Engaging in contact sports has a profound impact on brain health in athletes, even when those athletes do not experience concussions. It has been found that not only concussions but also subconcussive blows can lead to chronic traumatic encephalopathy, or CTE [1,2]. Further, after the end of the season, athlete performance on neurocognitive testing does not necessarily return to baseline levels. In our previous studies, it has been presented that high school football players who experienced repetitive subconcussive head trauma may show changes in their neurometabolism during a verbal working memory task [3]. This work seeks to explore the effects of the history of hits and recovery time on brain health in high school contact sport athletes.

Participants:
35 members from two local high school football teams (aged 14-18), and 12 non-contact sport athletes, also of high school age (aged 14-18).

Collision Monitoring:
Football players participated without intervention in their regular season wearing the Head Impact Telemetry System (HITS; Simbex; New Lebanon, NH) in their helmets. The system used 6 linear accelerometers to estimate the magnitude and location of blows to the head.

Data acquisition:
Two to nine months after the end of the season (mean=148, std: 47 days), each player participated in an fMRI session (gradient-echo epi TR=1.5s; TE=26ms; flip angle=35; 3.8mm isotropic; 34 slices; FOV=24cm). During the fMRI session, players completed verbal and visual working memory tasks.

Data Processing:
fMRI data were processed using AFNI to obtain a statistical map in standard Talairach brain space for each football player and control. Each player was compared to the group mean of the non-contact sport athletes using a Pearson’s correlation over the volume of the brain, resulting in a single value for each task representing how well their brain activation matched their healthy peers. For both tasks, the spatial correlations were compared to post-season recovery time and in-season hit count. (Figures 3 and 4). Statistical analysis included computing the correlations between a participant’s spatial correlation and post-season recovery time, as well as number of hits. All statistical analyses were performed using MATLAB software (Mathworks; Natick, MA). P-values < 0.05 were considered significant. (Table 1)

Among the 35 participants, the lower bound of the spatial correlation exhibited an increasing trend over time for both verbal and visual tasks, with the last of the football players reaching the 95% confidence interval for the controls approximately 210 days after end-of-season. Correlation between the players’ fMRI results and time of recovery prior to the scan was not significant, nor was the correlation between the players’ post-season fMRI results and in-season experienced number of hits.

Conclusions
Even months after the contact season end, sequelae of repetitive head trauma are still observed by fMRI in some members of a cohort of high school football players, although these effects were not predicted by accumulated head trauma events or post-season recovery time. As a cohort, however, the lower bound of fMRI activation relative to a “healthy” population increased over time, with time-to-recovery for the group being approximately 7 months. Further longitudinal study of individual players may be informative as to the relation between accumulated trauma and recovery time.

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References