

Retinal Age Predicts Years to Dementia Diagnosis

A longitudinal study using routine community optometry fundus images linked to national health records

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Background & Methods

Retinal age gap (RAG) — predicted minus chronological age — tracks cardiovascular disease, mortality, and neurodegeneration. We map its longitudinal trajectory in pre-dementia individuals using real-world data for the first time.

Key novelty

Images from **community optometry practices** — different practitioners, devices, protocols — linked to real-world health records spanning **up to 18 years** of follow-up.

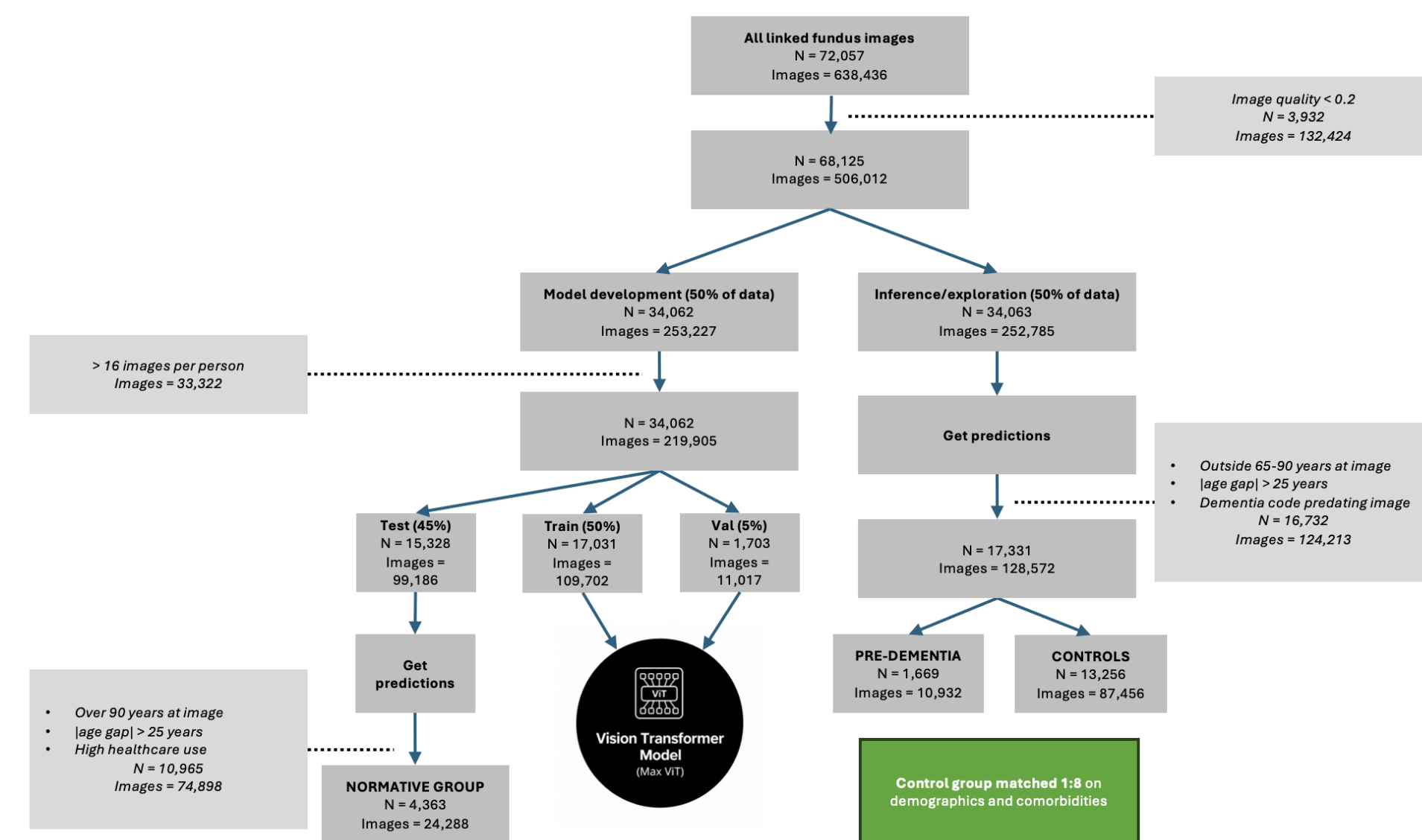
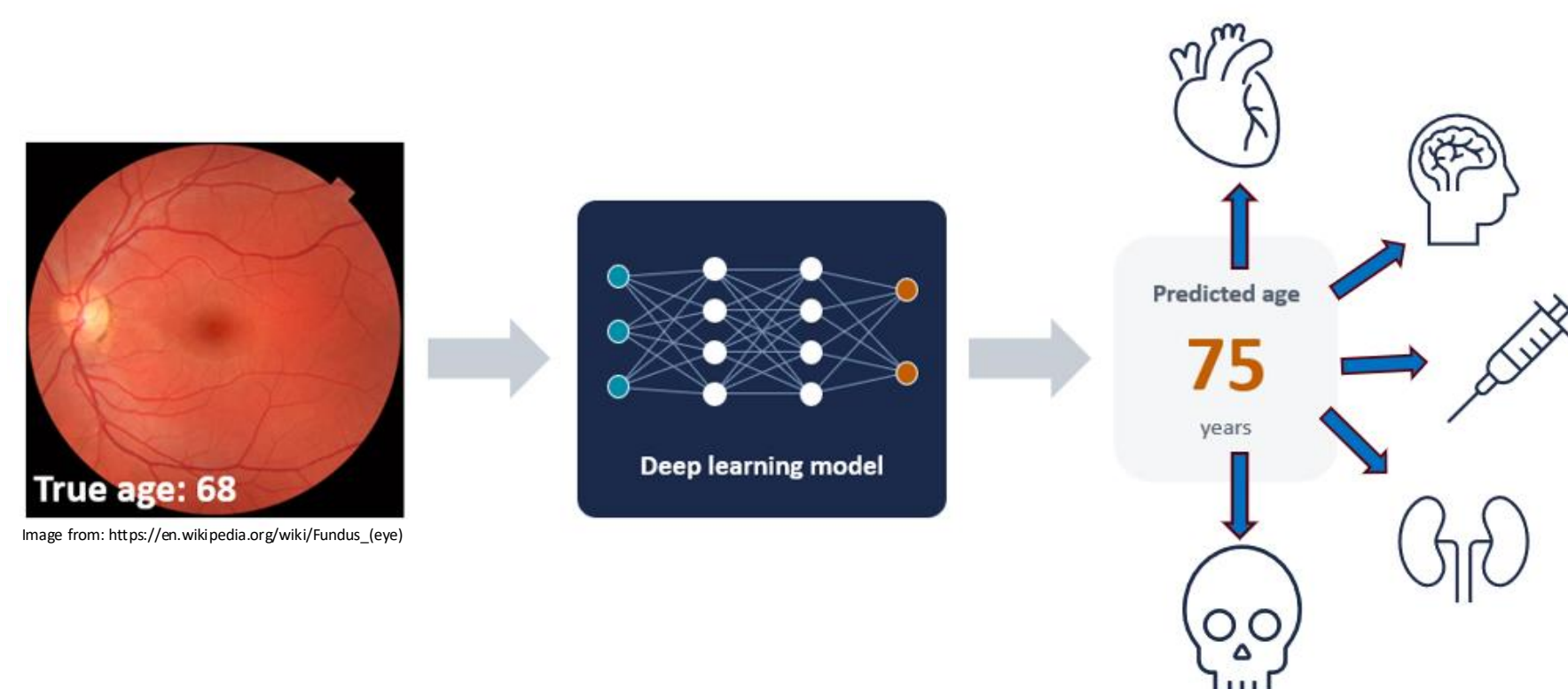


Fig 1. Study design. 72,057 people; 638,436 images. 50:50 split for model training vs inference. Pre-dementia (n=1,669) matched 1:8 to controls (n=13,256).

Normative Percentile Score

Retinal age percentile calculated from a **low healthcare-use reference population** (n=4,363).

- Score of 50 = typical for age. Score >50 = retina looks older than expected.



Model performance

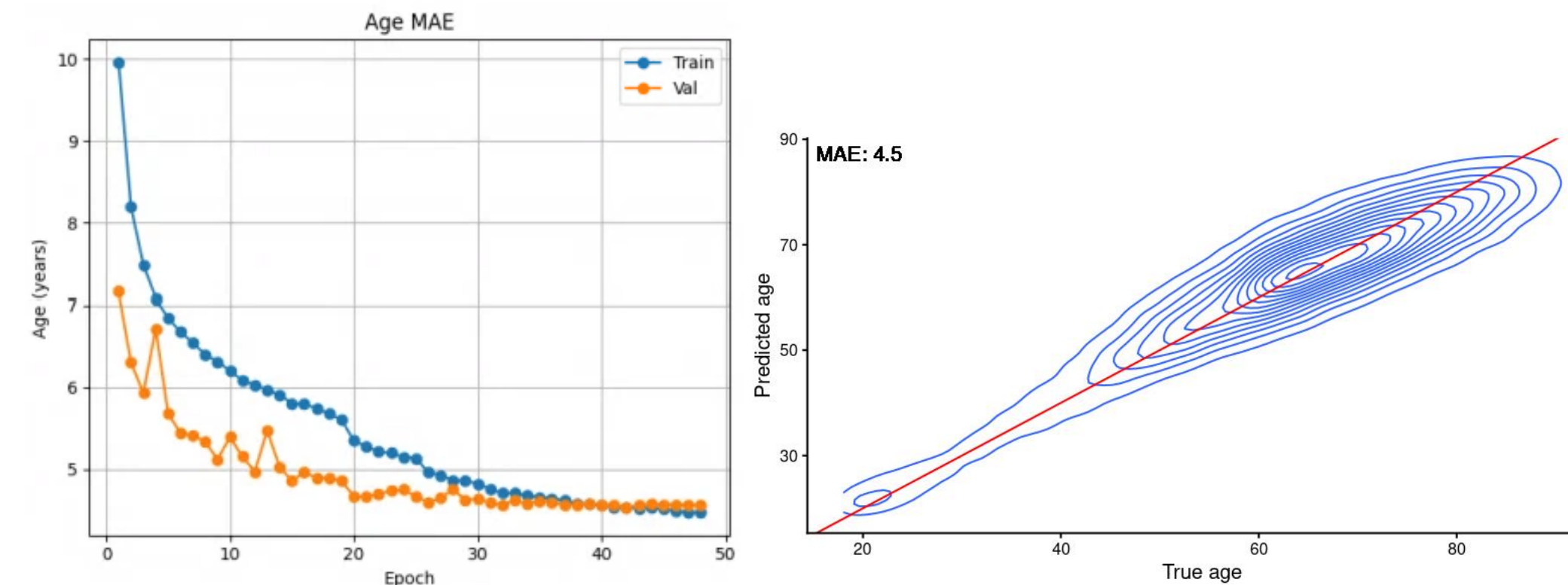
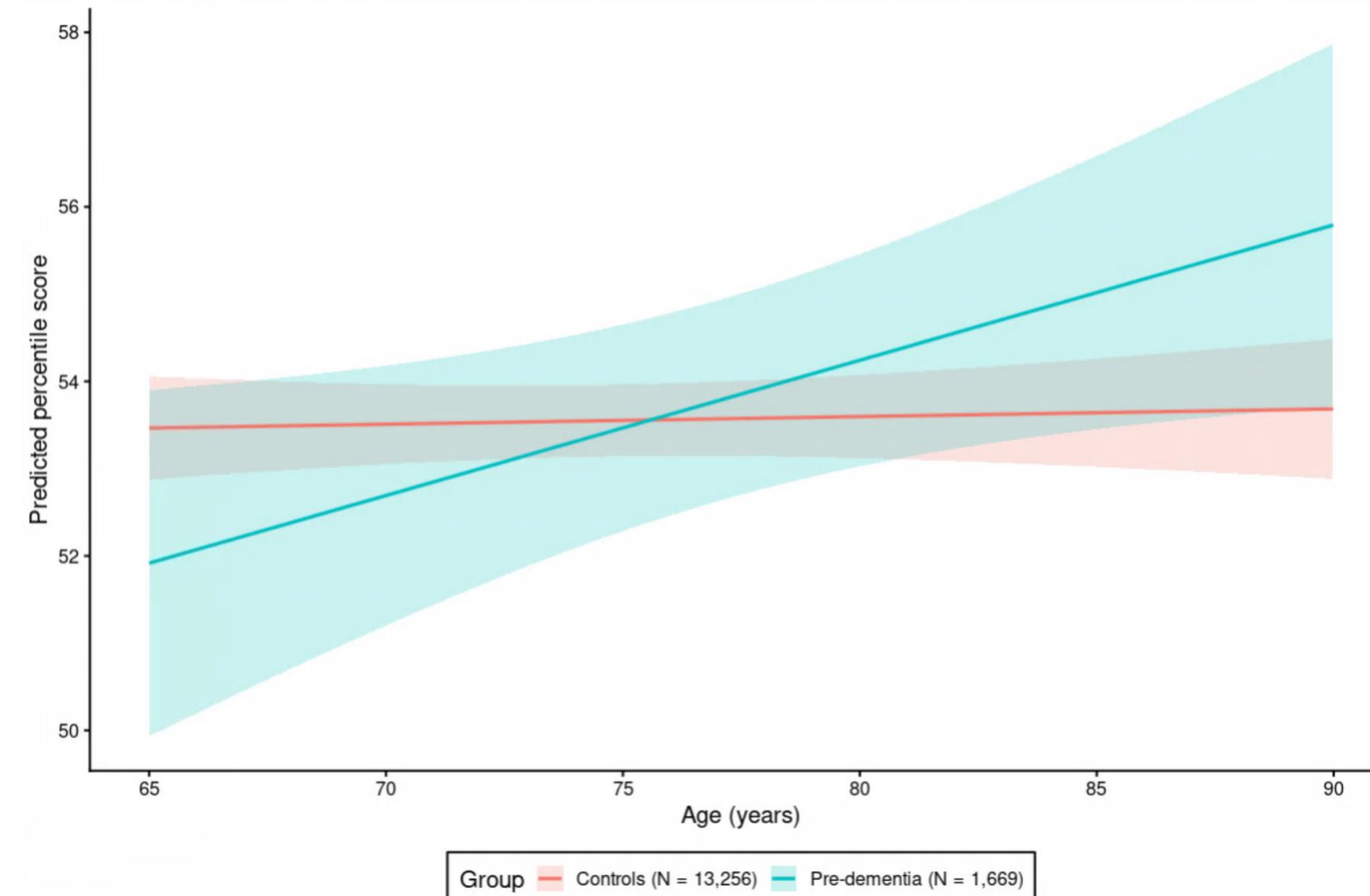


Fig 2 (left). Training and validation mean absolute error curves (50 epochs). Fig 3 (right). Predicted vs true age; test set low healthcare-use group, mean absolute error = 4.5 years.

Do trajectories of retinal age percentiles differ between pre-dementia and controls?

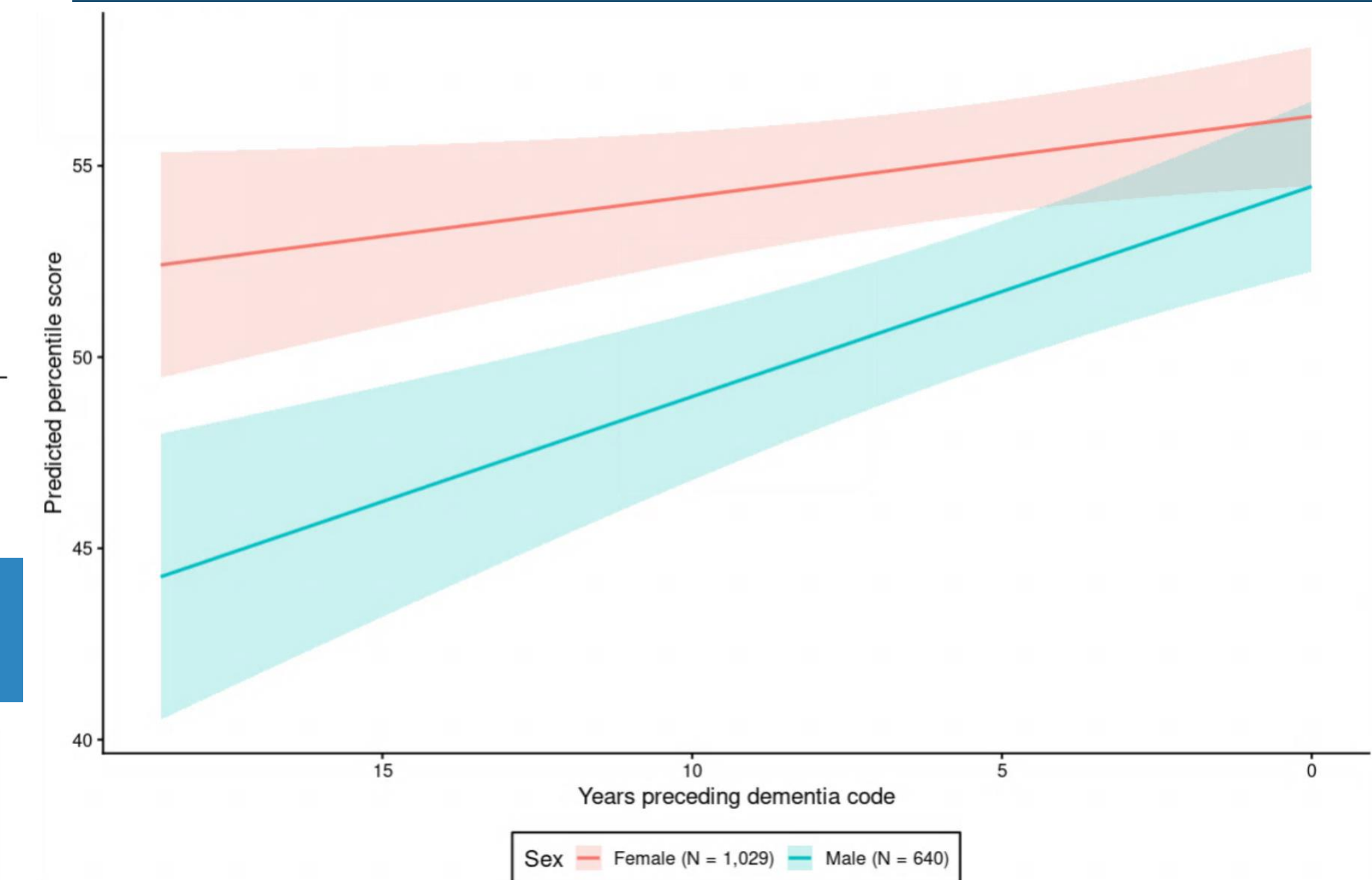


Retinal age gap percentile scores rise faster in pre-dementia individuals

- Both groups start above the population median (score >50). Estimated using a linear mixed-effects model with random intercepts per participant.

R code: `lmer(percentile score ~ age at image * group + (1|subject))`

Do retinal age percentile trajectories differ by sex in the years preceding diagnosis?



Sex x time interaction

- Both sexes show rising scores before diagnosis. Males rise faster (+0.55/yr) than females (+0.21/yr). At diagnosis: **females 56.3, males 54.4** (both above median of 50).

R code: `lmer(percentile_score ~ years to diagnosis * sex + (1|subject))`

Conclusions

- Retinal age percentile scores **rise progressively** in the years before diagnosis.
- Effect present in both sexes; **faster in males** despite lower incidence.
- Signal is present to **real-world data** — heterogeneous images, variable protocols, imperfect clinical coding.
- Infrastructure for population-level retinal **dementia risk monitoring may already exist** in healthcare systems with mature optometry networks.

Approvals

Data: SCONE (Scottish Collaborative Optometry-Ophthalmology Network e-research) linked to national health records via Public Health Scotland Safe Haven. Ethics: The creation of the SCONE repository and its research is covered by the National Safe Haven ethical approval (East of Scotland NHS Research Ethics Service). NHS Scotland's Public Benefit and Privacy Panel for Health and Social Care approved use of SCONE's images with linked NHS data for neurodegenerative disease prediction research (2324-0177, 15/11/2024).