

Ultra-Low-Field MRI for Dementia Assessment: A Scoping Review

Jacqueline Robbins^{1,2}, Wesley Pyke¹, Elizabeth Barrett^{1,3}, Maria Liljeroth^{1,4}, James Dobrzanski⁵, Sukhi Shergill^{1,2,6}, Joanne Rodda^{1,2}

¹Kent & Medway Medical School ²Kent & Medway Mental Health NHS Trust ³Dartford & Gravesham NHS Trust ⁴Royal Surrey NHS Foundation Trust ⁵Essex Partnership University NHS Trust
⁶Institute of Psychiatry, Psychology & Neuroscience, King's College London



Background

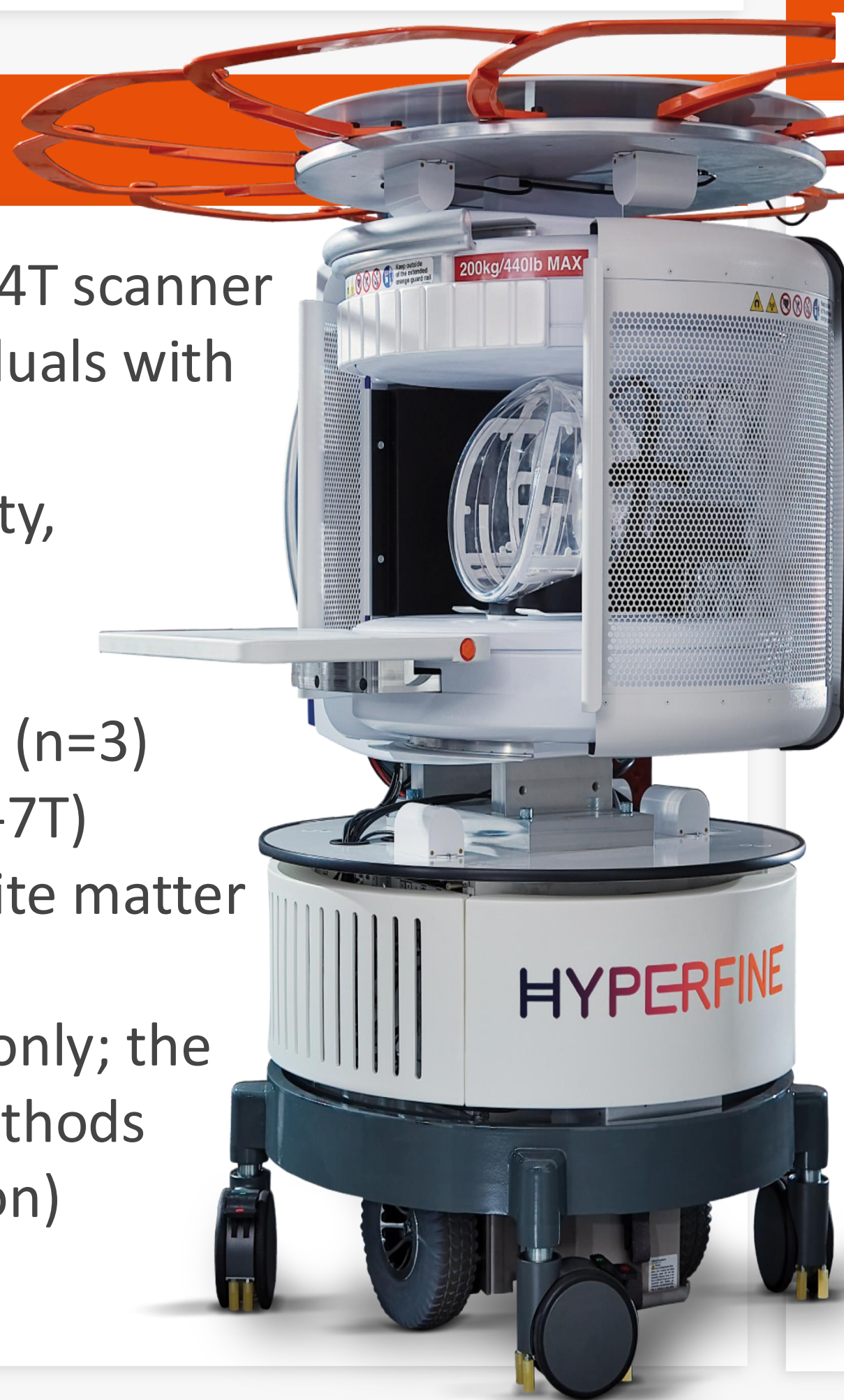
- **Structural neuroimaging** is a cornerstone of dementia assessment, yet timely access remains a major global challenge, often constrained by hospital-based pathways and long waiting times.
- **Ultra-low-field (ULF) MRI** is an emerging technology combining low magnetic field strength with advanced AI reconstruction to produce clinically interpretable brain images.
- ULF-MRI scanners are compact, portable, less enclosed, and operate from a standard power socket. No specialist cooling or shielding required.
- These features open new opportunities to deploy neuroimaging in more accessible settings, including memory clinics, community sites, and lower-resource environments.
- **This scoping review** synthesises current evidence on ULF-MRI in contexts directly relevant to dementia assessment.

Methods

- Followed PRISMA Extension for Scoping Reviews (PRISMA-ScR)
- Five electronic databases searched using predefined terms relating to ULF-MRI and adult neuroimaging.
- **Inclusion:** non-acute adult neuroimaging studies; comparison between ULF-MRI and high-field MRI.
- **Exclusion:** acute presentations (traumatic brain injury, acute cerebrovascular events).
- Study selection and data extraction performed independently by three reviewers using a standardised framework.
- 2,015 unduplicated records identified → 24 full-texts reviewed → **13 studies met inclusion criteria.**

Study Characteristics

- **All studies:** used the Hyperfine Swoop 0.064T scanner
- **Populations:** healthy volunteers and individuals with AD/MCI, MS, epilepsy, optic neuritis, PML
- **Settings:** hospital, memory clinic, community, national research cohorts across the USA, UK, Germany, Canada and Australia
- **Design:** prospective (n=11) or retrospective (n=3) paired comparison with high-field MRI (1.5-7T)
- **Outcomes:** brain morphometry (all 14), white matter hyperintensities (5), lesion detection (5)
- **Analysis:** 2 studies used visual assessment only; the remainder all used quantitative analysis methods (super-resolution + automated segmentation)



Included Studies

Study	Population	n	Key findings
Sorby-Adams 2024	Healthy, vasc. risk, MCI/AD	97	Brain atrophy & WMH measurable in MCI/AD; hippocampal volume distinguished AD from controls (p<0.001)
Váša 2025	Healthy adults	23	Brain volumes agreed strongly with standard MRI; reliable for hippocampus
Hsu 2025	Healthy adults	33	Brain volumes agreed strongly across regions; hippocampus moderate-to-good agreement; T2w better than T1w
Iglesias 2023	Neurological patients	11	AI image enhancement essential for accurate brain volume measurements; good results after enhancement
Cooper 2024	Healthy young adults	70	Strong agreement for overall brain size; cortical thickness less reliable without multi-orientation scans
Johnson 2025	Hospital inpatients	127	WMH volume agreed strongly (r=0.93); moderate-to-severe WMH reliably detected (κ=0.83)
de Havenon 2023	Stroke inpatients	33	Clinicians could identify significant white matter changes on ULF-MRI with moderate agreement
Arnold 2022	MS outpatients	33	9 in 10 patients had at least one MS lesion visible; larger lesions detected most reliably
Okar 2024	MS cohort	55	High sensitivity for large lesions; small lesions often missed; clinician training improved accuracy
Okar 2025	PML	11	All major white matter abnormalities detected; lesion volumes not significantly different from HF-MRI
Bauer 2024	Epilepsy	23	Abnormality detected in 17/24 cases; best for tumours & atrophy; microbleeds not detected
Lim 2024	Optic neuritis	20	ULF-MRI available sooner; specific but moderately sensitive for white matter dissemination
Islam 2025	Healthy adults	92	AI image enhancement (LoHiResGAN) substantially improved brain volume measurement accuracy

Results: Brain Morphometry

Global brain volumes

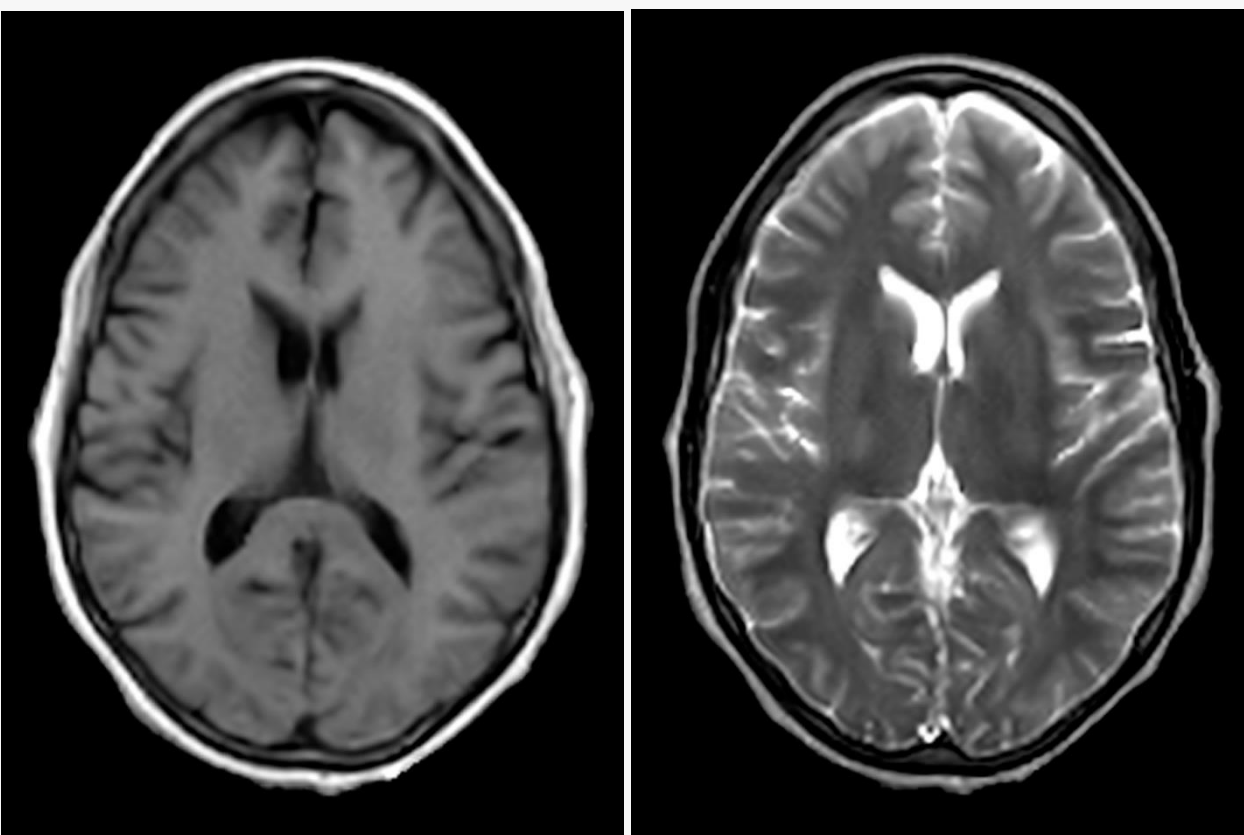
- Strong correlations with 3T for whole-brain volume across all studies (r = 0.95-1.00).
- Lateral ventricular volume also agreed strongly (r = 0.96-0.99) (Sorby-Adams et al. 2024).
- WM, cortical, subcortical volumes: r = 0.85-0.97 using super-resolution (Cooper et al. 2024).

Hippocampal volume

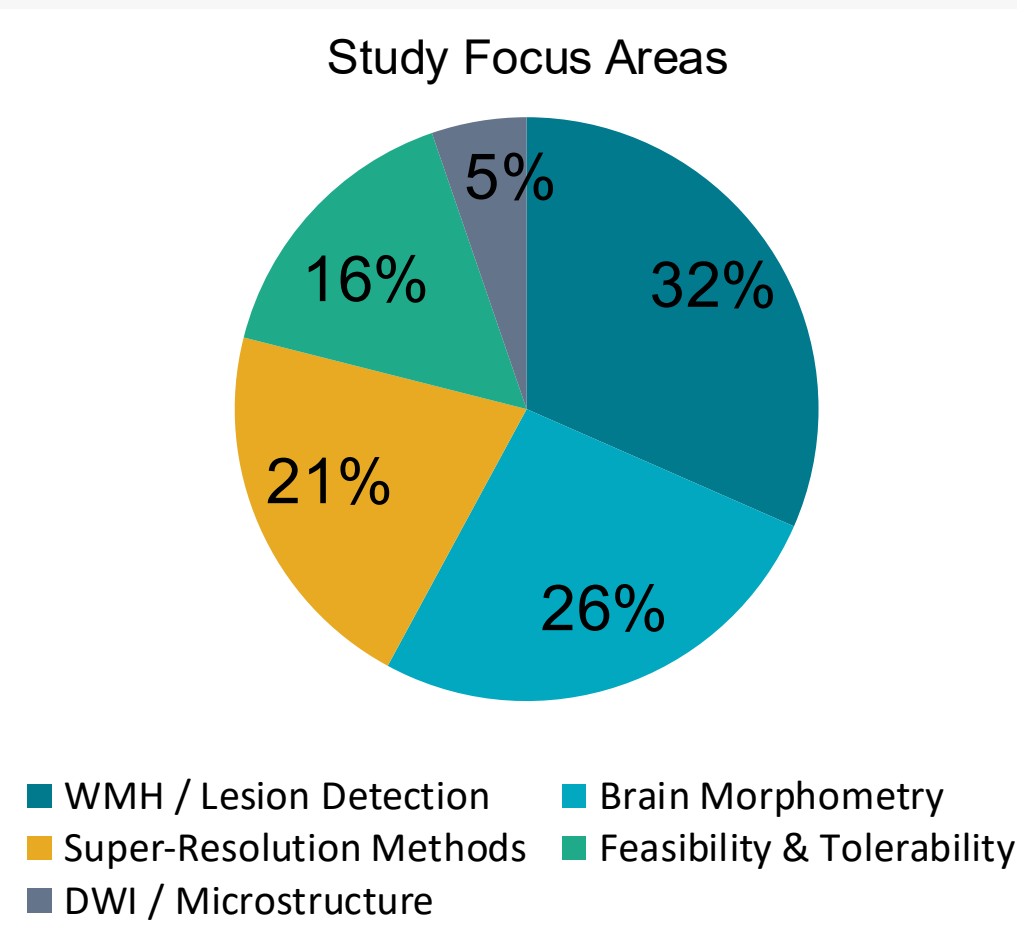
- Hippocampal volume showed strong agreement with 3T across studies: r = 0.85-0.94.
- In people with MCI or AD, ULF-MRI successfully distinguished smaller hippocampal volumes compared to those without memory problems (p<0.001) (Sorby-Adams et al., 2024).
- Results were less consistent for very detailed measures such as cortical thickness; larger brain structures were measured more reliably than smaller ones.
- Strong correlations also seen for thalamus and basal ganglia after super-resolution enhancement.
- Cortical thickness: low correspondence (r = 0.14) with standard protocols; improved with multi-orientation averaging.

Results: White Matter Hyperintensities

- **Volume of WMH agreed strongly** with high-field MRI (r = 0.89-0.93) across hospital, vascular, and AD cohorts (Sorby-Adams et al. 2024); Johnson et al. 2025).
- **Detecting moderate-to-severe WMH:** high agreement between ULF and standard MRI (κ = 0.83 for WMH >10 mL) (Johnson et al. 2025). ULF-MRI tends to slightly underestimate WMH volume by around 6%.
- **Visual rating:** clinicians could identify significant WMH on ULF-MRI in most cases, with moderate agreement between ULF and standard MRI for severe WMH (de Havenon et al. 2023).
- WMH volumes increased in line with clinical severity ratings (Fazekas scale), supporting its validity as a clinical tool (Sorby-Adams et al. 2024).
- Larger WMH are detected reliably; very small patches of white matter damage (<5 mm) can be missed.



Example of scans taken on 0.064T scanner (Hyperfine Swoop)



Take Home Messages

- **ULF-MRI can support expert visual assessment and quantitative measurement** of structural brain changes relevant to dementia.
- **Strong correlations with high-field MRI** for global and hippocampal brain volumes (r = 0.85-0.98) across healthy and clinical populations.
- **White matter hyperintensities** are detectable with good volume-level agreement; small lesions and cortical pathology remain challenging.
- **AI super-resolution methods** (SynthSR, SynthSeg) markedly improve accuracy and are now essential for quantitative analysis.
- **ULF-MRI shows promise** as an accessible neuroimaging approach with potential to reduce diagnostic delays and inequalities in dementia assessment pathways.

AAIC P-0542