

Longitudinal MRI Reveals Accelerated Nucleus Basalis of Meynert Atrophy in Alzheimer's Disease Dementia

Sam P. Walsh^{1,4}, Babak Ahmadi^{2,3,4}, Abbas Babajani-Feremi^{1,4}

¹Dept. of Neuroscience; ²Dept. of Industrial & Systems Engineering; ³Dept. of Neurology – University of Florida; ⁴Magnetoencephalography (MEG) Lab, Norman Fixel Institute for Neurological Diseases, UF Health – Gainesville, FL, USA

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POSTER
0540

COHORT
ADNI

MODALITY
T1 MRI

KEY TAKEAWAY

Longitudinal MRI shows nucleus basalis of Meynert (NBM) atrophy accelerates most strongly in Alzheimer's Disease (AD) dementia, while larger baseline NBM volume is associated with slower cognitive decline.

1 BACKGROUND

- The nucleus basalis of Meynert (NBM) is the principal source of cortical cholinergic innervation and degenerates in Alzheimer's disease (AD).
- The NBM is **extremely small** — about **0.02% of total intracranial volume (TIV)** — making reproducible delineation on MRI difficult.
- Scalable **deep-learning segmentation** may enable longitudinal quantification in large, multi-site cohorts.

2 METHODS

- Data:** longitudinal T1-weighted structural MRI from ADNI (Alzheimer's Disease Neuroimaging Initiative); automated pipeline with quality control (QC) and pre-trained DnSeg NBM segmentation; TIV estimated via CAT12 toolbox.
- Groups:** cognitively normal (CN), early MCI (EMCI), late MCI (LMCI), and AD dementia — where MCI is mild cognitive impairment.
- Both models:** linear mixed-effects; covariates age, sex, TIV, field strength; random effects subject + site. **Atrophy (Fig. 2):** NBM volume, **time × baseline diagnosis**, + manufacturer.
- Cognition (Fig. 3):** score, **time × standardized NBM volume**, + baseline diagnosis.
- Robustness:** longComBat harmonization (sensitivity analysis) omits manufacturer, the batch variable.
- Cognition:** Logical Memory, RAVLT, ADAS-Cog 13, and MMSE.

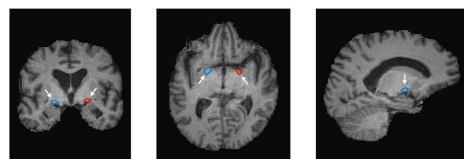


Figure 1. Automated NBM segmentation on T1-weighted MRI. Left (blue) and right (red) NBM produced by DnSeg, a deep-learning model. Example total volume 312 mm³ (~0.02% of TIV).

5,491	1,864	722	335	520	287
QC-PASS SCANS	PARTICIPANTS	CN	EMCI	LMCI	AD

3 RESULTS — ACCELERATED NBM ATROPHY

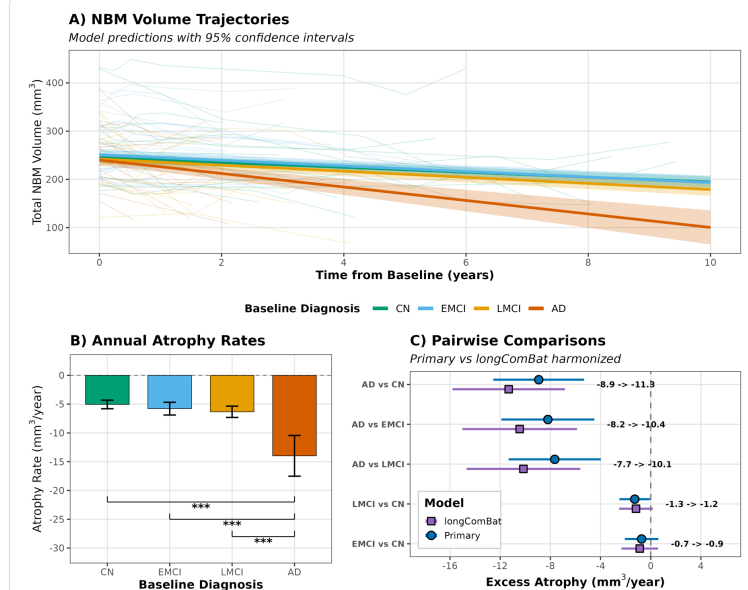


Figure 2. (A) NBM volume trajectories by baseline diagnosis. (B) Annualized atrophy rates with 95% CI; Tukey-adjusted across all 6 pairs, AD-vs-other brackets (***p* < 0.001). (C) Excess atrophy, primary vs longComBat — AD contrasts slightly larger after harmonization, robust to scanner manufacturer effects.

-8.93

mm³/year excess atrophy
(AD vs CN; 95% CI -12.54 to -5.31)

AD dementia atrophied at **-13.97 mm³/year** vs **-5.05 mm³/year** in CN (*p* < 0.0001). AD differed from all groups; CN, EMCI & LMCI did not differ. Baseline NBM volume did **not** differ by diagnosis.

4 COGNITIVE RELEVANCE

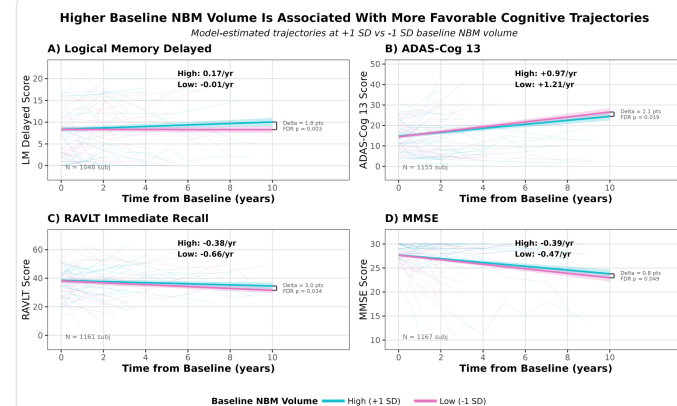


Figure 3. Model-estimated, covariate-adjusted trajectories for high (+1 SD) vs low (-1 SD) baseline NBM volume. Brackets mark the year-10 high-vs-low contrast (Δ); *p*-values are Benjamini-Hochberg FDR-adjusted across 8 longitudinal cognition tests (4 shown). Models used complete cases with ≥ 2 timepoints.

Higher baseline NBM volume was associated with more favorable 10-year cognitive trajectories across memory and global cognition (positive Δ favors larger NBM):

Δ 1.8
Logical Memory
p = 0.003

Δ 2.1
ADAS-Cog 13
p = 0.019

Δ 3.0
RAVLT
p = 0.034

Δ 0.8
MMSE
p = 0.049

Δ = model-estimated year-10 contrast (high vs low NBM), oriented so positive = better (e.g., less worsening on ADAS-Cog 13); points are within-test, not comparable across tests.

5 CONCLUSIONS

- Accelerated NBM atrophy is **specific to the AD dementia stage**.
- Baseline NBM volume shows a **reserve-like effect** — larger volume predicts slower 10-year cognitive decline, independent of diagnosis.
- Automated NBM segmentation enables **robust, scalable quantification** for multi-site longitudinal MRI studies and cholinergic-targeted trials.

DATA & ACKNOWLEDGEMENTS

Data from the **Alzheimer's Disease Neuroimaging Initiative (ADNI)** database (adni.loni.usc.edu). MEG Lab, Norman Fixel Institute for Neurological Diseases, UF Health. NBM segmentation used DnSeg (Doss et al., AJNR 2023;44:1020); we thank Dr. Derek J. Doss for model access.

ABBREVIATIONS

NBM, nucleus basalis of Meynert · AD, Alzheimer's disease · ADNI, Alzheimer's Disease Neuroimaging Initiative · TIV, total intracranial volume · CN/EMCI/LMCI, cognitively normal / early / late MCI (mild cognitive impairment) · RAVLT, Rey Auditory Verbal Learning Test · ADAS-Cog, Alzheimer's Disease Assessment Scale-Cognitive · MMSE, Mini-Mental State Examination · CI, confidence interval · FDR, false discovery rate · SD, standard deviation.

CONTACT

Sam P. Walsh · University of Florida
samwalsh@ufl.edu