Personalised Consumer Wearable Data for Near-Term Fall Risk Classification in Community-Dwelling Older Adults

G. Fotheringham[1]; M. Guglielminetti[1]; A. Melling[1]; G. Sprague[1]; A. Anand[2]

1. Smplicare Ltd. 2. Institute of Neuroscience and Cardiovascular Research, University of Edinburgh, Edinburgh, United Kingdom

Smplicare

THE UNIVERSITY of EDINBURGH

BACKGROUND

- Falls affect 1 in 3 adults over 65 annually
- Clinical risk assessments are episodic snapshots; wearable devices offer continuous passive monitoring
- Prior studies using wearable data use clinical-grade sensors or lab-based gait tests so limited real-world applicability
- Consumer wearables (Fitbit, etc.) are widely adopted but underexplored for fall risk classification

AIMS

- Evaluate whether consumer wearable data (Fitbit) combined with clinical features can discriminate fall-associated periods from non-fall periods in community-dwelling older adults
- Quantify the incremental value of wearable features over established clinical predictors using rigorous nested cross-validation

STUDY METHODS

This was an observational cohort study over 6 months with 140 Fitbit users.

- Nested cross-validation: outer 10-fold × 5 repeats, inner 10-fold for hyperparameter tuning
- 6 models compared: 4 sequential logistic regression baselines + XGBoost wearable-only + XGBoost full
- The model classified each 7-day window as fall-associated, if it preceded a reported fall, or non-fall-associated.

RESULTS:

96 users included

44 excluded for insufficient data

318 samples from 96 users

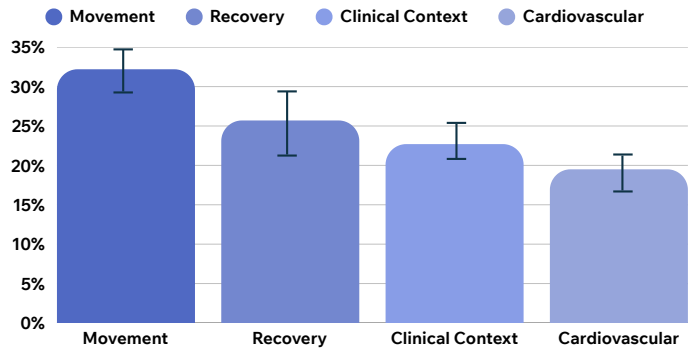
Variable	Included (n=96)	Excluded (n=44)	p-value
Age, years	75.6	74.6	0.772
Female sex, n	72	31	0.719
CFS score	4.6	5.1	0.096
Prior falls, n	73	34	1
Fell during study, n	31	21	0.117

Model	AUROC (95% CI)	AUROC gap vs full model (95% CI)
LR: Age + sex	0.38 (0.33–0.43)	0.40 (0.33–0.47)
LR: + prior falls	0.58 (0.54–0.62)	0.20 (0.15–0.25)
LR: + visual aids	0.71 (0.66–0.76)	0.07 (0.02–0.12)
LR: + CFS	0.68 (0.63–0.73)	0.10 (0.05–0.15)
XGB: Wearable-only	0.69 (0.65–0.73)	0.09 (0.06–0.12)
XGB: Full	0.78 (0.74–0.82)	Ref

Paired AUROC difference computed on matched folds. 95% CI excluding zero indicates statistical significance at $p<0.05$.

NOTE: LR = Logistic Regression XGB = XGBoost

Feature importance by domain



DISCUSSION:

- Combined (wearable + clinical) model significantly outperformed all baselines, showing wearable data adds value beyond clinical features alone
- Wearable-only performance was comparable to the best clinical-only model, suggesting consumer wearables capture genuine fall-risk signal
- Feature contributions across movement, sleep, cardiovascular, and clinical domains support a multidimensional view of fall risk
- Within-person baseline modelling may detect changing vulnerability that episodic, point-in-time assessment can miss
- Scalable wearable monitoring could help identify emerging risk between clinical contacts and support timely preventive action