce fall risk in unevenly added mass conditions. Our data suggests that some of the impacts of added mass may not be in the initial CoM excursion but rather changes in the return to a stable, upright stance. Understanding this is crucial to effectively recreating fall conditions in a laboratory environment.

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