Measuring T2 at ultra high field: effects of age and sex

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Background: T2 is affected by several factors such as tissue density, tissue water content, iron (including blood volume) and myelination [1,2]. The literature suggests that T2 changes with age (in adulthood) but with conflicting trends [2,3]. To our knowledge, there are no reports of significant sex differences in T2 values. To date, all studies have been carried out at < 3.0 T.

Aim: To measure T2 at 7.0 T and determine if there is any effect of age or sex on T2 in healthy adults.

Method: 28 healthy volunteers were recruited (4M/4F age 40-49y, 3F/4F age 50-59y, 4F/4M age 60-69y, 3F/2M age 70-79y). Volunteers were non-smokers, had no history of neurological impairment and passed the Addenbrooke's cognitive test. They were scanned using the GESSE sequence [4] on a 7.0 T Philips MRI scanner with a NOVA SENSE head coil. The sequence parameters were: 0.93 x 0.93 x 3 mm^3 voxel size, TE = 40 ms, TR = 1500 ms, GE spacing (ΔT) = 1.16 ms, number of gradient echoes M = 31, number of slices = 18, total imaging time 9 mins. To obtain values of T2, ROIs were drawn manually using Analyze® software in several white matter (WM) and grey matter (GM) regions and data fitted to eq. (1) using the Powell algorithm [5]. All WM and GM regions were averaged together to test for age and sex effects. Statistical analysis was used to test for changes due to age (linear and quadratic regression) and sex (independent samples t-test) in WM and GM.

$$S(t) = S_0 \exp - \left(\frac{TE + i\Delta T}{T_2} + \frac{|i\Delta T|}{T_2'} \right) \qquad (eq.1)$$

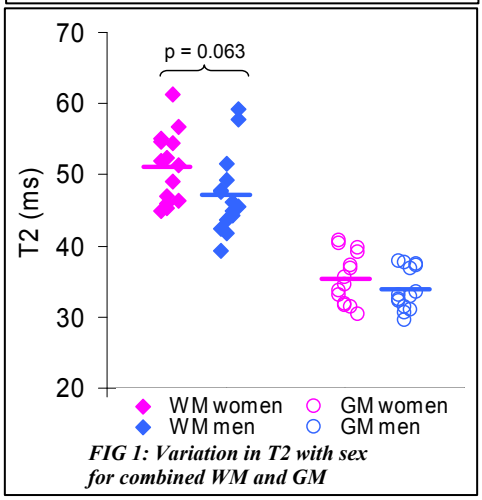
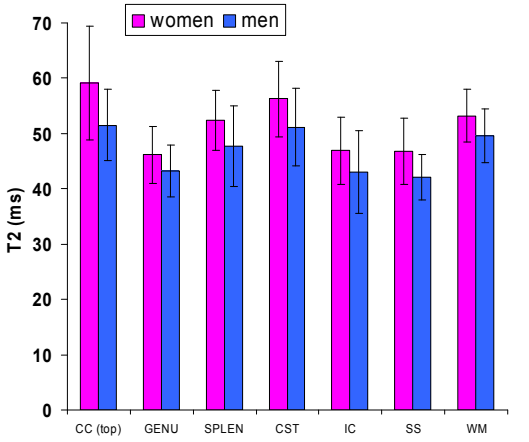


FIG 1: Variation in T2 with sex for combined WM and GM

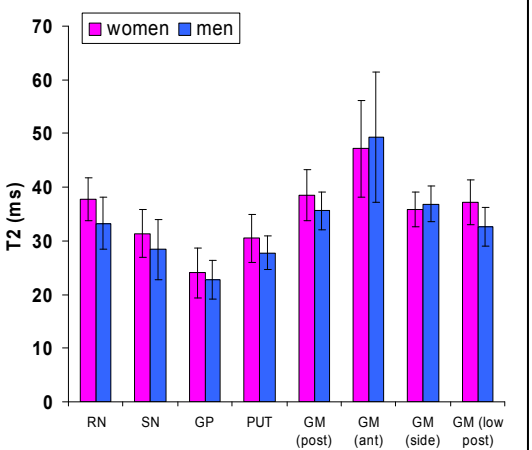
Results: *FIG 1* shows sex differences in T2 measured in GM and WM. There is a trend for women to have longer T2s than men, which is approaching significance for WM (p = 0.063) but is not significantly different for GM (p = 0.211). *FIGS 2* and *3* show how different WM and GM regions contribute to this trend and also show the variation across the regions. *FIG 4* shows individual T2 values in WM plotted against age. There is no significant change with age for WM in women (lin p = 0.476, quad p = 0.75) but there is a significant effect of age in WM in men (lin *p = 0.045, quad *p = 0.043). *FIG 5* shows individual T2 values in GM plotted against age. There was no significant change with age in GM for either men (lin p = 0.743, quad p = 0.264) or women (lin p = 0.944, quad p = 0.364).

FIG 2: Variation in T2 with sex for WM ROIs



KEY: corpus callosum (top, genu and splenium), corticospinal tract, internal capsule, sagittal stratum, cortical white matter

FIG 3: Variation in T2 with sex for GM ROIs



KEY: red nucleus, substantia nigra, globus pallidus, putamen, cortical grey matter (posterior, anterior, side and low posterior)

Conclusion: There is a trend for women to have longer T2s than men in WM; increasing the sample size would be required to confirm the significance of this finding. There is a significant increase in WM T2 with age from 40-75 years in men only.

References: [1] Bartzokis *et al.* MRI. 15:29-35 (1997), [2] Agartz *et al.* Radiology. 181:537-543 (1991), [3] Breger *et al.* Radiology. 181:545-547 (1991), [4] Cox *et al.* Proc. ISMRM 08, p1411 [5] Press *et al.* Num. Rec. in C. 2nd Ed.

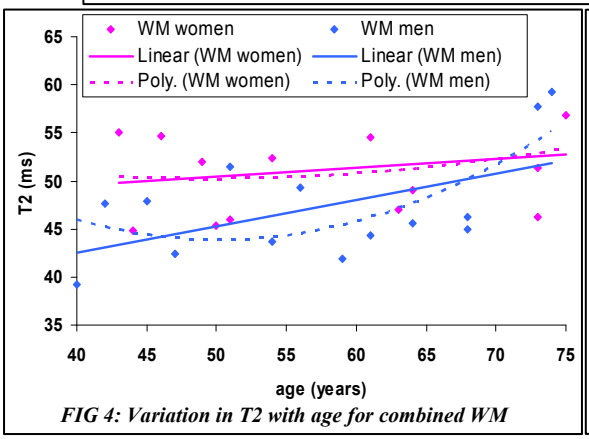


FIG 4: Variation in T2 with age for combined WM

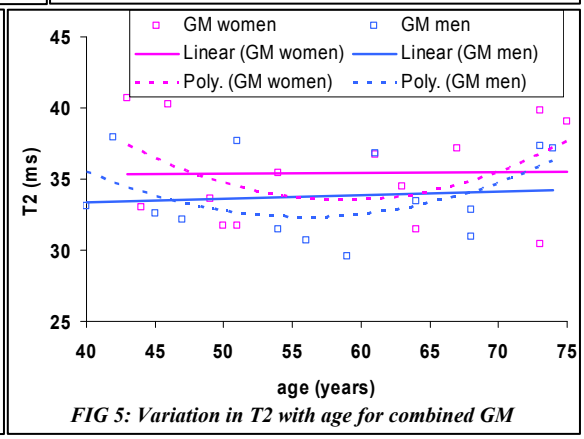


FIG 5: Variation in T2 with age for combined GM