

OneHeart: Predicting Cognitive Impairment using Heart Rate Variability and Demographics

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Aims: This work was done as part of the 2026 PhysioNet Challenge, which focuses on predicting cognitive impairment using multimodal sleep signals. With the proliferation of smart wearables and the development of remote photoplethysmography, continuous heart rate variability (HRV) monitoring is increasingly accessible. This study aims to develop a machine learning model utilising demographic and HRV features to detect cognitive impairment, prioritising compatibility with everyday consumer devices.

Methods: We analysed challenge electrocardiogram data, identifying R-peaks using a thresholding algorithm to extract seven standard HRV features. A Random Forest classifier was trained exclusively on these metrics and demographics (Race, Sex, Age and BMI). Separately, Mann-Whitney U tests and point-biserial correlations evaluated these features alongside an independently computed extrasystole frequency, derived via a moving mean of RR intervals.

Results: Model performance and correlations are summarised in the adjacent table. The Random Forest demonstrated strong discriminative ability during local cross-validation (CV). On the hidden validation set, the AUROC remained competitive, though AUPRC and Accuracy dropped sharply, likely reflecting a severe class imbalance in the hidden data. Statistical analysis confirmed that demographic factors (BMI) and specific cardiac events (extrasystole frequency, pNN50) significantly correlate with cognitive impairment.

Conclusion: Basic demographic and standard HRV features offer an accessible pathway for early cognitive impairment screening, evidenced by a robust AUROC, while extrasystole frequency demonstrates strong clinical relevance. Future work will integrate extrasystole metrics into the model and calibrate decision thresholds to address class imbalances and improve precision on unseen data.

Performance and Feature Analysis

Metric	Local CV	Hidden
AUROC	0.800	0.757
AUPRC	0.754	0.124
Accuracy	0.770	0.058

Feature	Corr (r)	p-value
BMI	+0.513	< 0.001
Extrasystoles	-0.111	0.006
pNN50	-0.104	0.012