Assessment of RMTs for Discriminating Stages of Alzheimer's Disease

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GOAL OF THE RADAR-AD STUDY:

Identification of individual or combinations of Remote Monitoring Technologies (RMTs) that can be effectively for early detection of Alzheimer's Disease

RESEARCH QUESTIONS

1. How accurately do RMTs discriminate between healthy control and AD stages?
2. How do the performance levels of RMTs compare to more traditional clinical tests and questionnaires?
3. Can combining multiple RMTs enhance their performance in detecting Alzheimer's Disease?

STUDY POPULATION

GROUP	AMYLOID	CDR	MMSE	N	M/F	Age	Edu
Healthy controls	Negative	0	>=28	69	31/38	67.3(7.5)	14.5(3.6)
Preclinical AD	Positive	0	>=27	39	16/23	70.7(5.8)	15.6(2.8)
Prodromal AD	Positive	0.5	24 - 26	65	38/27	69.7(7.7)	14.6(4.6)
Mild to moderate AD	Positive	>=1	18 - 23	56	31/25	70.0(8.9)	13.7(4.2)

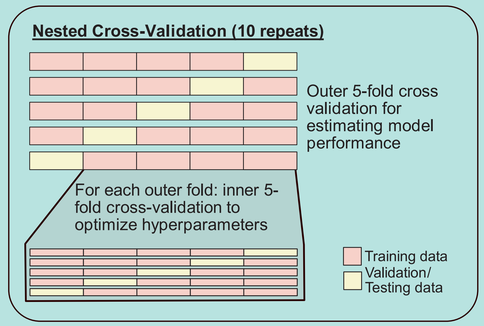
STUDY DESIGN:

RADAR-AD Study

- The RADAR-AD study is an observational, cross-sectional, multicenter study conducted across 13 European countries. It aims to monitor functional decline in Alzheimer's disease at various stages using Remote Measurement Technologies (RMTs).
- During the 8-week study period, participants underwent in-clinic tests and utilized multiple RMTs.
- The study involved the use of mobile applications (Altoida, Banking Mezurio), wearable technologies (Axivity AX3, Fitbit Charge 3, Physilog Gait sensor), and questionnaire-based assessments (such as Amsterdam A-iADL) by the participants.

Machine Learning Pipeline

- Employed ML pipeline to assess RMT performance in binary classification tasks (HC vs. PreAD, HC vs. ProAD, HC vs. MildAD, PreAD vs. ProAD,and ProAD vs.MildAD).
- Used algorithms: penalized Logistic Regression, Random Forest, and XGBoost
- Ensured robust performance estimation with repeated nested cross-validation (see Figure).
- Experimental setup: Base models utilized demographic variables (sex, age, site, education), with an additional model incorporating BMI and season of the year. RMT model combined baseline variables with RMT-derived features, while the Clinical Functional Assessment (CFA) model integrated baseline variables with scores derived from clinical tests and questionnaires for disease stage discrimination.



RESULTS & CONCLUSIONS

Results

- Diagnostic groups could not be discriminated solely based on demographic data (Base).
- HC versus PreAD: Average AUROC ranged from 53.5% to 65.6%, with most RMTs falling short behind A-iADL score (65.6%) and CFA (63.2%).
- HC versus ProAD: CFA exhibited strong discrimination with an AUROC of 87.0%. Altoida (DNS) achieved an AUROC of 72.6%, while Physilog-based tasks performed poorly.
- HC versus MildAD: The CFA demonstrated exceptional performance with an AUROC of 96.4%. Mezurio achieved the highest RMT AUROC of 76.6%.
- Combining RMTs with each other or with A-iADL/CFA showed some benefits in specific cases, although the effect was moderate and likely not practical for widespread use.

Conclusion

- Remote Monitoring Technologies (RMTs) demonstrate substantial potential in discerning prodromal and mild-to-moderate stages of Alzheimer's Disease, with Altoida, Fitbit, and Mezurio emerging as the most promising tools.
- Early-stage Alzheimer's Disease detection remains challenging for RMTs; however, Axivity, a passive RMT, shows promising early-stage detection capabilities.
- The A-iADL questionnaire provides a competitive alternative to traditional clinical assessments. It is potentially suitable for remote settings and offers time and cost efficiency.

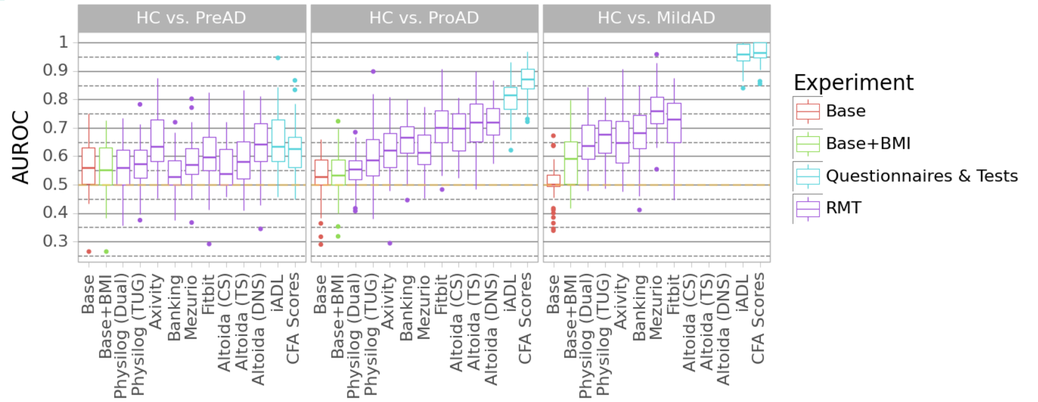


Figure 1: Discrimination Ability (Area Under ROC) of different RMTs

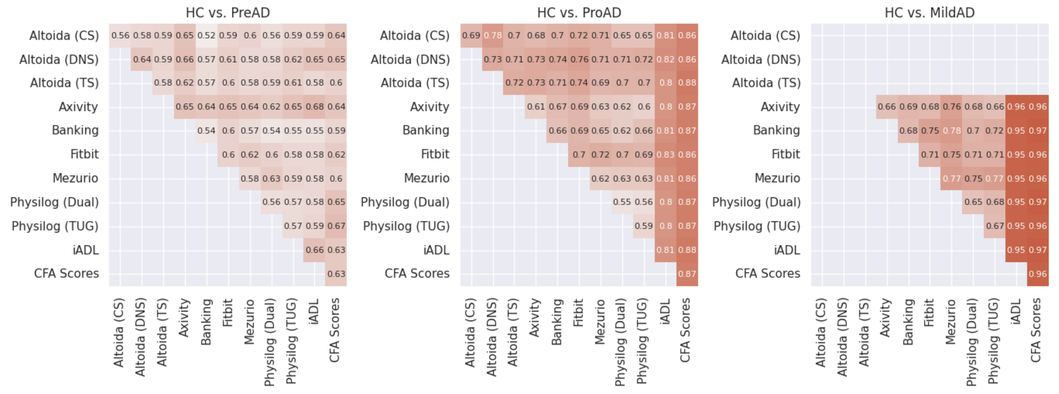


Figure 2: Average AUROCs for Pairwise Combinations of RMTs, Tests, and Questionnaires

RADAR-AD receives funding from the Innovative Medicines Initiative 2 Joint Undertaking under grant agreement No. 806999. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and EFPIA. **See www.imi.europa.eu for more details.**