Brain Structural and Functional Connectivity are Decoupled as a Function of Age in Female Roller Derby Athletes

Monroe DC, DuBois S, Rhea CK, Duffy DM: University of North Carolina at Greensboro, Department of Kinesiology

Context: Brain structure and function change throughout the lifespan and their decoupling may be a sign of unhealthy brain aging. Athletes competing in contact and collision sports are at risk for sustaining mild traumatic brain injuries that may accelerate the onset of cognitive decline later in life. However, most research examining brain structure and function in a sport context has focused on male athletes, even though sex differences are known to exist. Brain structure, function, and their coupling in female athletes relative to non-athlete females has not yet been examined, nor has the influence of age in this context. **Objective**: To compare age-connectivity relationships between Women's Flat Track Roller Derby (RD) athletes and non-athletes (NA). **Design:** Cross-sectional. **Setting**: Brain Imaging Laboratory. **Patients or Other Participants**: RD athletes (n=19) were 24-41 years old (mean = 32.1 years). NA (n=14) were 20-49 years old (mean = 24.6 years). **Main Outcome Measures**: Structural connectivity (SC) was defined by the number of fibers, normalized by fiber length, that connected each pair of brain parcels. Functional connectivity (FC) was defined by the Pearson correlation coefficient (negatives discarded) between the blood oxygen level dependent signal measured in those same brain parcels at rest. A behavior partial least squares correlation was performed to determine whether age was predicted independently by brain SC, FC, and SC-FC coupling and whether that predictive relationship was different between the two groups. 10,000 permutations were performed to test for statistical significance of each latent variable. Stability of the saliences was estimated using a bootstrapping technique (1000 iterations) and correlations are reported with 95% confidence intervals. Brain areas with a bootstrap ratio >|1.96| (a 95% confidence interval) were examined to characterize the brain networks that contributed strongly to these effects. **Results**: One significant latent variable (p<.001) revealed that age was predicted by lower SC (r =.21[-.66,-.02]) and greater FC (r =.42[.12,.95]) and SC-FC coupling (r =.88[.83,.98]) in NA. That same latent variable revealed that, in RD athletes, age was predicted by greater FC (r =.66[.64,.87]), but was not predicted by SC (r =.26 [-.10,.63]) and was predicted by lower SC-FC coupling (r =-.25[-.65,-.02]). Areas in the frontoparietal, default, and primary and secondary visual networks contributed the most to this effect. **Conclusions**: Most studies show a linear relationship between age and SC-FC coupling. We report that this trajectory was reversed in RD athletes, apparently due to a decline in brain white matter structure with age relative to NA. Frontoparietal and default networks, which were the strongest contributors to this relationship, are known to exhibit early signs of neurodegeneration even in the absence of clinical symptoms. This warrants a more extensive evaluation of post-collegiate female athletes competing in contact and collision sports.