

Supplementary Table S1. Selection frequency of 45 gait variables across 300 bootstrap resamples of the LASSO feature-selection procedure.

Variable	Selection frequency (%)
Step length	89.33
AI-Initial support time	77.00
Landing control force	70.67
AI-Step duration	68.67
Initial support time	63.67
CV-Thigh acceleration	62.33
Toe-off angle	56.33
AI-Thigh acceleration	55.67
CV-Stride length	52.67
AI-Gait speed	52.33
CV-Stride duration	51.00
CV-Terminal support time	48.00
Gait speed	46.67
AI-Toe-off angle	41.00
Terminal support time	39.33
CV-Cadence	38.00
AI-Landing control force	37.33
CV-Thigh swing work	37.00
AI-Cadence	36.00
CV-Ground reaction force	33.67
AI-Terminal support time	33.33
Swing time	33.00
AI-Double support time	32.33
Thigh acceleration	31.67
CV-Swing time	30.67
CV-Double support time	30.33
CV-Step length	29.67
CV-Initial support time	26.67
AI-Swing time	26.33
CV-Toe-off angle	25.00
AI-Thigh swing work	24.33
AI-Stride duration	24.00
Double support time	23.67
AI-Step length	22.33
AI-Ground reaction force	21.00
AI-Stride length	20.00
CV-Gait speed	18.67
CV-Cadence	18.67

CV-Landing control force	17.33
Thigh swing work	15.00
Ground reaction force	11.33
Step duration	8.33
Cadence	7.67
Stride duration	6.33
Swing time	3.00

Note: Bootstrap resampling (300 iterations) repeated the entire LASSO feature-selection procedure. Selection frequency is the percentage of resamples in which a variable had a non-zero coefficient. CV denotes coefficient of variation (gait variability), and AI denotes the asymmetry index calculated for the corresponding gait parameter.

Supplementary Table S2. Apparent and optimism-corrected discriminative performance, and apparent calibration, of the nested models.

Model	Apparent AUC	Optimism-corrected AUC	Apparent calibration intercept (bootstrap 95% CI)	Apparent calibration slope (bootstrap 95% CI)	Apparent Brier score
Model 1 (demographic + clinical)	0.641	0.619	−0.223 (−0.700 to 0.536)	0.874 (0.620–1.271)	0.104
Model 2 (+ IC Impairment Score)	0.668	0.646	−0.198 (−0.651 to 0.450)	0.885 (0.652–1.215)	0.102
Model 3 (+ Gait Score)	0.684	0.659	−0.212 (−0.648 to 0.362)	0.877 (0.655–1.193)	0.102
Model 3 (sensitivity analysis: full pipeline with LASSO feature re-selection in each bootstrap sample)	0.676	0.607	—	—	—

Note: All model-performance and reclassification analyses were based on 843 complete cases (105 fallers). Calibration intercepts, slopes, and Brier scores for Models 1–3 are apparent estimates obtained in the development cohort. The 95% confidence intervals for calibration intercepts and slopes were derived by non-parametric bootstrap resampling and are not optimism-corrected. The full-pipeline sensitivity-analysis row reports apparent and optimism-corrected AUCs only; calibration metrics were not estimated for that analysis.

Supplementary Table S3. Reference values and coefficients used to calculate the Gait Score.

Variable	Unit	Reference mean	Reference SD	Standardized coefficient
Step length	m	0.554157	0.075993	−0.258019
Landing control force	G	2.865611	0.985874	−0.053636

Toe-off angle	°	25.364292	12.079236	−0.021053
Step-duration asymmetry	%	103.148636	117.365327	+0.046433
Initial support time	ms	133.116963	17.913051	−0.000452

Note: Variables were z-standardized using the reference means and standard deviations derived from the development cohort. The Gait Score was calculated by multiplying each standardized variable by its corresponding coefficient and summing the resulting values.

Abbreviations: SD, standard deviation.

Fig. A

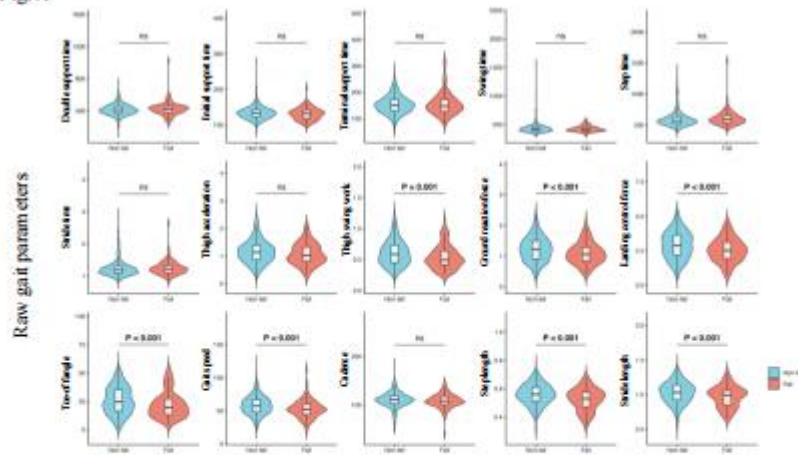


Fig. B

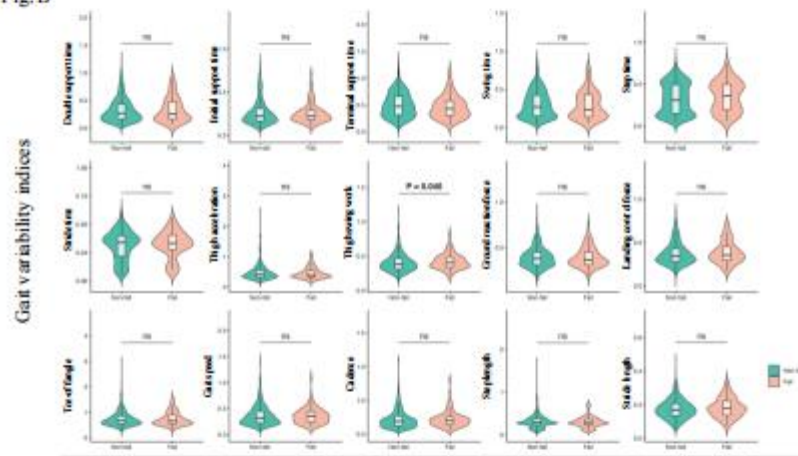
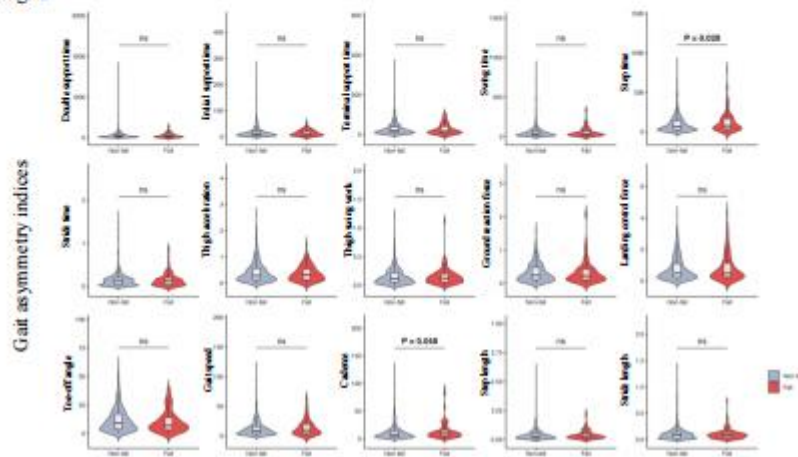
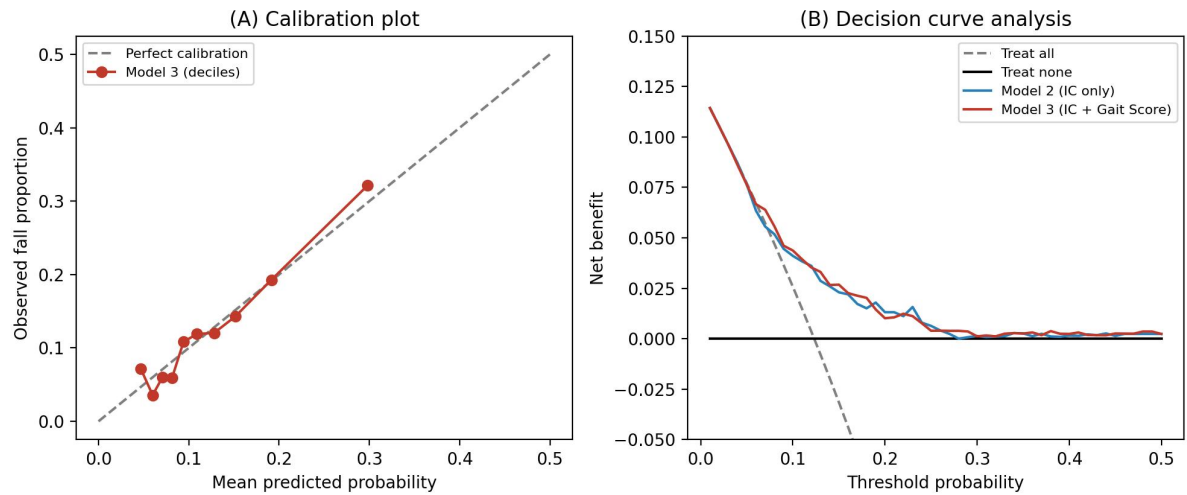


Fig. C



Supplementary Figure S1. Comprehensive landscape of the 45 digital gait biomarkers stratified by fall status.



Supplementary Figure S2. (A) Calibration plot for Model 3, showing observed versus predicted fall probability by decile. (B) Exploratory decision-curve analysis based on apparent development-cohort predictions, comparing the net benefit of Model 2 and Model 3 across threshold probabilities relative to treat-all and treat-none strategies. This analysis does not establish clinical utility.