

Longitudinal Characterization of Whole-Brain Magnetic Susceptibility in Community-Dwelling Older Adults



Abstract Control **#3786**

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Background

Quantitative susceptibility mapping (QSM) is sensitive to tissue properties related to iron accumulation and myelin content, both of which are implicated in late-life brain aging and neurodegenerative vulnerability. While cross-sectional studies have reported age-related differences in magnetic susceptibility, the longitudinal evolution of whole-brain susceptibility in community-based older adults remains insufficiently characterized.

Methods

Cohort: 255 community-dwelling older adults (764 scans; 2–4 visits/subject; mean inter-scan interval $\approx$ 1.5 yr) from the Rush Memory and Aging Project, Minority Aging Research Study, Religious Orders Study, and Latino/Clinical Core cohorts.

Imaging: 3T multi-echo 3D GRE (0.7×0.7×1.3 mm³; 5 echoes; TE₁ = 4.6 ms; Δ TE = 4.5 ms) and T1-weighted MPRAGE (1 mm³). Susceptibility maps reconstructed with Morphology Enabled Dipole Inversion (MEDI).

Analysis: Whole-brain masks yielded median susceptibility per scan, adjusted for sex and scanner. Scan-level values were plotted against age and connected per subject to form trajectories; a global linear regression was fit across all observations. For distributional analysis, voxel-wise values were pooled by visit and summary metrics (mean, SD, FWHM, entropy, kurtosis, peak amplitude, central AUC -0.05 to 0.05 ppm) were computed across visits.

Demographics	
Total participants	255
Average age at scan (range)	81.26 (64.3-97.8)
Male (%)	85 (33%)
Total visits	764
Average inter-scan interval in years	1.48
Scanners used	Philips Achieva 3.0T Siemens Magnetom 3.0T

(a) Demographics for the longitudinal QSM study, summarizing participants' age range, sex, total number of visits, inter-scan intervals, and scanner platforms.

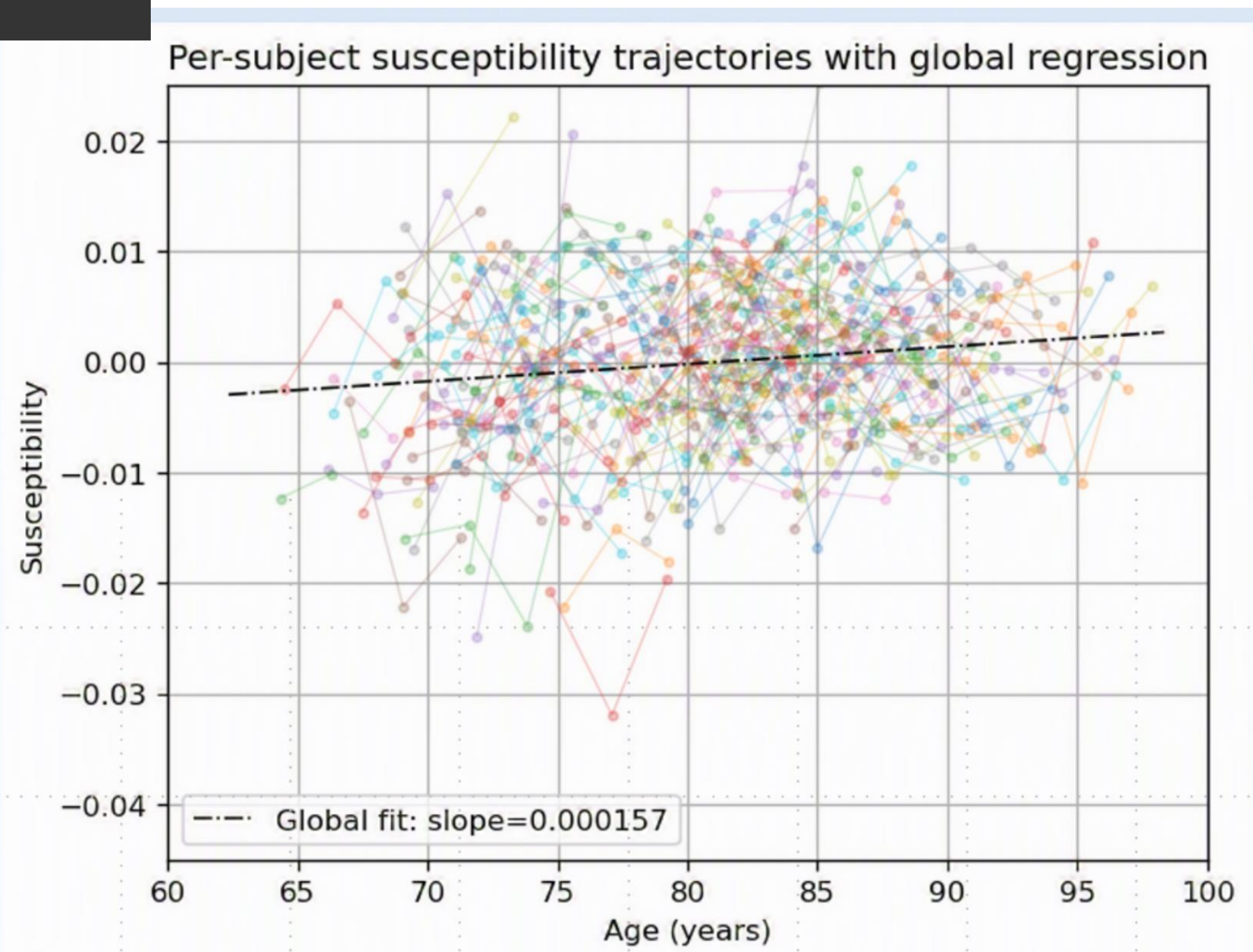
Results

Median whole-brain magnetic susceptibility increased with age at scan (adjusted for sex and scanner); the global regression slope was 0.000157 ($p < 0.05$).

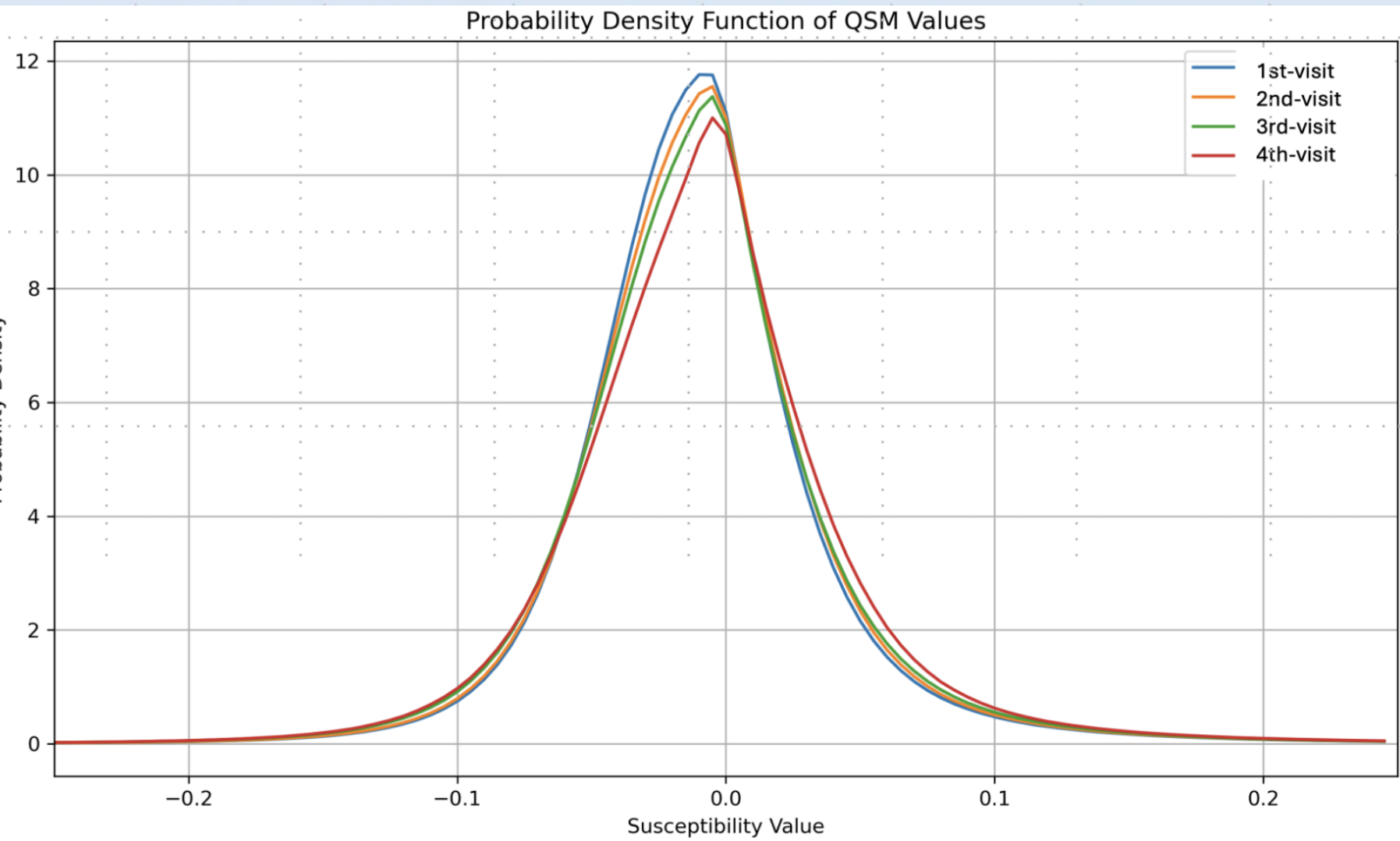
Across visits, voxel-wise distributions showed progressively lower peak amplitude, greater dispersion (higher SD and FWHM), higher entropy, lower kurtosis, and reduced central AUC (-0.05 to 0.05) relative to earlier visits.

Stats/Test	1st visit	2nd visit	3rd visit	4th visit
Number of participants	255	255	206	48
Average interval between prior visit in days	N/A	407	556	554
Whole-brain magnetic susceptibility distribution characteristics				
Mean	-0.0075	-0.0067	-0.0069	-0.0048
Standard deviation	0.0461	0.0472	0.0493	0.0511
FWHM	0.075	0.075	0.075	0.080
Peak value	11.761	11.553	11.375	11.001
Entropy	5.134	5.177	5.244	5.310
Kurtosis	3.686	3.425	3.146	2.765
Peak to Width ratio	156.81	154.04	151.67	137.51
AUC (-0.05 to 0.05)	0.786	0.777	0.759	0.744

(b) Whole-brain magnetic susceptibility distribution characteristics across visits. For each visit, summary metrics—including mean, standard deviation, full width at half maximum (FWHM), peak value, entropy, kurtosis, peak-to-width ratio, and area under the curve (AUC; -0.05 to 0.05)—capture systematic changes in distribution shape over time, reflecting progressive broadening, reduced peak amplitude, and increased dispersion of susceptibility values across the cohort.



(c) Individual longitudinal trajectories of whole-brain magnetic susceptibility as a function of age at scan. Points represent median susceptibility values (adjusted for sex and scanner) for each visit, with lines connecting repeated scans from the same participant. The dotted black line represents global regression over all the points.



(d) Scan-wise distributions of whole-brain magnetic susceptibility for each visit, shown as probability density functions aggregated across all participants. Later visits exhibit broader distributions, reduced peak height, and increased dispersion relative to the first visit, consistent with progressive changes in tissue susceptibility properties over time.

Conclusion

Whole-brain magnetic susceptibility in community-dwelling older adults follows a systematic temporal pattern: a positive age-related slope alongside progressively broader, flatter voxel-wise distributions across visits. Increasing susceptibility with reduced central peak and greater dispersion is consistent with aging-related iron accumulation and/or myelin loss.

To our knowledge, this is among the first longitudinal characterizations of whole-brain susceptibility — and its full distributional shape, not just summary means — in a large community-dwelling cohort followed over multiple visits, suggesting QSM may be a sensitive biomarker for tracking late-life brain aging relevant to neurodegenerative risk.

References and acknowledgements

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