

# Application Fields and Innovative Technologies

**Machine Learning-Based Fall Prediction Models for Older Inpatients: A Systematic Review** Lee, D., Lee, J, H. *Gerontechnology* 25(s)

**Purpose** Inpatient fall is a major patient safety issue. It causes serious harm and contributes to longer hospital stays and higher medical costs (1, 2). Older adults experience falls more frequently among inpatients due to age-related factors such as mobility limitations and cognitive impairment, thus accurate fall-risk prediction and prevention are crucial (3). The purpose of this review is to examine machine-learning models for predicting falls among older inpatients, identify key fall-risk variables, and evaluate model performance to guide future development of prediction tools. **Method** This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (4) and was prospectively registered in PROSPERO (CRD420251239062). Searches were conducted in October 2025 using four databases: PubMed, CINAHL, EMBASE, and the Cochrane Library. The search strategy combined key terms and MeSH headings such as “older adults,” “fall prediction,” “machine learning,” “inpatient falls,” and “risk assessment” using Boolean operators (AND, OR). Inclusion criteria were studies published in English that developed machine-learning based fall-prediction models for hospitalized older adults. Exclusion criteria included studies involving community-dwelling or outpatient populations and machine-learning studies using biometric data derived from wearable devices, motion sensors, or accelerometers. **Result and Discussion** A total of 1,366 records were identified, and 13 studies were included in the final analysis. All thirteen included studies were published between 2017 and 2025, indicating that machine learning–based fall prediction in hospitalized older adults is an emerging research area. The United States, Japan, Spain, and Taiwan each had two studies (15.4%), while France, China, South Korea, and Brazil each had one study (7.7%). A total of 381,573 participants were included across all studies. Twelve studies (92.3%) used EMR data, while one study (7.7%) used public data. The five most frequently included features were age, gender, history of falls, medication use, and comorbidities, and only one study reported feature importance. The most frequently reported best-performing models were XGBoost, Random Forest, and Gradient Boosting Machine. For model validation, eight studies (61.5%) conducted internal validation only, two studies (15.4%) performed external validation only, and three studies (23.1%) conducted both. Model performance was primarily evaluated using AUROC, which ranged from 0.70 to 0.90, indicating generally good discrimination. However, seven studies (53.8%) did not report accuracy, and most studies did not report F1 scores. Robust external validation, comprehensive performance reporting, and transparent feature importance reporting are critical for enabling accurate automatic identification of high-risk patients. These advances could support the replacement of traditional paper-based fall-risk assessment tools. In addition, these models can identify institutional-level fall patterns, providing insights to support hospital fall prevention policies. This review highlights the potential of machine learning for fall risk prediction in older inpatients and identifies key directions for future study. This approach contributes to timely preventive interventions, thereby enhancing patient safety.

## References

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