

Psychological distress, functional health, and memory difficulty in later life

A population-based interpretable machine-learning study

Mohammad Amin Kamaleddin¹, Mina Mirjalili² | ¹Temerty Centre for AI Research and Education in Medicine, University of Toronto ²Centre for Addiction and Mental Health

Background & aim

Memory difficulty in later life can reflect neurocognitive change, psychiatric distress, and functional vulnerability.
Aim: develop and interpret machine-learning models that classify self-reported memory difficulty among adults aged 65 years or older.
Emphasis: predictive performance plus clinically interpretable drivers of classification.

Data & model development

Design: cross-sectional secondary analysis of the 2023 National Survey on Drug Use and Health (NSDUH) public use file.

4,941
analytic sample

39.0%
weighted prevalence

500
bootstrap reps

Outcome: any difficulty remembering or concentrating, dichotomized as none vs any difficulty.

Predictor domains

Demographics and social factors
Self-rated health and functional limitations
Kessler-6 psychological distress and major depressive episode
Substance-use indicators and cardiometabolic conditions

Models compared: logistic regression, decision tree, random forest, and XGBoost with 5-fold stratified cross-validation and survey-weighted evaluation.

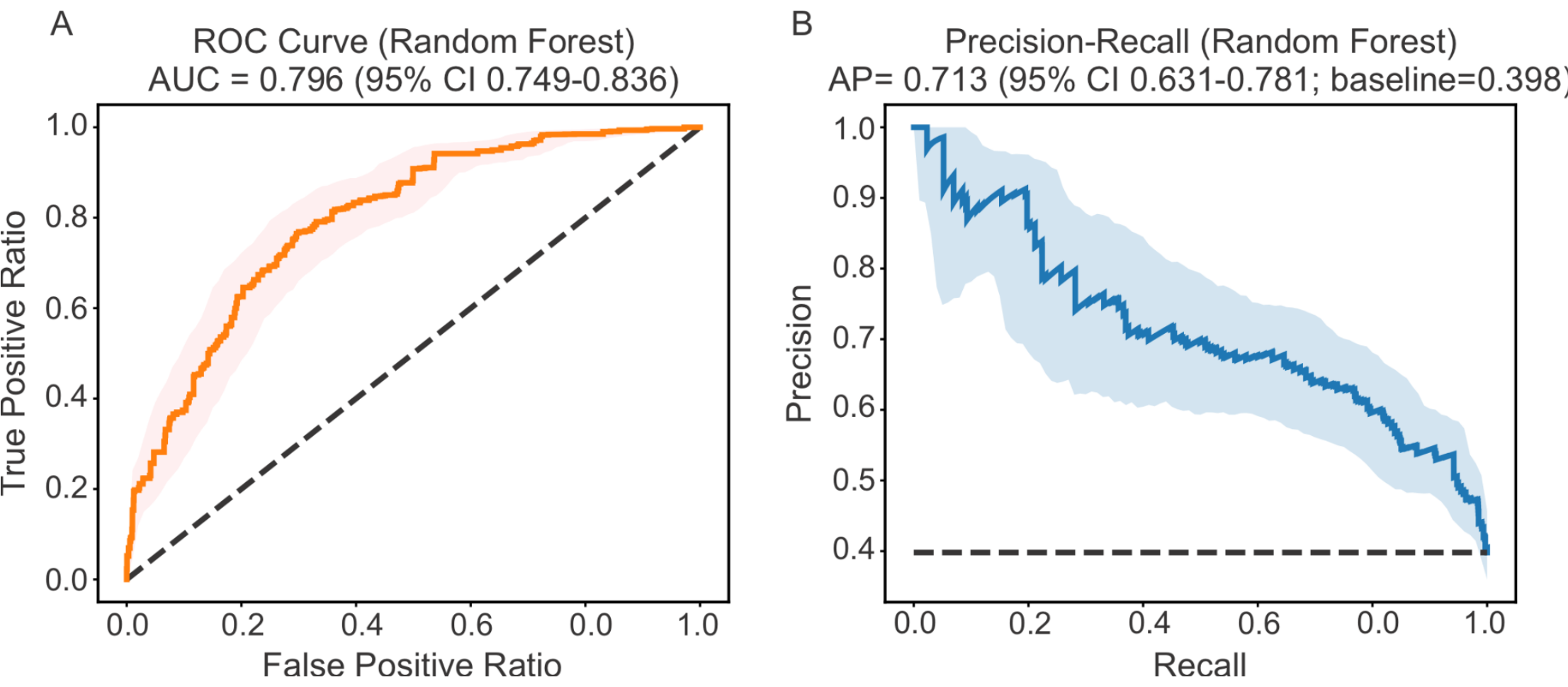
Performance summary

0.796
Random forest AUC

0.749-0.836
95% CI

0.713
Average precision

0.398
PR baseline



ROC and precision-recall curves for the selected random forest. Shaded regions show 95% bootstrap confidence intervals.

Classification operating point

At threshold = 0.50, the model was conservative: high specificity but moderate sensitivity.

0.707
Accuracy

0.455
Sensitivity

0.874
Specificity

0.705
PPV

0.708
NPV

0.553
F1

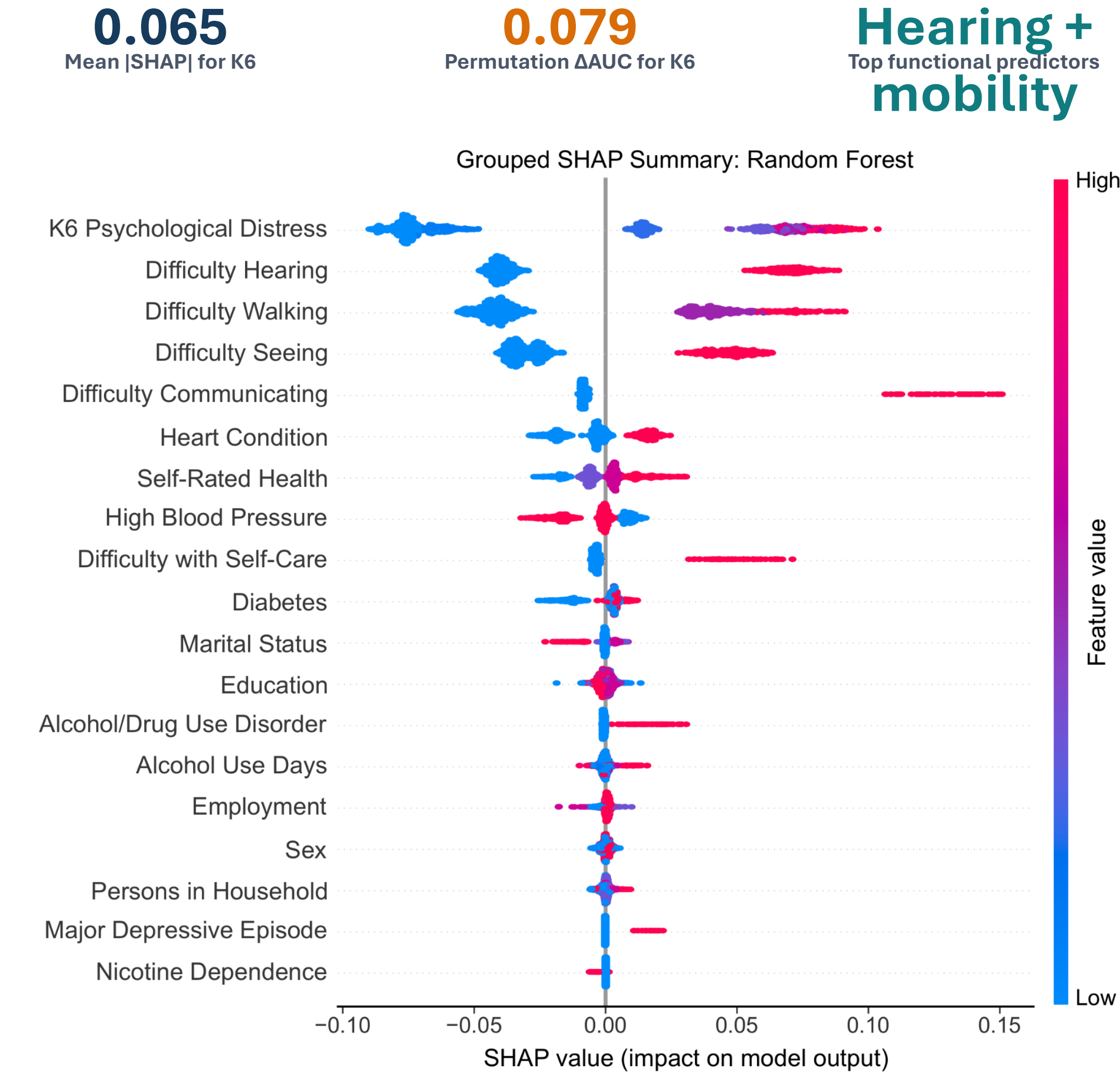
Interpretation: useful enrichment for triage; threshold should be tuned according to screening vs rule-in goals.

Contact & data

Correspondence: amin.kamaleddin@gmail.com
Data source: 2023 NSDUH public use file (SAMHSA).

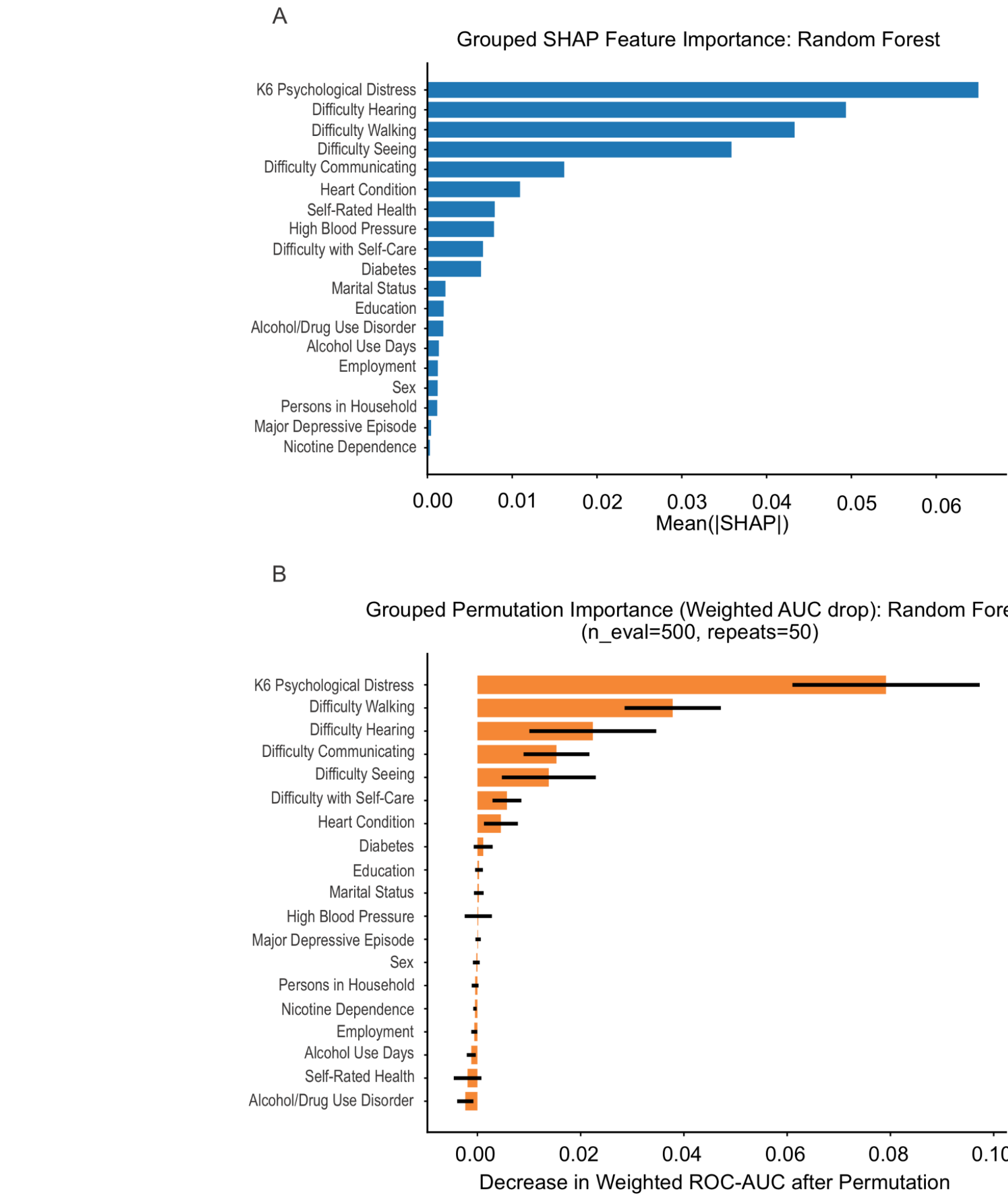
Key result: dominant predictors

Grouped SHAP and permutation importance converged on the same signal: psychological distress was the leading predictor, followed by functional limitations.



Grouped SHAP summary: high K6 and functional limitation values push predictions toward memory difficulty.

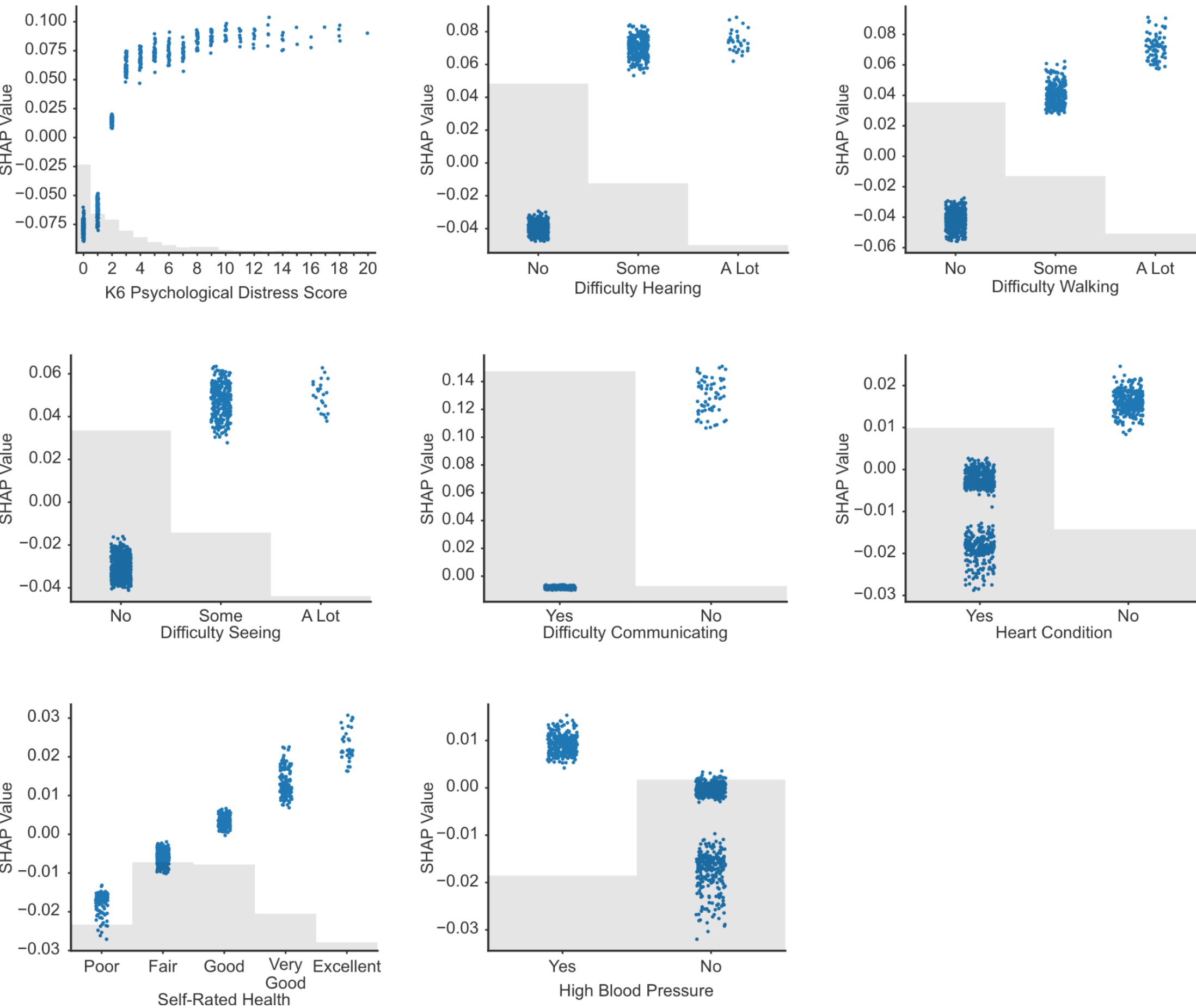
Global importance ranking



SHAP importance and grouped permutation importance consistently identify psychological distress, walking difficulty, hearing difficulty, vision difficulty, and communication difficulty as the leading contributors.

Direction and pattern of effects

Dependence plots indicate monotonic and threshold-like effects: higher K6 scores and transition from “no” to “some/a lot” difficulty in sensory or mobility domains increase predicted probability of memory difficulty.



Selected SHAP dependence plots for top predictors. Grey bars show feature distributions.

Clinical interpretation

Memory difficulty clustered with mental health burden and functional vulnerability, not only with cardiometabolic disease.
Functional domains are clinically actionable: hearing/vision evaluation, mobility and fall-risk assessment, and communication supports.
K6 psychological distress may capture depressive, anxiety, somatic, and attentional symptoms that co-occur with cognitive complaints.
The default threshold favored specificity; screening workflows may require a lower threshold or calibrated risk strata.

Strengths & limitations

Strengths: nationally representative survey data; survey-weighted model training and evaluation; complementary explainability methods.
Limitations: cross-sectional design; self-reported memory/concentration difficulty rather than clinical dementia or MCI diagnosis; excludes institutionalized older adults; internal test-set validation only.

Conclusion

Interpretable machine learning classified self-reported memory difficulty with good discrimination in U.S. adults aged 65 years or older. Psychological distress and sensory/mobility limitations dominated predictions, highlighting actionable domains for assessment pathways and population surveillance.

Take-home message

In later life, reported memory difficulty is strongly intertwined with distress and functional health. Cognitive assessment pathways should actively screen for mental health symptoms, hearing/vision problems, and mobility limitations.