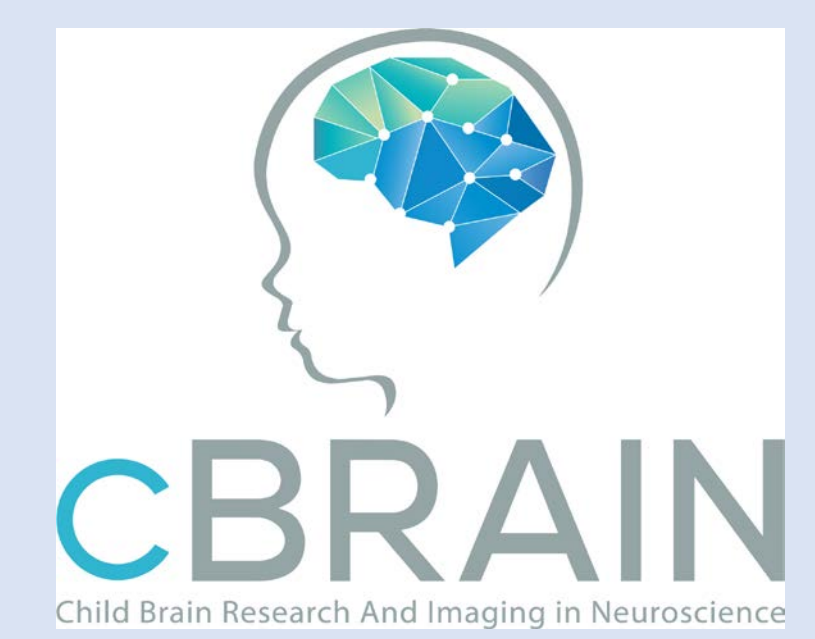


ENIGMA Sports-Related Brain Injury: Framework and Preliminary dMRI Meta-analysis



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Introduction

Athletes participating in contact sports are exposed to repetitive head impacts (RHI). Evidence suggests a link between RHI and impaired cognitive function in adolescents and young adults but the underlying pathomechanism remains to be elucidated. Diffusion MRI (dMRI) is highly sensitive, but imaging study cohorts investigating RHI are generally small and results are mixed. Here, we used the meta-analytic approach of the ENIGMA consortium to analyze the effect of RHI on white matter microstructure across multiple cohorts.

Methods

Sites processed dMRI locally with a harmonized protocol based on TBSS (tract-based spatial statistics) (<http://enigma.usc.edu>). Fractional anisotropy (FA), mean diffusivity (MD), radial diffusivity (RD), and axial diffusivity (AD) were calculated and averaged across the ENIGMA-DTI skeleton, and within each of 5 midline, and 19 bilaterally averaged white matter (WM) regions of interest (ROIs) from the Johns Hopkins University (JHU) atlas. RHI/control effect sizes were calculated within each site. Statistical results were then pooled across sites to conduct a meta-analysis on the individual regression parameters, testing for group differences across the WM ROIs corrected for age and sex as well as for multiple comparisons using Bonferroni correction ($p < 0.05/25 = 0.002$).

Cohorts

Diffusion MRI from college-level athletes (n=54) in American football, soccer, or ice hockey along with controls (n=13) were included.

- Rochester Football (PI Bazarian)
- Munich Soccer (PI Koerte)
- Hockey Concussion Education Project (PI Echlin)
- Sports Concussion (PI Buckley)

If pre- and postseason MRI was available, preseason was included in the meta-analysis.

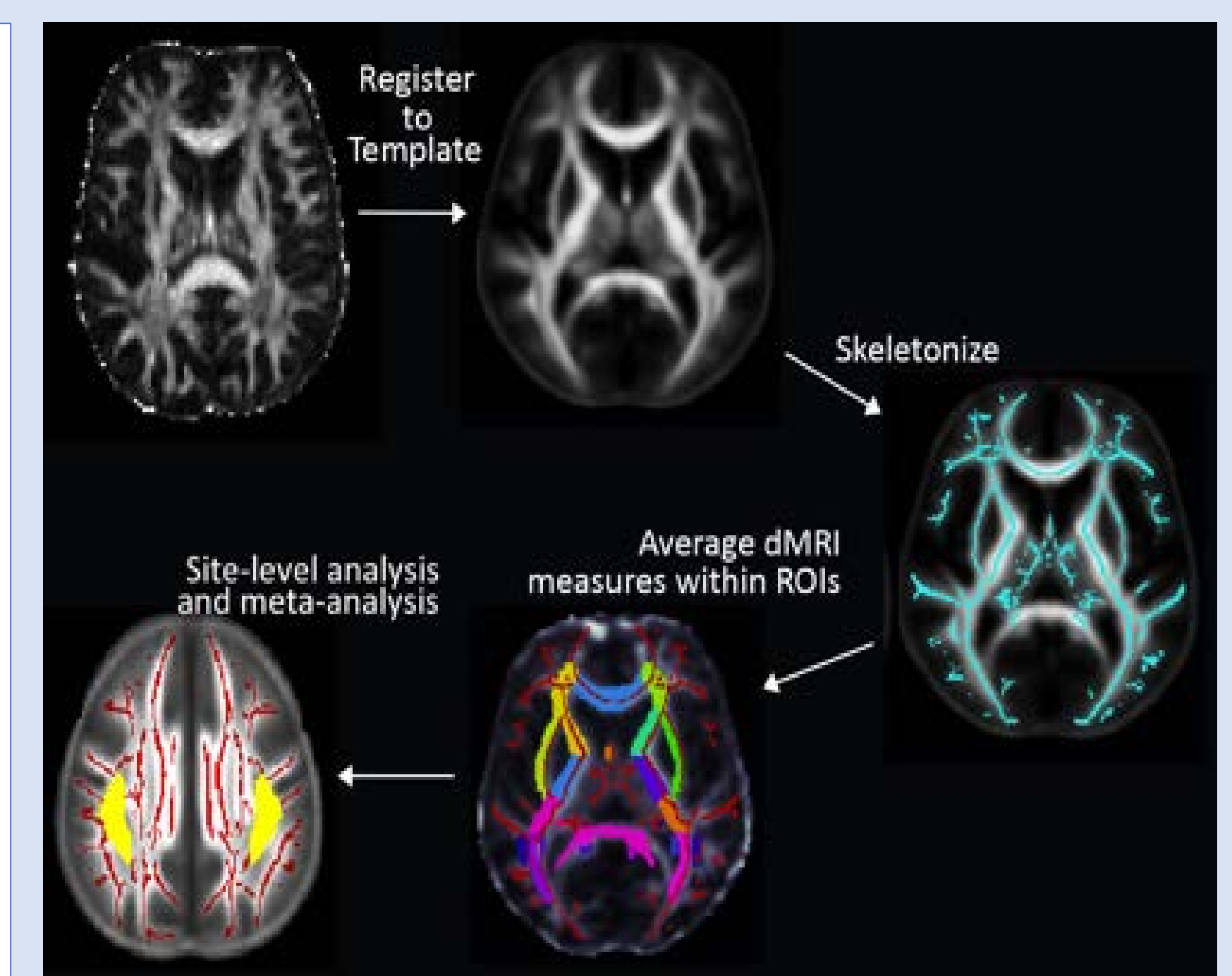


Figure 2. ENIGMA dMRI workflow.

Results

FA:

- significantly lower FA in the RHI group in the superior fronto-occipital fasciculus (Cohen's D=-1.13, $p=0.0009$) and
- borderline lower FA in the uncinate fasciculus

MD:

- borderline higher MD in the posterior thalamic radiation and uncinate fasciculus in the RHI group

RD:

- significantly higher RD in the RHI group in the uncinate fasciculus
- borderline higher RD in the superior fronto-occipital fasciculus

AD:

- significantly higher AD in the RHI group in the corona radiata.

Discussion

This meta-analysis of pre-existing data revealed decreased FA and increased MD across multiple studies based in different countries and including participants from different contact sports with exposure to RHI. Results are in line with previously published reports from single center studies. Decreased FA and increased MD in the white matter suggest, e.g., neurodegenerative and neuroinflammatory processes.

Future Directions

Future work will include a larger sample to further examine the location and extent of WM alterations following RHI and their associations with cognitive function. Further, we will assess the effect of female versus male sex, age, sports played, and amount of exposure to RHI.

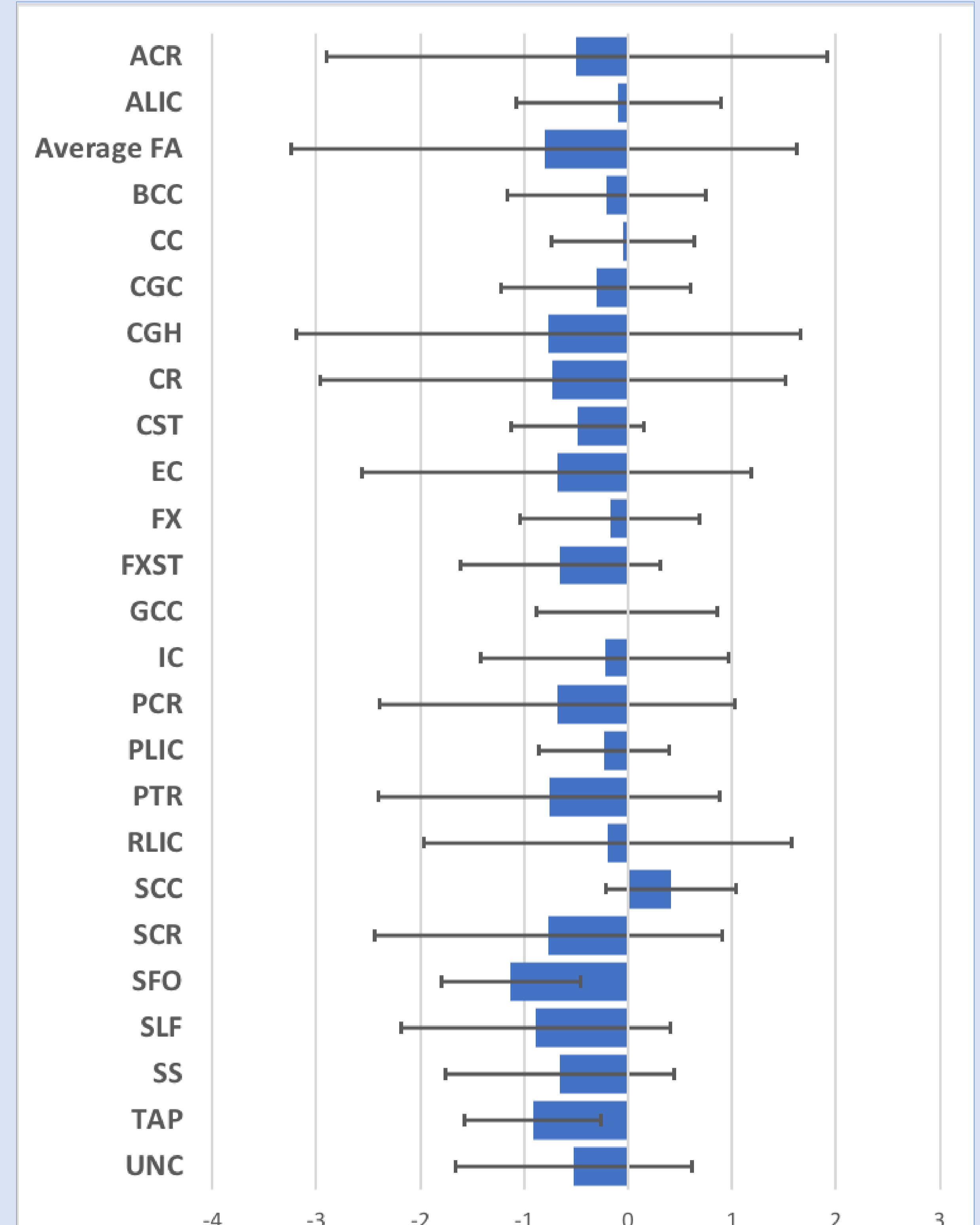


Figure 2. Group differences in the A. acute, B. post-acute, and C. chronic phases. Cohen's D statistics are shown across ROIs, with bars indicating 95% CI. # denotes significant effects ($p < 0.002$) and * denotes borderline effects ($0.002 < p < 0.05$).

Have data?
Want to join our future studies?
Please email: ikoerte@bwh.harvard.edu

Looking for a postdoc position?
Interested in neuroimaging?
Please email: ikoerte@bwh.harvard.edu

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