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WHITE PAPER · FALL RISK

Real-World Validation of a Smartphone-Based, Gait-Centric Fall Risk Assessment

Performance of OneStep's multidimensional Fall Risk Assessment in two skilled nursing facilities with very different baseline fall rates

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COVER LETTER

RE Real-World Validation of a Smartphone-Based, Gait-Centric Fall Risk Assessment: Performance of OneStep's Fall Risk Assessment in Two Skilled Nursing Facilities

Falls follow patterns. The assessment that finds them early.

OneStep's Fall Risk Assessment was tested where it matters most: two skilled nursing facilities whose residents fall at rates nearly ten times apart.

671	2	246	30 days
Patients assessed	Skilled nursing facilities	Recorded falls	Prediction window

In both facilities, residents the system classified as Very High risk went on to fall far more often than those classified Low; in the higher-risk facility, 28.8% of Very High assessments were followed by a fall within 30 days, against 0% for Low. The single metrics clinicians usually rely on, Timed Up and Go time and gait speed, predicted falls reasonably in the lower-risk facility and barely at all in the higher-risk one. The combined score held up in both.

What this means for an operator

One number, many signals

Gait parameters, TUG, Sit-to-Stand, fear of falling and fall history are combined into one 0–100 score with a confidence measure, so staff act on a single interpretable result.

Administered by anyone

The assessment needs only a smartphone in the resident's pocket. Trained non-clinical staff can run it, expanding fall-prevention capacity without adding clinical workload.

Timing, not just likelihood

Time-to-event analysis shows higher-risk residents fall sooner as well as more often, which tells care teams when to intervene, not only whom to watch.

THE CONSERVATIVE READ

These results likely **understate** the system's predictive power. Staff could see the scores and acted on them, so some predicted falls were prevented, which is exactly the point. A prospective study with blinded scores is the next step.

To learn how OneStep's fall risk program fits your facility's workflow and documentation, contact us at hello@onestep.co or through our contact form.

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The full white paper follows.

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Performance of OneStep's multidimensional Fall Risk Assessment in two skilled nursing facilities with very different baseline fall rates

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ABSTRACT

Background. Falls are a leading cause of injury and hospitalization in older adults, particularly in skilled nursing facilities (SNFs). Existing screening tools show inconsistent accuracy in real-world use, and single metrics such as gait speed or Timed Up and Go (TUG) time lose predictive value in populations where impaired mobility is widespread.

Objective. To evaluate OneStep's Fall Risk Assessment (FRA) system, which integrates smartphone-derived gait parameters, standardized physical performance tests (TUG and Sit-to-Stand), self-reported fear of falling and fall history into a single risk level, in routine SNF care.

Methods. Retrospective analysis of 671 patients in two SNFs with markedly different baseline fall rates (SNF A, n = 471, one fall per 13.7 patient-months; SNF B, n = 200, one fall per 1.5 patient-months). Weekly FRA levels were related to falls in the following 30 days (calibration), alongside TUG time and gait velocity as single-metric comparators. Time to first fall was analysed with Cox proportional hazards models and Kaplan–Meier curves over 90 days.

Results. Despite the tenfold difference in absolute fall rates, the FRA stratified patients by relative risk within each facility. In SNF A, Very High assessments were followed by a fall in 4.8% of cases versus under 1% for Low; in SNF B, 28.8% versus 0%. TUG time and gait velocity predicted falls in the lower-risk facility but poorly in the higher-risk one. Hazard ratios relative to Low risk were 2.47 (Very High), 2.17 (High) and 1.11 (Medium); higher risk was associated with earlier first falls.

Conclusions. A multidimensional, smartphone-enabled assessment identifies patients at elevated fall risk across very different clinical environments and outperforms single-metric screening where it matters most. Because clinicians saw and acted on the scores, the observed associations likely understate the system's predictive accuracy.

KEY POINTS

Question	Does a smartphone-based fall risk assessment that combines gait, performance tests, fear of falling and fall history stratify real-world fall risk in skilled nursing facilities?
Findings	In 671 patients across two SNFs with a tenfold difference in baseline fall rates, FRA level tracked 30-day fall occurrence within each facility (Very High: 4.8% and 28.8%; Low: under 1% and 0%), while TUG time and gait velocity alone were unreliable in the higher-risk facility. Higher risk levels were associated with earlier first falls.
Meaning	An integrated, easily administered assessment gives care teams a consistent signal of who is most at risk and when to act, even in settings where traditional screening breaks down.

KEYWORDS fall risk · skilled nursing · gait analysis · Timed Up and Go · calibration · time-to-event · smartphone · risk stratification

1 Introduction

Falls in healthcare settings, especially elder care facilities, are a significant concern because of their impact on patient health, quality of life and healthcare expenditure.[1] Numerous fall risk assessment tools have been developed to predict and mitigate these events,[2,3] but they have shown inconsistent accuracy in real-world scenarios, limiting their practical utility.[4]

To improve predictive capability, OneStep developed a comprehensive fall risk assessment (FRA) system that integrates gait parameters collected with the OneStep mobile application, standardized physical performance tests (3-meter Timed Up and Go [TUG] and Sit-to-Stand), self-reported fear of falling and historical fall events. All of this data is collected within the app, which makes the assessment easy to administer while still capturing large amounts of objective data. The system builds on OneStep's

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clinically validated gait analysis, which measures gait from a smartphone placed in the patient's pocket.[5]

The FRA emphasizes recent and clinically negative data, assigning them greater weight, and attaches a confidence measure reflecting the quantity, clinical relevance and recency of the available data.

This paper analyses the FRA's effectiveness in two skilled nursing facilities (SNFs) with distinct fall profiles, relating FRA-derived risk levels to actual fall occurrence to assess the system's practical utility in clinical settings.

2 Methods

2.1 Data collection

Mobility and fall data were collected from SNF A (June–November 2023) and SNF B (December 2023–February 2024). Gait analyses and standardized tests (3-meter TUG and Sit-to-Stand) were conducted with the OneStep mobile application, which also captured patient-reported fear of falling. Complete fall records were provided by facility staff. Table 1 summarizes the populations; age distributions are shown in the supplementary figures.

Facility	Total	Female	Male	N.D.
SNF A	471	219 (46.5%)	250 (53.1%)	2 (0.4%)
SNF B	200	121 (60.5%)	78 (39.0%)	1 (0.5%)

Facility	No device	Cane	Walker	Rollator	Other / N.D.
SNF A	77 (16.3%)	24 (5.1%)	283 (60.1%)	41 (8.7%)	46 (9.8%)
SNF B	31 (15.5%)	5 (2.5%)	135 (67.5%)	18 (9.0%)	11 (5.5%)

Table 1. Study populations. Sex and walking-aid breakdown of patients who completed at least one fall risk assessment in each facility. N.D. = no data.

2.2 Fall risk scores

OneStep's proprietary FRA algorithm incorporates gait parameters, TUG and Sit-to-Stand performance, self-reported fear of falling and documented fall history, weighting recent and clinically negative data more heavily. A confidence metric reflecting the volume, clinical relevance and recency of data was applied, and only FRA scores above a predetermined confidence threshold were analysed. Scores range from 0 to 100 and map to four levels: Low, Medium, High and Very High.

2.3 Fall frequency

A patient-month was defined as one month (30.5 days) during which a patient was observed and considered at risk of falling. "Falls per patient-month" therefore measures how frequently falls occur adjusted for total observation time, allowing comparison across different numbers of patients and durations of observation.

2.4 Calibration

For each patient, weeks containing at least one assessment were identified; multiple assessments in the same week were averaged. If a fall occurred mid-week, assessments from that week were split into before- and after-fall periods. Weekly scores were binned by risk level and, within each bin, the proportion of patient-weeks followed by a fall within the next 30 days was determined. Patient-weeks were excluded if the fall reporting period or the episode of care ended less than 30 days after the assessment. The same procedure was applied to individual gait velocity and TUG measurements. Confidence intervals use the Clopper–Pearson exact method.

2.5 Time-to-event analysis

Time to fall was defined as the interval between the earliest recorded FRA and a fall event; patients without a fall were censored at their last eligibility date. Hazard ratios for Very High, High and Medium risk versus Low were estimated with Cox proportional hazards models adjusted for facility. The Cox model additionally included two smaller facilities, SNF C (54 patients, October–December 2024) and SNF D (85 patients, August 2024–February 2025), which lacked sufficient data for the standalone analyses. Kaplan–Meier curves over 90 days were plotted separately for SNF A and SNF B.

3 Results

3.1 Fall frequency

The two facilities differed substantially. In SNF A, one fall occurred every 13.7 patient-months; in SNF B, one fall every 1.5 patient-months, nearly tenfold higher. In absolute terms, 58 of 471 SNF A patients experienced at least one fall (101 falls in total), compared with 103 of 200 SNF B patients (145 falls). Differences in gait and mobility metrics alone did not explain this disparity.

3.2 FRA level and fall occurrence

Despite the marked difference in absolute fall rates, the FRA stratified patients within each facility according to their relative risk (Figure 1). Because the underlying fall rates differ, the absolute risk at each level differs too: Very High assessments were followed by a fall within 30 days in 4.8% of cases in SNF A and 28.8% in SNF B, while Low assessments were followed by a fall in under 1% and 0% of cases respectively. The system remained informative in both environments, allowing care to be prioritized appropriately in each.

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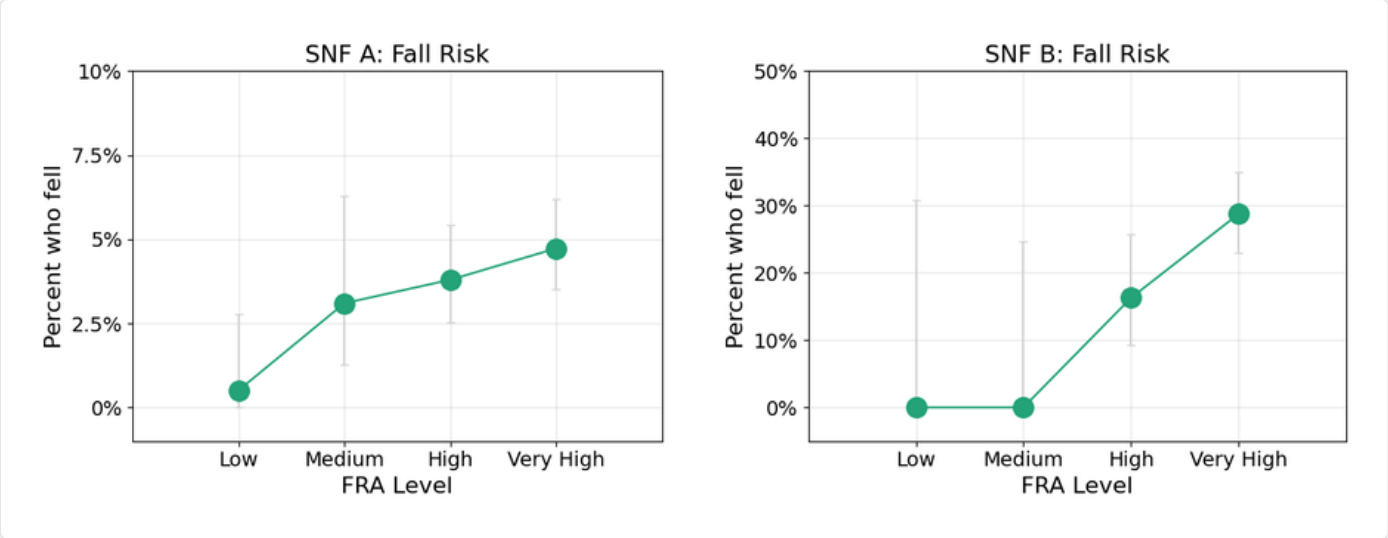


Figure 1. Fall occurrence versus FRA level. Calibration graphs show the percentage of assessments in each risk level that were followed by a fall within 30 days in SNF A (left) and SNF B (right). Error bars are binomial confidence intervals. Note the different y-axis scales.

3.3 Single metrics: TUG and gait velocity

Both TUG time and gait velocity are components of the FRA and have substantial literature supporting their association with fall risk.[6,7] Evaluated alone, TUG time showed a generally increasing (though uneven) relationship with falls in SNF A, but was largely ineffective in SNF B (Figure 2). Gait velocity was an excellent predictor in SNF A, with lower velocities consistently associated with higher fall rates, but correlated poorly with falls in SNF B, where fall incidence even rose slightly at the highest velocities, a range with few patients and wide confidence intervals (Figure 3).

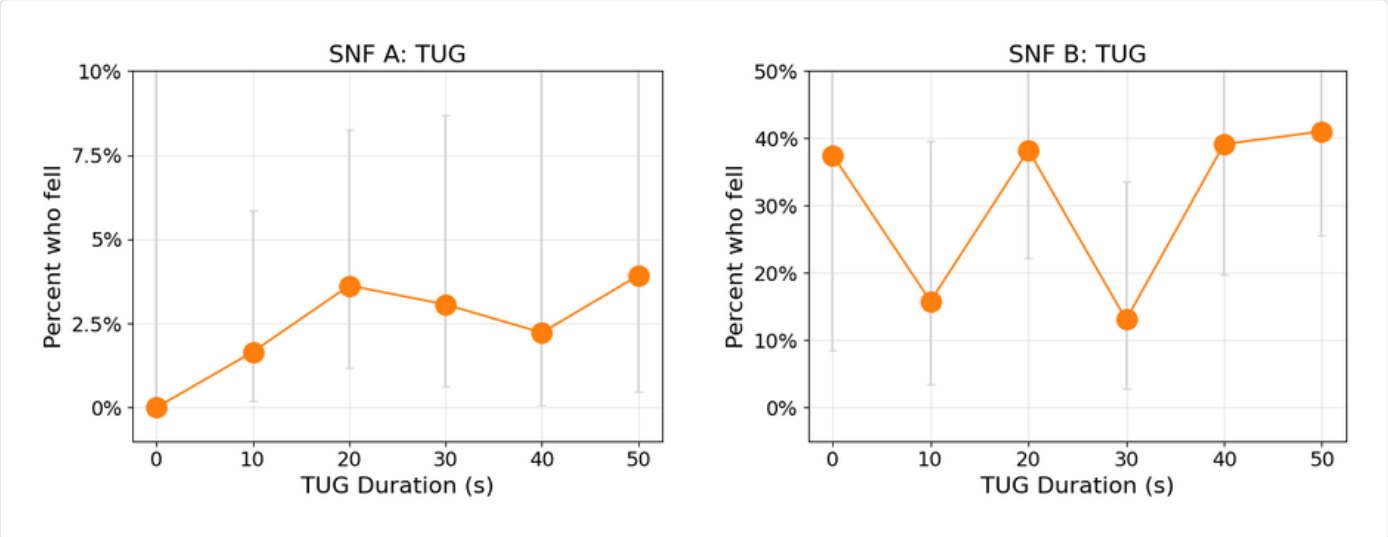


Figure 2. Fall occurrence versus TUG duration. SNF A (left) and SNF B (right). The final bin includes all TUG times of 50 seconds and above. Note the different y-axis scales.

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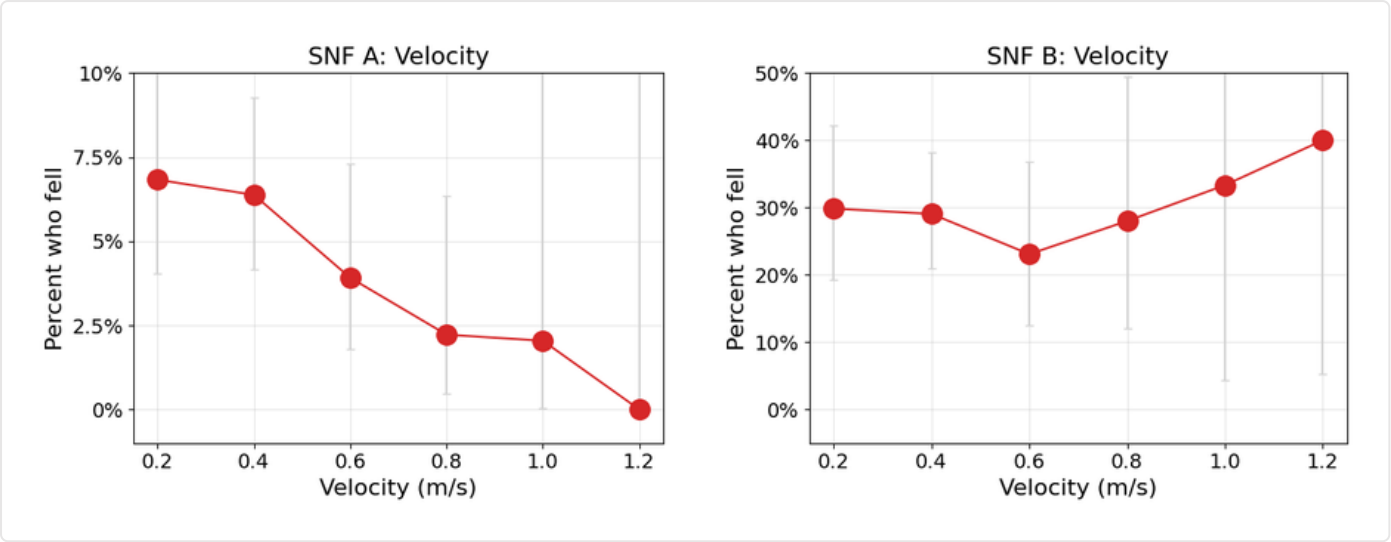


Figure 3. Fall occurrence versus gait velocity. SNF A (left) and SNF B (right). The final bin includes all velocities of 1.2 m/s and above.

3.4 Time to fall

The Cox model showed increasing hazard with higher risk level relative to Low: 2.47 for Very High ($p = 0.14$), 2.17 for High ($p = 0.22$) and 1.11 for Medium ($p = 0.90$) (Figure 4). Although not statistically significant, the trend is consistent. Kaplan–Meier curves (Figure 5) show that higher initial risk was generally associated with both an earlier first fall and a greater cumulative incidence over 90 days, with some overlap between levels. Because only the initial assessment was used, these curves mainly reflect prediction in the period immediately following assessment.

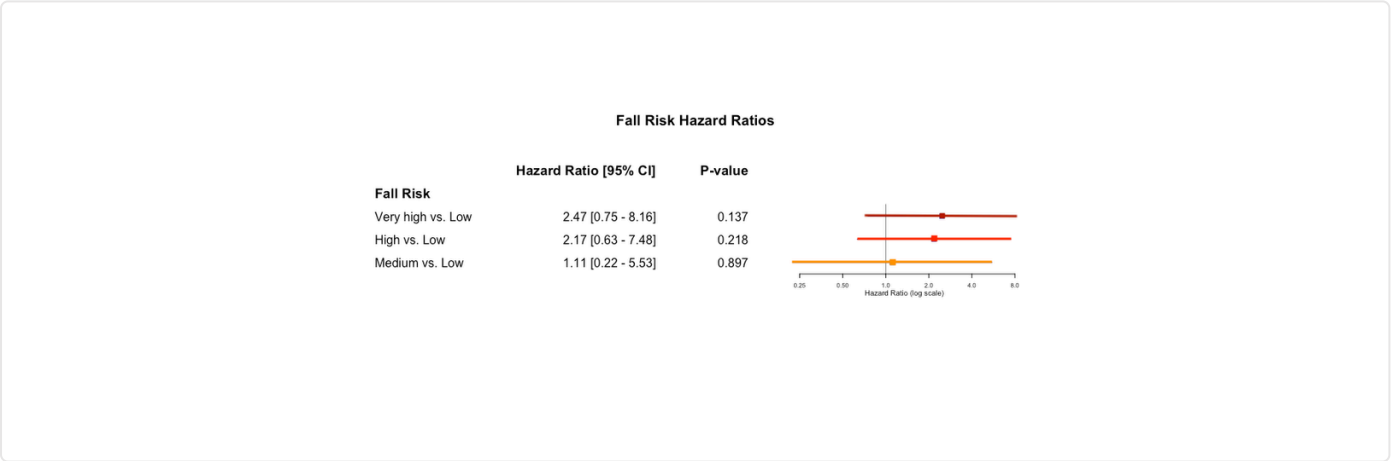
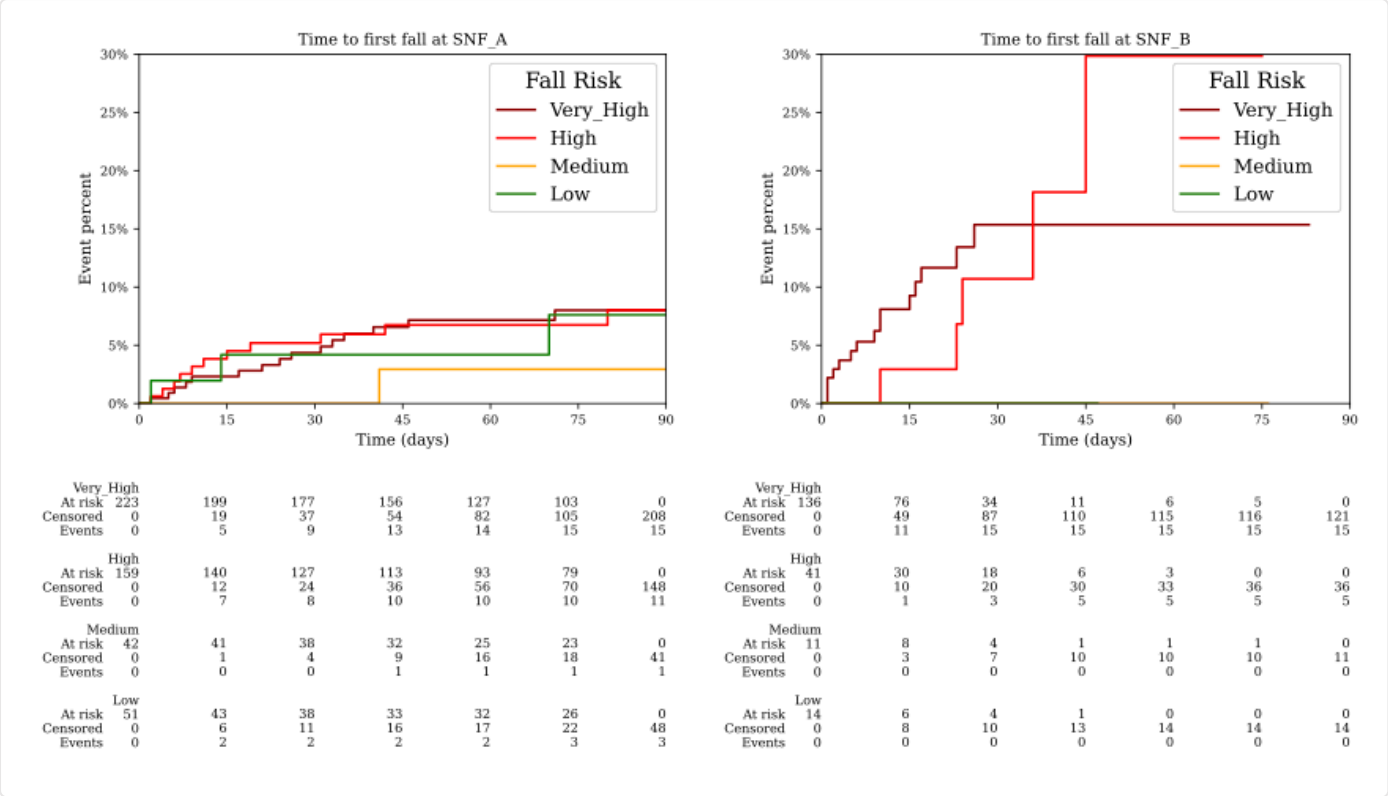


Figure 4. Cox proportional hazards model. Hazard ratio estimates with 95% confidence intervals for Very High, High and Medium risk relative to Low, adjusted for facility.

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Very_High							
At risk	223	199	177	156	127	103	0
Censored	0	19	37	54	82	105	208
Events	0	5	9	13	14	15	15
High							
At risk	159	140	127	113	93	79	0
Censored	0	12	24	36	56	70	148
Events	0	7	8	10	10	10	11
Medium							
At risk	42	41	38	32	25	23	0
Censored	0	1	4	9	16	18	41
Events	0	0	0	1	1	1	1
Low							
At risk	51	43	38	33	32	26	0
Censored	0	6	11	16	17	22	48
Events	0	2	2	2	2	3	3

Very_High							
At risk	136	76	34	11	6	5	0
Censored	0	49	87	110	115	116	121
Events	0	11	15	15	15	15	15
High							
At risk	41	30	18	6	3	0	0
Censored	0	10	20	30	33	36	36
Events	0	1	3	5	5	5	5
Medium							
At risk	11	8	4	1	1	1	0
Censored	0	3	7	10	10	10	11
Events	0	0	0	0	0	0	0
Low							
At risk	14	6	4	1	0	0	0
Censored	0	8	10	13	14	14	14
Events	0	0	0	0	0	0	0

Figure 5. Time-to-event curves. Kaplan–Meier cumulative incidence of first fall over 90 days by initial FRA level, SNF A (left) and SNF B (right), with numbers at risk, censored and events below each panel.

4 Discussion

The FRA, which combines gait analysis, physical performance, patient-reported outcomes and fall history, stratified patients by fall risk in both facilities despite considerable variation in absolute fall rates. This supports the robustness of the method across diverse clinical environments.

The difference in overall fall rates between SNF A and SNF B suggests that factors beyond mobility contribute substantially to falls: environmental hazards, reporting practices, patient-staff ratios, staff training, adherence to preventive protocols, patient-specific conditions and possibly awareness of being studied. These variables merit investigation as part of comprehensive fall-prevention strategies.

The limited accuracy of single-metric assessments underscores the value of integrating multiple modalities. Gait velocity and TUG time are useful for quick screening but lack the context needed to assess risk accurately, particularly in populations with widespread impaired mobility.

4.1 Limitations

Sample size may limit statistical power; larger studies are needed. More importantly, the data were collected in facilities actively using the FRA to guide care. Patients flagged at higher risk may have received more attention and preventive intervention, reducing their subsequent falls, and SNF staff routinely implement precautions for residents deemed at risk. Both effects would attenuate the observed associations, so the results likely understate the system's true predictive accuracy. Prospective studies in which risk levels are not disclosed to providers, and studies in community-dwelling older adults who are not closely monitored, would give a cleaner estimate. The optimal prediction window (one week versus one month, for example) also remains to be established.

5 Conclusion

By reliably stratifying patients according to risk, and by indicating not only the likelihood but also the timing of falls, the FRA allows providers to prioritize interventions and allocate resources more efficiently. Future work should integrate environmental and operational factors into the model and evaluate tailored intervention programs informed by FRA results across clinical settings.

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Supplementary figures

Population characteristics of the two facilities.

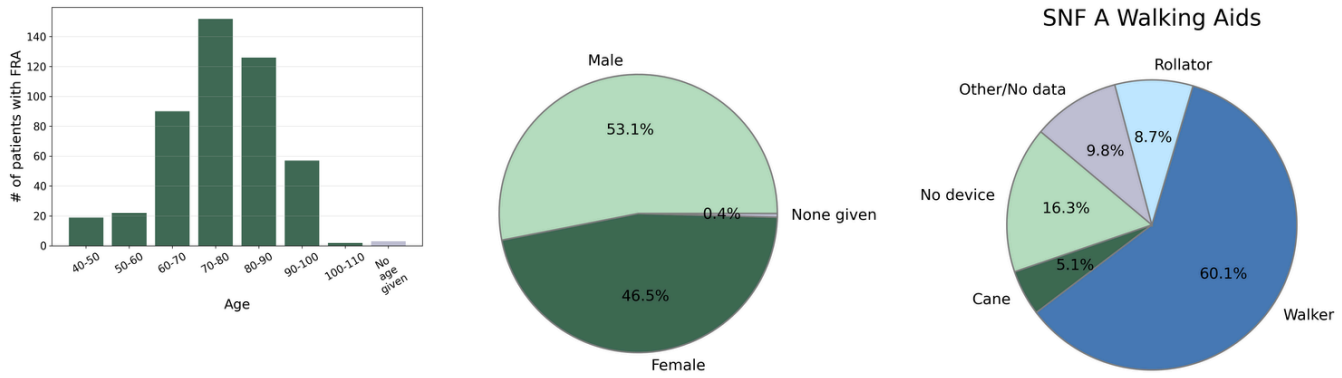


Figure S1. SNF A population. Age distribution of patients with an FRA (left), sex (centre) and walking aids (right).

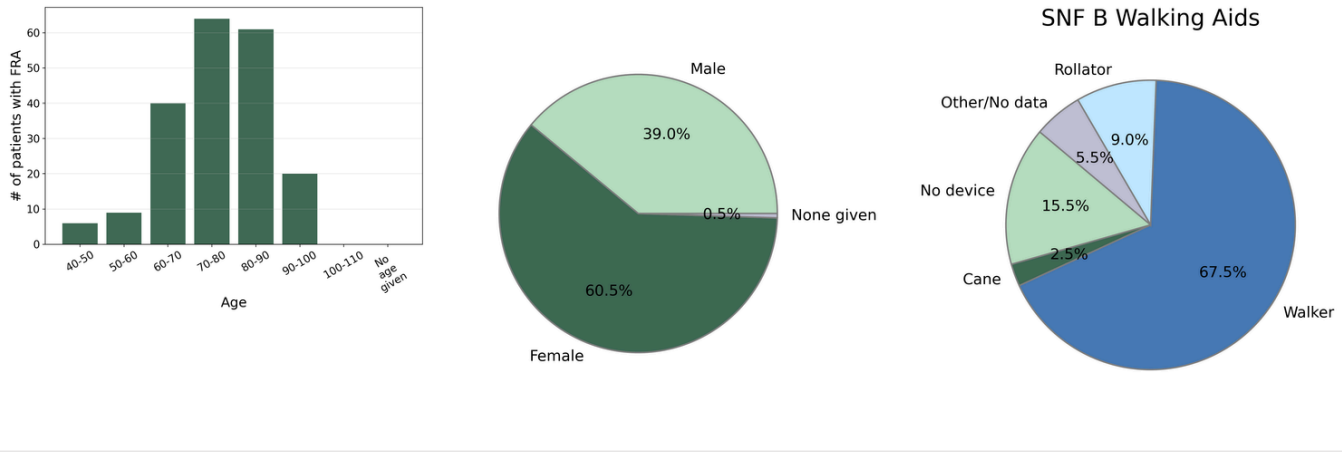


Figure S2. SNF B population. Age distribution of patients with an FRA (left), sex (centre) and walking aids (right).

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