

Francisco Veterans Affairs Health Care System, University of California, San Francisco, CA, USA. <sup>5</sup>Boston University School of Public Health, Department of Biostatistics, Boston, MA, USA

**Objective:** Gulf War Illness (GWI) is a debilitating multi-symptom condition that affects nearly a third of 1990-91 Gulf War (GW) veterans. Symptoms include chronic pain, debilitating fatigue, gastrointestinal issues, and cognitive decrements. Prior studies have documented reduced cognitive functioning in this affected population, particularly in the areas of memory, attention and response inhibition. To date, research has focused on cognitive functioning in male and female veterans together. Very limited research has reported on GW women's cognitive functioning separately mostly due to scarcity of data on women veterans. In this study, we had the unique opportunity to utilize a newly combined neuropsychological test dataset from women GW veterans in the Boston, Biorepository and Integrative Network (BBRAIN) for GWI. The aim was to compare neuropsychological outcomes with toxicant exposures in women veterans with and without GWI.

**Participants and Methods:** Cognitive data from the BBRAIN biorepository was used for this study. The sample consisted of 62 women veterans who were deployed to the Persian Gulf War from 1990-91. Neuropsychological test scores included the Conners Continuous Performance Test Third Edition (CPT3), Delis-Kaplan Executive Function System (D-KEFS) Color-Word Interference, and the California Verbal Learning Test Second Edition (CVLT-II). War-related exposure to chemical weapons, anti-nerve gas pills and pesticides were measured by a self-reported survey. For analysis, war-related exposure was classified into three groups: controls with 0-6 days of exposure; cases with 0-6 days of exposure and cases with 7 or more days of exposure. Multiple linear regression modeling was used to measure differences in neuropsychological scores across the three groups by each war-related exposure.

**Results:** After adjusting for age, education and other exposures, an increase in duration of exposure to pesticides was significantly associated with worse CPT3 commission errors, fewer words correct in the CVLT-II trials 1-5, and an increase in self-corrected errors on DKEFS Color-Word Interference Test Trials 1, 2 and 4

( $p < 0.05$ ). More days reported hearing chemical alarms and seeing smoke from oil well fires was significantly associated with fewer words correct on all CVLT-II trials, and more self-corrected errors on Color-Word Interference Trials 2 and 4 ( $p < 0.05$ ). An increase in exposure duration to pyridostigmine bromide anti-nerve gas pills was associated with fewer words correct on the CVLT-II learning Trials 1-5 and short delay recall and an increase in self-corrected errors on Color-Word Interference Trials 2, 3, and 4 ( $p < 0.05$ ). When associations were adjusted for PTSD, all significant associations stayed constant ( $p < 0.05$ ).

**Conclusions:** In this study, women veterans with GWI who had higher levels of exposure to pesticides, oil well fires and who took more anti-nerve gas pills during the war are showing increased learning difficulties and more deficits in attention and response inhibition. Future research should examine if similar patterns of neuropsychological symptoms are also present in male GW veterans with higher war-time related toxicant exposures.

**Categories:** Drug/Toxin-Related Disorders (including Alcohol)

**Keyword 1:** cognitive functioning

**Keyword 2:** neurotoxicity

**Correspondence:** Dylan Keating Boston University, School of Public Health, Department of Environmental Health [dmk13@bu.edu](mailto:dmk13@bu.edu)

## 22 Neuropsychological Outcomes Vary by Sex in Neurotoxicant Exposed Veterans with Gulf War Illness

Dylan Keating<sup>1</sup>, Jenna Groh<sup>2</sup>, Maxine Krengel<sup>2</sup>, Rosemary Toomey<sup>3</sup>, Linda Chao<sup>4</sup>, Emily Quinn<sup>5</sup>, Julianne Dugas<sup>5</sup>, Kimberly Sullivan<sup>1</sup>

<sup>1</sup>Boston University School of Public Health, Department of Environmental Health, Boston, MA, USA. <sup>2</sup>Boston University School of Medicine, Department of Neurology, Boston, MA, USA. <sup>3</sup>Department of Psychological and Brain Sciences, College of Arts and Sciences, Boston University, Boston, MA, USA. <sup>4</sup>San Francisco Veterans Affairs Health Care System, University of California, San Francisco, CA, USA. <sup>5</sup>Boston University School of Public Health, Department of Biostatistics, Boston, MA, USA

**Objective:** More than 30 years after the 1990-91 Gulf War (GW), approximately 200,000 veterans are still suffering from Gulf War Illness (GWI). Veterans who have this multi-symptom disorder experience impaired cognition, chronic pain, sustained fatigue, and gastrointestinal issues. GWI is believed to be associated with neurotoxicant exposures during the war. Prior research has shown cognitive deficits in combined samples of male and female GW veterans with GWI. These studies have shown that veterans with GWI have cognitive decrements in memory, learning and sustained attention. Studies have yet to compare neuropsychological outcomes by sex. This is mainly due to the lack of collected data on women GW veterans in the past. This study aims to analyze neuropsychological differences in males compared with female veterans with GWI and in those with neurotoxicant exposures from the Boston, Biorepository and Integrative Network (BBRAIN) for GWI repository dataset.

**Participants and Methods:** The total sample included 297 veterans with GWI (women  $n=50$ , men  $n=247$ ) who were deployed to the 1990-91 Gulf War with an average age of 52 years. GWI case status was defined by the Kansas GWI criteria. Neuropsychological data including the Conners Continuous Performance Test Third Edition (CPT3), Delis-Kaplan Executive Function System (D-KEFS) Color-Word Interference Test, and the California Verbal Learning Test (CVLT-II) were combined from the BBRAIN repository datasets. War-related exposures, including chemical weapons, anti-nerve gas pills and pesticides were measured by a self-reported survey. Multiple linear regression was used to analyze the association between sex, war-related exposures, and neuropsychological test score outcomes.

**Results:** After adjusting for age, education level and PTSD, men had a significantly lower number of words correct in the CVLT-II learning Trials 1-5, short delay recall and long delay recall compared with women veterans ( $p<0.05$ ). The two groups also differed significantly in CPT3 commission scores, and total time on the D-KEFs Color-Word Inference total times in Trials 1 and 2 with men performing worse ( $p<0.05$ ). Reported exposure to chemical weapons, pesticides, pyridostigmine bromide (PB) anti-nerve gas pills or smoke from oil well fires were all significantly associated with fewer words correctly recalled on all learning trials of the CVLT-II, long delay, and short delay to a greater degree in men as compared to women

( $p<0.05$ ). Reported exposure to chemical weapons or smoke from oil well fires were significantly associated with more commission errors on CPT3 in men with GWI ( $p<0.05$ ). Chemical alarms, smoke from oil well fires and PB were associated with slower response time on the Color-Word Interference test Trial 1 in men compared with women veterans.

**Conclusions:** In this study, men with GWI demonstrated significantly poorer performance in verbal memory, learning, response speed and attention. Male veterans reporting neurotoxicant exposures during the war also showed worse learning and verbal memory, impulsivity and response speed decrements compared to exposed women veterans. Future research should consider men and women separately when examining outcomes from war-related exposures.

**Categories:** Drug/Toxin-Related Disorders (including Alcohol)

**Keyword 1:** neurotoxicity

**Keyword 2:** cognitive functioning

**Correspondence:** Dylan Keating Boston University, School of Public Health, Department of Environmental Health [dmk13@bu.edu](mailto:dmk13@bu.edu)

### 23 The Impact of Parental History of Substance Use on Preadolescent Rewarding Processing in the ABCD Study

Gabriella Y Navarro, Elizabeth Ashley Stinson, Ryan Sullivan, Krista Lisdahl  
University of Wisconsin Milwaukee, Milwaukee, WI, USA

**Objective:** Parental history (PH) of problematic substance use has been identified as a risk factor for adolescent substance use, which can lead to increased use in adulthood. Researchers hypothesize that individuals with PH exhibit premorbid differences in their reward processing, increasing their likelihood of engaging in reward-driven behavior. Studies have shown that preadolescents with PH have greater activation in their putamen and nucleus accumbens (NA); however, most research has only investigated PH of alcohol use (PHA), not PH of drug use (PHD). Additionally, limited research has assessed whether reward processing develops differently among youth