

# Modified FRAX Score for Prediction of Fall-induced Hip Fractures; The Added Value of Fall Energy, Number, and Social Vulnerability Index

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## INTRODUCTION:

The Fracture Risk Assessment Tool (FRAX), widely used for predicting the 10-year likelihood of hip fractures, does not incorporate factors like falls and sociodemographic characteristics, notably the Social Vulnerability Index (SVI). Recognizing these limitations, we aim to evaluate the predictive accuracy of FRAX by integrating fall frequency, fall energy, and SVI into the model for assessing the risk of fall-induced hip fractures.

## METHODS:

A retrospective case-control study was conducted, and patients aged  $\geq 40$  years with a documented diagnosis of fall-induced hip fracture were age-matched with controls with a history of falls without an associated hip fracture. Basic demographic data, along with information about the number of prior falls and the energy of the current falls were collected. The FRAX and SVI were calculated accordingly. Logistic regression analysis was employed to identify significant predictors. The performance of the models was evaluated and reported using appropriate metrics. Baseline characteristics of the dataset were presented as medians with interquartile ranges (IQR) or as percentages, where applicable. The significance of the identified variables was quantified using Odds Ratio (OR) along with their 95% Confidence Interval (CI). A p-value threshold of 0.05 was set for statistical significance.

## RESULTS:

A total of 261 patients per group were included with a median age of 74 (IQR 67-80) and 72 (IQR 62-83) years. The FRAX score was significantly associated with the likelihood of experiencing a fall-induced hip fracture, as indicated by an OR of 1.06 (CI: 1.03-1.09)[Table 1.]. Participants with a one-time history of falls had an OR of 1.58 (CI: 1.02-2.37), compared to 1.84 (CI: 1.09-3.1) for those with multiple falls. The white race, along with the Housing Type and Transportation domain of the SVI, were also demonstrated to play a role (OR= 2.85 (CI: 1.56-5.2) and OR= 0.3 (CI: 0.12-0.8), respectively). The modified FRAX tool demonstrated slight improvements in the accuracy as well as sensitivity and Youden index (Table 2).

## DISCUSSION AND CONCLUSION:

This study underscored the significance of factors such as fall frequency, housing type, transportation aspects of the SVI, and race in predicting fall-induced hip fractures. It also highlighted the need for further refinement of the FRAX tool. We recommend that future research should be focused on validating the impact of these sociodemographic and fall characteristics on a broader scale, along with exploring the implications of clinical surrogates related to falls.

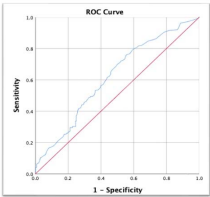


Figure 1. Receiver Operator Characteristics (ROC) Curve for the FRAX Model

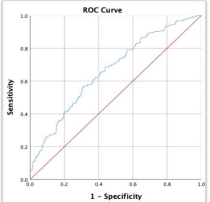


Figure 2. Receiver Operator Characteristics (ROC) Curve for the Best Model, Including the FRAX, Race, Fall Frequency, and Housing Domain of the SVI

Table 1. Logistic regression analysis, outlining the impact of different variables on fall-induced hip fracture

Variables	Coefficient	Odds Ratio (CI)	P value
FRAX	0.06	1.06 (1.03-1.09)	< 0.001
Energy of falls	0.25	1.28 (0.76-2.15)	0.34
Number of falls (=0)			0.04
Number of falls (=1)	0.44	1.58 (1.02-2.37)	0.04
Number of falls (>1)	0.61	1.84 (1.09-3.10)	0.02
Race (white vs non-white)	1.05	2.85 (1.56-5.20)	0.001
Social Vulnerability Index	-0.45	0.64 (0.30-1.36)	0.25
Housing Type and Transportation	-1.16	0.30 (0.12-0.80)	0.01
Socioeconomic	-0.23	0.80 (0.40-1.70)	0.55
Household Characteristics	-0.30	0.76 (0.30-2)	0.58
Racial and Ethnic Minority Status	-0.82	0.44 (0.13-1.43)	0.17

Table 2. The performance metrics across logistic regression models using FRAX tools and the prediction model developed in this study (Modified FRAX).

Models	AUC	Specificity	Sensitivity	Youden's J	NPV	PPV
FRAX	62%	73.6 %	41.8%	0.15	55.8 %	61.2%
Modified FRAX	67%	64.1%	58.2%	0.22	61.2%	61.2%