High school football athletes with a history of concussion have relatively vulnerable and faster aging resting state brain network than those without

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Purpose: A recent study[1] demonstrated that asymptomatic high school football athletes exhibit significant differences in resting state connectivity compared to the non-contact controls as a long-term effect of sub-concussive brain injury. An independent study[2] has shown that sub-concussive injury has a differential short-term effect on rugby athletes with and without history of concussion. In this study, graph-theoretical analysis was used to characterize long-term effects of sub-concussive injury on the resting state network (RSN) of asymptomatic high-school football athletes with and without history of concussion. Knowledge of the differential effect of history of concussion could help trainers and athletes avoid long-term effects associated with mTBI and sub-concussive injury.

Methods: Eighteen male football athletes from local high schools, aged 14-18, participated in this study on voluntary basis, outside of their competition season. Of these 18 athletes, nine participants had no history of concussion (NoHoC), while the other nine participants (HoC) reported exactly one diagnosed concussion at the time of enrollment. All HoC athletes had been cleared for contact participation by the team physician or athletic trainer prior to participation in this study. All athletes participated in one imaging session during which a 5min30sec resting state fMRI (rs-fMRI) scan (TR = 1.5s) was acquired along with a high resolution structural scan[1]. Correlation matrices were computed at the individual level by correlating the average time series from each of 116 AAL ROIs[3] with every other ROI. These matrices were used to create a resting state network (RSN) and compute group differences in transitivity, global efficiency and assortativity network measures across a wide range of network densities[4]. These measures quantify a network's segregation, integration and resilience respectively. Confidence intervals for each network measure were calculated using a non-parametric permutation test with 20000 repetitions. The minimum network density at which no individual network is fragmented (D_{min}) was identified for both groups.

Results: D_{min} values for groups HoC and NoHoC were 0.34 and 0.31 respectively. Fig. 1 shows that HoC exhibited significantly lower values of transitivity and assortativity, and border-line significantly higher values of global efficiency, relative to NoHoC.

Discussion: First, lower values of transitivity indicate a less segregated RSN for those athletes with a history of concussion (HoC) than for those without (NoHoC). Reduced segregation is expected with aging over the healthy adult life span[5]. Second, HoC athletes exhibited significantly lower values of assortativity than NoHoC athletes, suggesting that their high degree hubs are relatively widely distributed and thus likely more vulnerable.

Conclusion: High school football athletes with a history of concussion (HoC) display characteristics of an older brain than those exhibited by athletes who did not have a history of concussion (NoHoC). Such athletes are likely to be more vulnerable to external injuries that could affect highly connected regions of their brain, and thus need more careful monitoring.

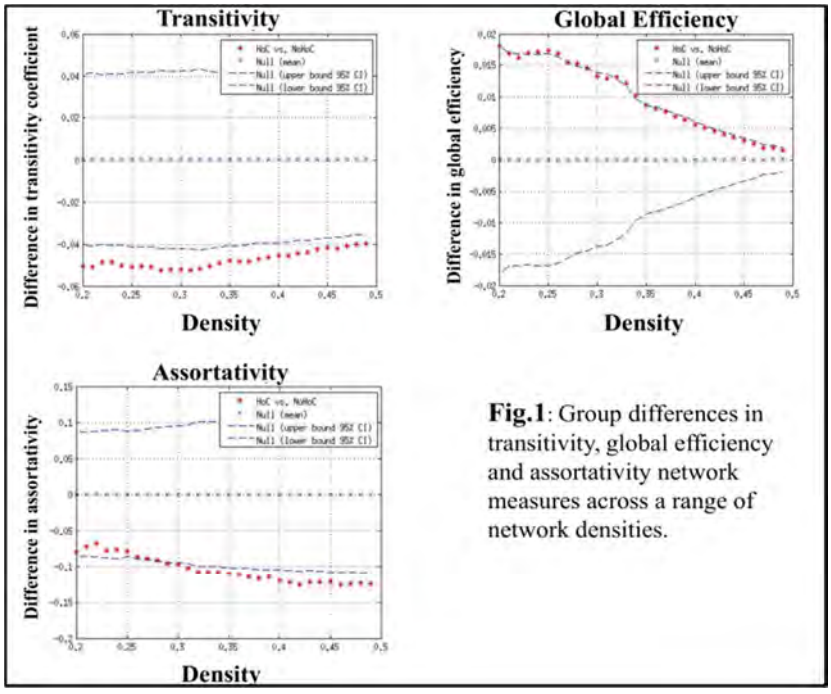

Fig.1: Group differences in transitivity, global efficiency and assortativity network measures across a range of network densities.

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