Remote assessment of functional impairment in Alzheimer’s disease: results of the RADAR-AD study


BACKGROUND
Remote monitoring technologies (RMTs), such as smartphone apps and smartwatches, are changing the way functional and cognitive performance are measured in Alzheimer’s disease (AD). Due to their sensitivity, objectivity, and the option of long-term and continuous measurement, RMTs have the potential to detect a subtle decline in the earliest stages of AD.

AIM OF THE STUDY
Here, we present the results of the European RADAR-AD project (Remote Assessment of Disease and Relapse – Alzheimer’s disease), which aims to test the feasibility, acceptability and validity of RMT measures across all stages of AD, from cognitively normal to mild dementia.

STUDY DESIGN
In-clinic baseline assessment:
- CERAD: cognition
- Questionnaires: FSS (sleep), ESS (sleepiness), GLTE (physical activity), QDS (depressive feelings)
- Caregiver questionnaires: NPI-Q (neuropsychiatric symptoms)
- Amsterdam IADL (IADL), SFS (social functioning), Ecog (everyday cognition)
- Digital tests:
  - Banking app: managing finances
  - Aloida augmented reality app: cognition
- Physilog sensors: gait
- Smartphone proficiency test

At-home remote assessments (8 weeks):
- Fitbit Charge 3: activity, heart rate, sleep (continuous)
- Axivity AX3: activity, sleep (continuous)
- Mezurio app: cognition (daily)
- pRMT app: smartphone use (continuous)
- Aloida augmented reality app: cognition (weekly)
- Amsterdam IADL Questionnaire: IADL (weekly)
- Wearable camera: activities (optional, 6 days)

METHODS
- We included 229 participants from 12 different European countries, in 4 study groups (Table 1).
- Features were extracted for all RMTs and compared across groups using ANCOVA, with adjustment for relevant confounders.

DATA & RESULTS
- Feasibility: Compliance was high, but decreased with disease severity. Real-time monitoring and involvement of study partner increased compliance.
- Acceptability: Problem rates were highest for the active apps, and increased with disease severity.
- Validity: Various individual sensors discriminated symptomatic AD participants from asymptomatic participants (p<0.05), and even discriminated preclinical AD from healthy controls, for example the Aloida app and Axivity activity tracker.

Table 1 | Demographics and example features per study group.

<table>
<thead>
<tr>
<th>Features</th>
<th>Healthy control (N=69)</th>
<th>Preclinical AD (N=39)</th>
<th>Prodromal AD (N=65)</th>
<th>Mild-to-moderate AD (N=56)</th>
<th>ANCOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amyloid status</td>
<td>Negative</td>
<td>Positive</td>
<td>Positive</td>
<td>Positive</td>
<td>p=0.001*</td>
</tr>
<tr>
<td>CDR (0/0.5/1/2)</td>
<td>69 (0/0/0)</td>
<td>38 (1/0/0)</td>
<td>0/5/0 (0)</td>
<td>5/4/2 (8)</td>
<td>p&lt;0.001*</td>
</tr>
<tr>
<td>MMSE</td>
<td>29 (1)</td>
<td>29 (1)</td>
<td>27 (2)</td>
<td>22 (3)</td>
<td>p=0.001*</td>
</tr>
<tr>
<td>Male [%]</td>
<td>31 (45%)</td>
<td>16 (41%)</td>
<td>38 (59%)</td>
<td>31 (55%)</td>
<td>p=0.218</td>
</tr>
<tr>
<td>Age</td>
<td>67 (8)</td>
<td>71 (6)</td>
<td>70 (8)</td>
<td>70 (9)</td>
<td>p=0.087</td>
</tr>
<tr>
<td>Years of education</td>
<td>14 (4)</td>
<td>16 (3)</td>
<td>15 (5)</td>
<td>14 (4)</td>
<td>p=0.149</td>
</tr>
</tbody>
</table>

CONCLUSION
The RADAR-AD study provides unique insights in the feasibility, acceptability, and validity of remote monitoring of functional abilities in AD and their potential to differentiate between syndromic stages.