Perivascular Space Burden in Combat Crewmen

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Introduction

Combat crewmen perform high-risk operations and training involving vessels traveling up to 40 knots through a variety of sea states. [1] Concerns regarding brain health risks have emerged in this population due to long-duration exposures to repetitive wave impacts and vibration. There is a need to characterize the unique brain health risk posed by high-speed boat operations. The glymphatic system is a brain waste clearance pathway that functions primarily during sleep, and glymphatic dysfunction may link brain trauma to poor long-term neurological outcomes.[2]

In this study combat crewmen were compared to a special operations sample that sustained similar blast and blunt neurotrauma but was less frequently exposed to high-speed boats. The purpose of this study was to compare the perivascular space (PVS) burden, an indirect biomarker of glymphatic function, between combat crewman and special operators while controlling for sleep quality and age.

Methods

A prospective analysis was conducted on data collected from combat crewman (n = 85) and special operators (n = 429). Participants were categorized based on their self-reported military occupational specialty (MOS) and were enrolled in a larger research study at the National Intrepid Center of Excellence (NICoE) between 2017 and 2024. All participants underwent MRI on a 3T scanner. T1- and T2-weighted images were preprocessed using the Human Connectome Project structural preprocessing pipeline. [3] PVS segmentation was performed using the Mapping Vascular and Perivascular spaces (MVP) toolset to quantify the burden of PVS.[4] PVS volume fraction was quantified as the ratio of white matter (WM) PVS volume to the total WM volume.

A multivariable linear regression model was used to assess how MOS, age, Pittsburgh Sleep Quality Index (PSQI) total score relate to WM PVS volume fraction.

Results

WM PVS volume fraction was modeled as a function of MOS group, age, and sleep quality. The age x PSQI interaction term was initially included but was found to be non-significant (p = .841) and was removed from the final model.

The main-effects model was statistically significant, $F(3, 510) = 6.72$, $p < 0.001$, though it explained only a small proportion of variance (R^2 = .038, *adjusted* R^2 = 0.032). **Age was a significant positive predictor** (B = .013, SE = 0.003, $t(510) = 4.30$, $p < .001$) 95% CI[0.007, 0.018]), indicating that each additional year of age was associated with a 0.013-unit increase in WM PVS volume fraction while holding other variables constant. In contrast, **neither MOS group nor PSQI total score were significant predictors.**

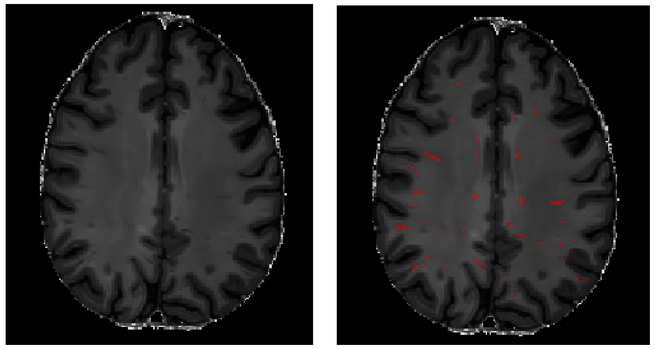

Figure 1. Enhanced Perivascular Contrast image (left) with segmented WM PVS burden mask (right)

Demographics	All	Special Operators	Combat Crewmen	*p*-value
N	514	429	85	
Mean Age (Years)	40.20±5.88	40.21±5.90	40.18±5.82	.869
Mean Time in Service (Years)	18.74±6.33	18.64±6.20	18.74±6.33	.170
PSQI Total Score	11.67±3.75	11.59±3.76	11.67±3.75	.254
PVS Volume Fraction	0.53±0.39	0.54±0.41	0.53±0.39	.356

Note. *p*-values derived from two sample t-tests

Table 1. Demographics and self-report

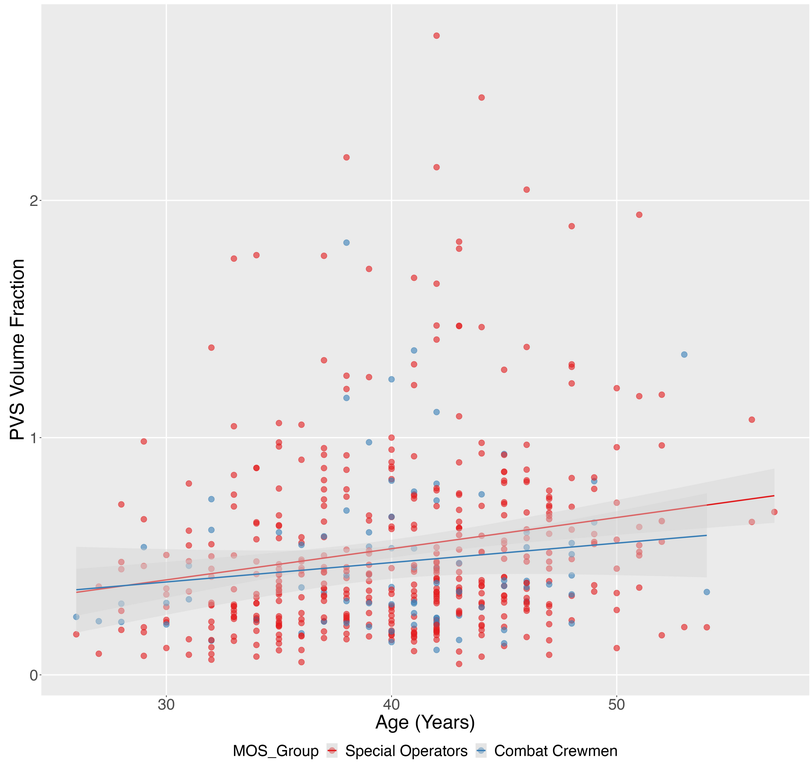

Figure 2. PVS Volume Fraction by Age and MOS Group

Conclusions

No significant differences in PVS burden were observed between combat crewmen and special operators. **Age, however, was significantly associated with greater PVS burden, consistent with age-related declines in glymphatic clearance efficiency.** Because both groups sustain more frequent neurotrauma than conventional forces, **glymphatic-related risk may be broadly comparable across these high-exposure occupations. Notably, a true low-exposure comparison group may also be needed** to assess brain health risks among high-exposure military occupations.

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily reflect the official policy of the Defense Health Agency, Department of War, or the U.S. Government.

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