

# MRI-based Post-Concussive Syndrome (PCS) Index: No Differences Between Athletes and Non-Athletes

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## Purpose

To evaluate for differences in patients with post-concussive syndrome from sports-related versus non-sports related mTBI, using a machine-learning algorithm of MRI data.

## Methods

For this retrospective study, we explored the MRI records of 28 Athletes (17M, 11F) and 16 non-Athletes (6M, 10F) with a history of concussion and clinical PCS, and 73 non-concussed reference controls (26M,47F). All subjects were between 19- and 35-years in age. The MRI studies were done in a clinical 3T MRI scanner. MPRAGE, DTI-FA and DTI-ADC images were used to extract radiomics features from automatically segmented MRI structures of the brain (Figure 1). After that, the radiomic features were processed to extract the MRI-PCS Index (Qmetrics Technologies, Rochester, NY). MRI-PCS Index is an Artificial-Intelligence (AI) derived holistic evaluation of brain health that ranges from 0.0 to 1.0. The index indicates the degree of signal/structural abnormalities found in the brain tissue of a concussed subject when compared to a non-concussed subject; hence it provides an objective measurement of PCS. Figure 2 shows the distribution of the MRI-PCS index across ages groups.

## Results

The sports played by the athletes were mainly football, hockey, lacrosse, and soccer while non-athletes were mainly concussed in motor vehicle accidents. Athletes' MRI-PCS Index was similar to non-athletes (0.78 vs 0.78,  $p=0.89$ ) and both indexes were very different to the reference control (MRI-PCS Index= 0.23, IQR=0.10-0.38,  $p<0.001$ ) as seen in Table 1 and Figure 3.

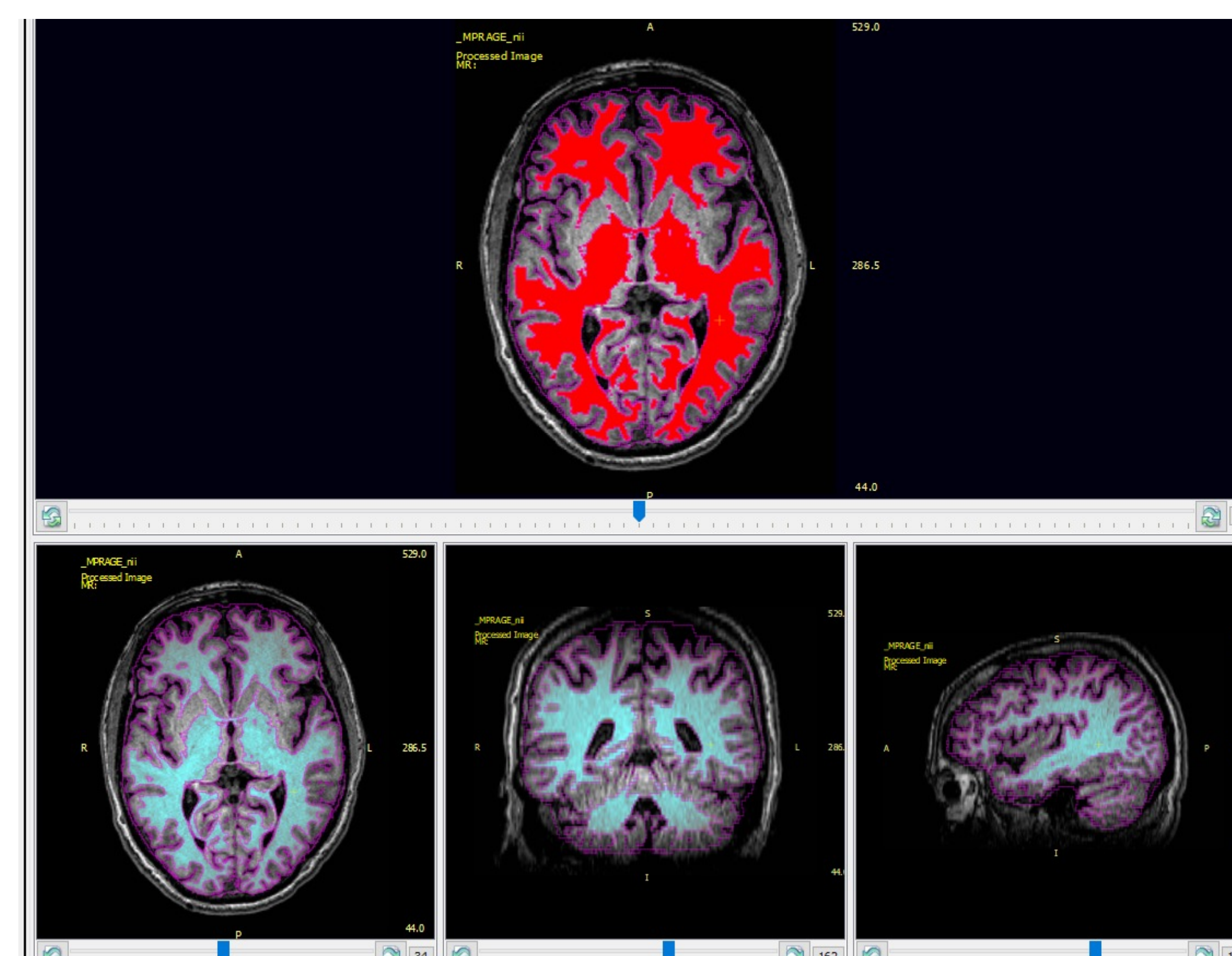


Figure 1. Standard MRI exams consisting of MPRAGE and diffusion (ADC, FA) images were automatically segmented into gray and white matter regions.

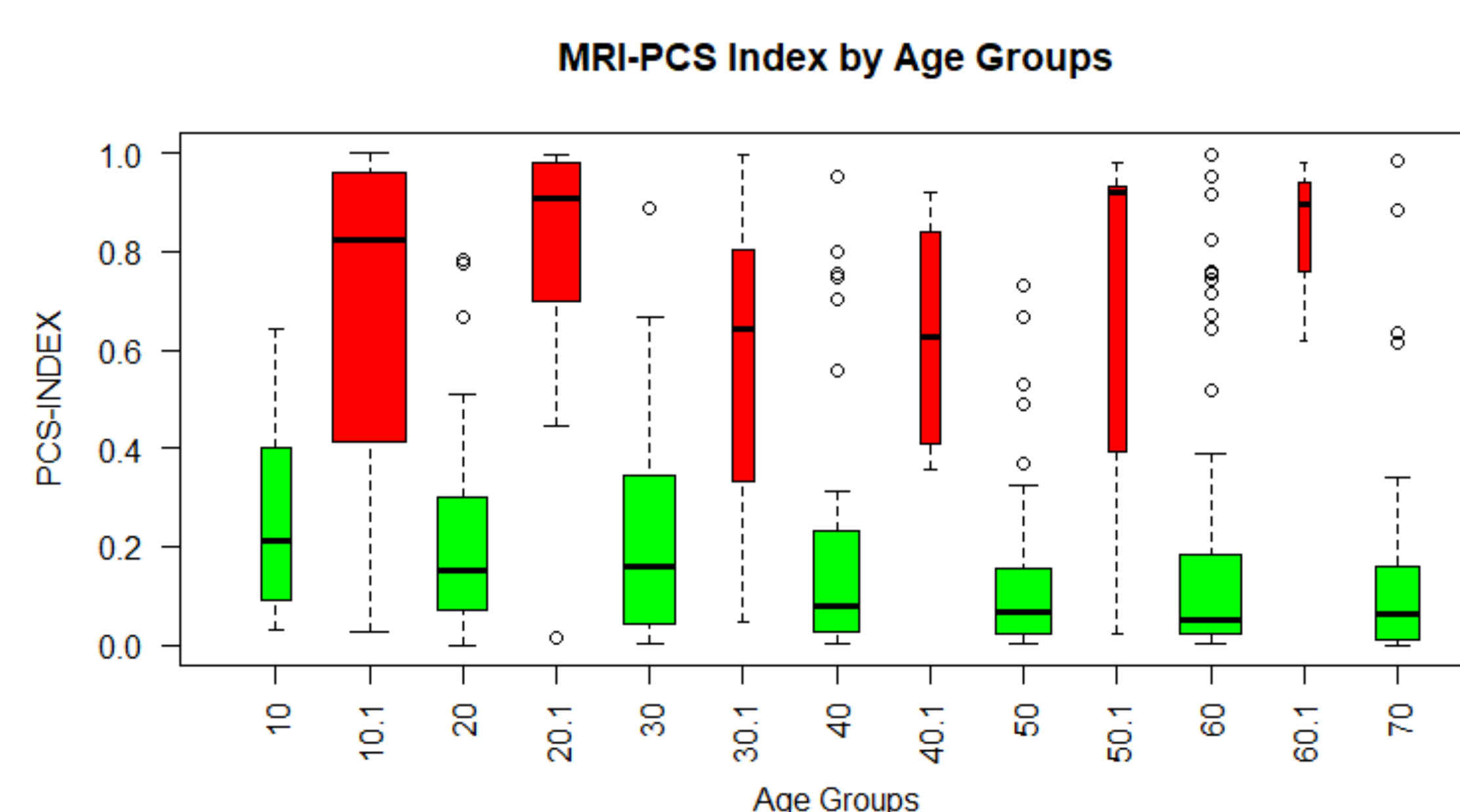


Figure 2. Distribution of the MRI-PCS index across age groups in cases and controls.

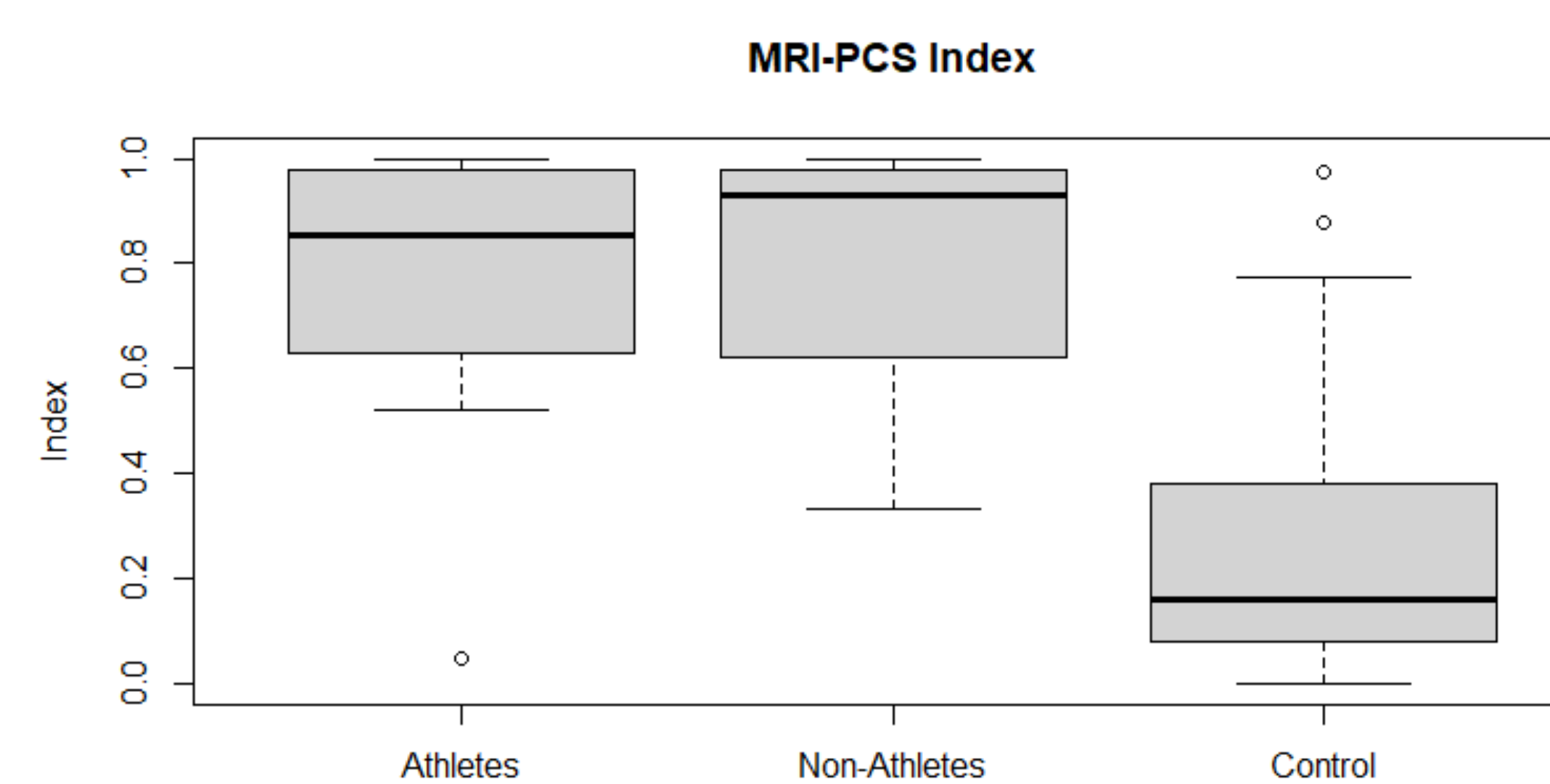


Figure 3. Box Plots of the distribution of the MRI-PCS Index in Athletes, Non-Athletes and Controls..

Table 1. The Mean MRI-based Post-Concussive Index, or Concussion Index (CI), for subjects injured playing sports was statistically similar to the CI for subjects injured in non-sports related activities. The mean CI for a comparative group of uninjured control subjects was significantly different than the mean CI of both injured cohorts.

Sports Concussions	Non-Sports mTBI	Uninjured Controls
N=28 (17M, 11F)	N=16 (6M, 10F)	n=73 (26M,47F)
Football, hockey, lacrosse, soccer	Mostly MVA	No clinical history of mTBI
Mean CI=0.78	Mean CI=0.78	Mean CI=0.23 (IQR=0.10-0.38 $p<0.001$ )

## Conclusions

The MRI-PCS Index, an objective measurement of structural brain health, indicated that subjects that suffer from PCS present similar MRI abnormality burden regardless of whether the mTBI was related to sports injuries or other trauma.