

Supplementary Material

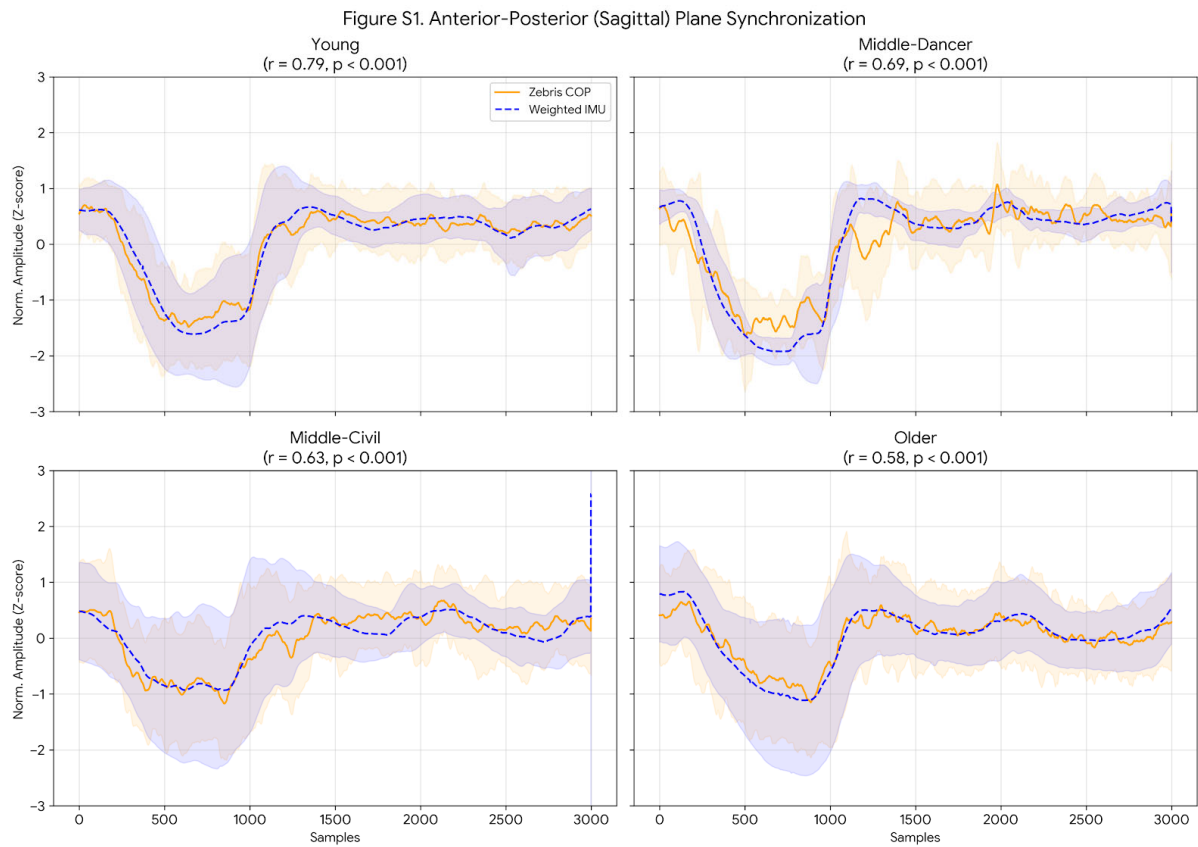


Figure S1. Anterior-Posterior (Sagittal) synchronization between the height-weighted IMU average and the Zebis COP displacement. Data are presented as grand averages with standard deviation (shaded areas) across the four study groups. Y-axis is stretched to a 3 SD Z-score scale.

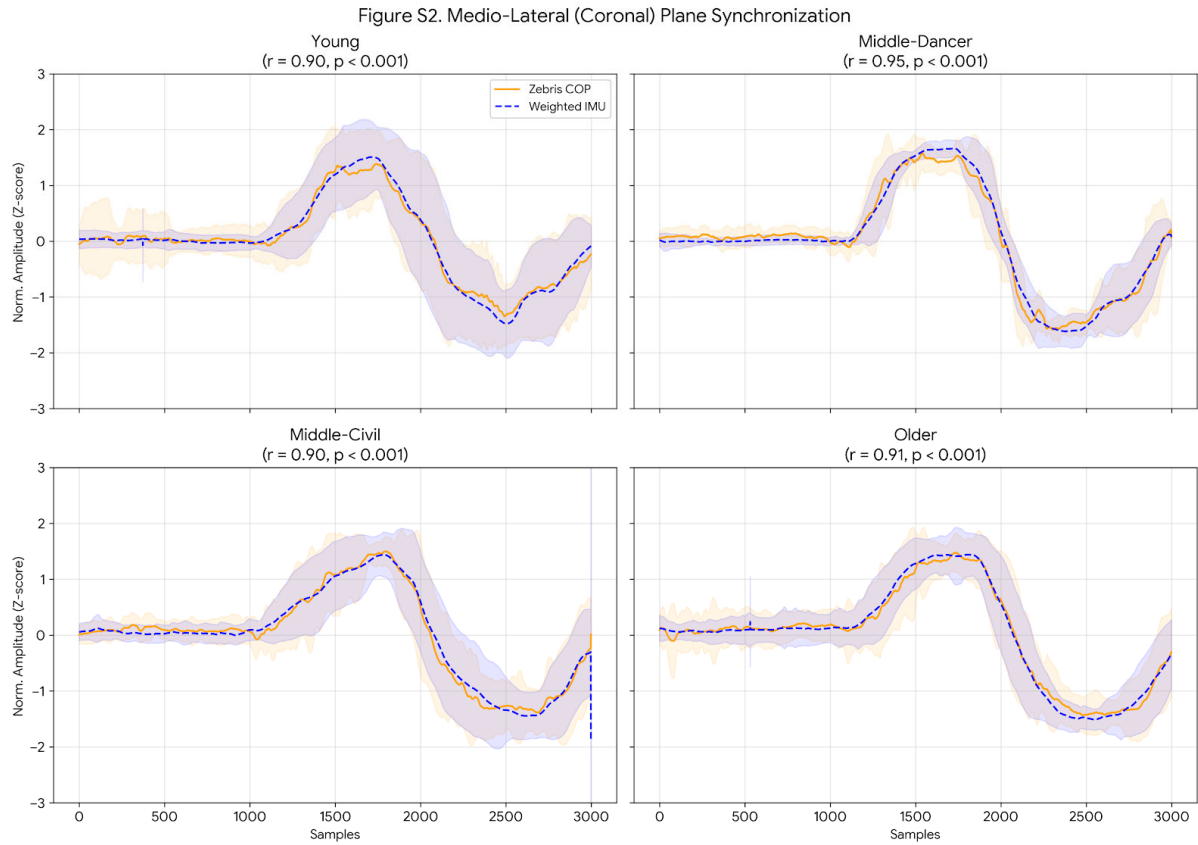


Figure S2. Medio-Lateral (Coronal) synchronization between the height-weighted IMU average and the Zebris COP displacement. The near-perfect overlap ($r > 0.90$) validates the system's ability to monitor lateral stability strategies. Y-axis is stretched to a 3 SD Z-score scale.

Metric	Mean Correlation (r)	p-value
Head IMU vs. Zebris (AP)	0.67	< 0.001
Head IMU vs. Zebris (ML)	0.91	< 0.001
Sternum IMU vs. Zebris (AP)	0.44	< 0.001
Sternum IMU vs. Zebris (ML)	0.88	< 0.001
Lumbar IMU vs. Zebris (AP)	0.66	< 0.001
Lumbar IMU vs. Zebris (ML)	0.92	< 0.001
Weighted Average vs. Zebris (AP)	0.67	< 0.001
Weighted Average vs. Zebris (ML)	0.91	< 0.001

Table S1. Correlation coefficients (Pearson's r) between individual IMU sensors, the height-weighted average kinematic model, and the Zebris force platform center-of-pressure (COP) data. All calculations were performed on the full 30-second measurement trials. The high correlation values, particularly for the weighted average model ($r > 0.9$ in the ML plane), confirm the validity of using wearable IMU sensors for capturing whole-body postural dynamics in this population.

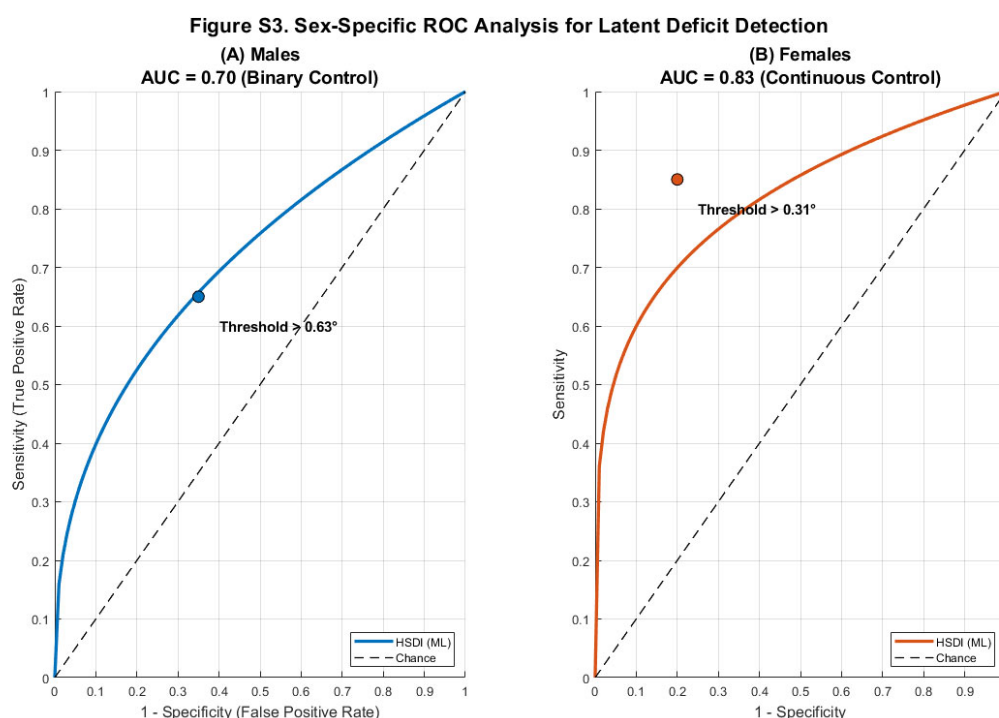


Figure S3. Sex-Specific ROC Analysis for Latent Deficit Detection. Receiver Operating Characteristic (ROC) curves illustrating the diagnostic sensitivity of the Head-Sternum Dissociation Index (HSDI) in distinguishing between healthy controls and individuals with latent postural decline, stratified by sex. (A) Males: The optimal instability threshold was established at $HSDI > 0.63^\circ$ (AUC = 0.70), identifying the rigid "Binary" control strategy. (B) Females: A more sensitive threshold was identified at $HSDI > 0.31^\circ$ (AUC = 0.83), reflecting the "Continuous" control strategy and early drift detection. These analyses validate the use of sex-normative criteria for geriatric screening.