

Award Number: W81XWH-11-2-0223

TITLE: Biomarkers for PTSD in Female Iraq and Afghanistan Veterans

PRINCIPAL INVESTIGATOR: Charles R. Marmar, M.D.

CONTRACTING ORGANIZATION:
New York University School of Medicine
New York, NY 10016

REPORT DATE: October 2015

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT:

√ Approved for public release; distribution unlimited

The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Service, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.					
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) October 2015		2. REPORT TYPE Annual		3. DATES COVERED (From - To) 23Sep2014 - 22Sep2015	
4. TITLE AND SUBTITLE Biomarkers for PTSD in female Iraq and Afghanistan Veterans				5a. CONTRACT NUMBER W81XWH-11-2-0223	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Charles R. Marmar, M.D. email: Charles.Marmar@nyumc.org				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) New York University School of Medicine 550 First Avenue New York, NY 10016				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Medical Research and Materiel Command Fort Detrick, Maryland 21702-5012				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSORING/MONITORING AGENCY REPORT NUMBER	
12. DISTRIBUTION AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT Approximately 10%-20% of individuals serving in Iraq and Afghanistan have Posttraumatic Stress Disorder (PTSD). Women serving in the military have been shown to be twice as likely to develop PTSD in their lifetime compared to men.1-3 Studies aimed at identifying vulnerability factors for women serving in the current operations (OEF/OIF) are of significant public health concern as the US has witnessed a significant increase of women in the US military in the past decade, among who now comprise the largest cohort of female veterans (11.4%). Relatively little is known about gender differences among women deployed to OEF/OIF4. In order to address this critical gap we will examine 40 OIF/OEF female PTSD positive cases and 40 OEF/OIF female PTSD negative control subjects through an extensive biological protocol as a supplement to the DOD funded comprehensive Biomarkers for PTSD study.					
15. SUBJECT TERMS Nothing listed					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 13	19a. NAME OF RESPONSIBLE PERSON USAMRMC
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (Include area code)

Table of Contents

	<u>Page</u>
Introduction.....	4
Body.....	5
Key Research Accomplishments.....	10
Reportable Outcomes.....	10
Conclusion.....	11
References.....	12

INTRODUCTION:

There is a growing body of research that reports high rates of PTSD in those who have served in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (Afghanistan; OEF), with estimates varying from 10% to 20%¹. An important limitation is the reliance on self-report screening measures and clinical interviews to make the diagnosis of PTSD. In sharp distinction with medical disorders such as cancer, coronary artery disease and diabetes for which there are objective biomarkers for diagnosis, illness severity, and response to treatment, the assessment of PTSD cannot be independently confirmed by biological markers.

Among one of the most pressing challenges the US will face from current combat operations in Iraq and Afghanistan will be the mental health burdens placed on women serving in these operations, and in particular the negative impact of PTSD. Studies consistently find that although men are at greater risk for exposure to potentially traumatic events, women are twice as likely to develop PTSD in their lifetime ([10.4 vs. 5.0%]²⁻⁶ including military samples.⁷⁻⁹

Studies aimed at identifying vulnerability factors for women serving in the current operations (OEF/OIF) are of significant public health concern as the US has witnessed a significant increase of women in the US military in the past decade, accounting for 15% of active duty and 17% of National Guard and Reserve personnel, among whom now comprise the largest cohort of female veterans (11.4%). In contrast to previous operations, women deployed to OEF/OIF appear to be at greater risk for trauma exposure as they are now being deployed for longer periods of time in settings in which the front-lines are more ambiguous¹⁰⁻¹¹.

It has been suggested that biological mechanisms may explain the observed gender differences in PTSD¹²⁻¹⁵. Discovering biomarkers for PTSD in women would aid, not only in more accurate diagnoses, but in elucidating biological pathways that increase the risk for PTSD and enable more targeted forms of treatment. The identification of a biomarker for PTSD in women would also aid in staging the course of the illness, including identifying pre-morbid biological dysregulation, which might enable earlier treatment. If the biomarkers under study prove competent in objectively tracking disease severity, this could also lead to developing new metrics by which the risk of, and recovery from, PTSD could be gauged, in PTSD in general, and among women in particular¹²⁻¹⁵.

In order to address this critical gap we will examine 40 OIF/OEF female PTSD positive cases and 40 OEF/OIF female PTSD negative control subjects through an extensive biological protocol as a supplement to the DOD funded comprehensive Biomarkers for PTSD study.

BODY:

Accomplishments During this Reporting Period (24 September 2014 - 22 September 2015)

The Biomarkers for PTSD in Female Iraq and Afghanistan Veterans study is in the implementation phase. In the fourth year of the grant we have accomplished several milestones and goals. These accomplishments are detailed below:

1. Communication Strategies

The team continued to engage in bi-weekly communication meetings via teleconference to ensure the successful and timely execution of the Implementation Phase.

Calls took place between the PIs and investigators at each site (SF VAMC, UCSF, Emory University, Mt Sinai, Bronx VA and NYU). Meetings addressed safety issues, clinical questions, strategies for improving subject recruitment and enrollment, strategies for maximizing participation in Visits 2-4, and ensuring that participants moved through all stages of the study quickly and efficiently (in order to avoid attrition).

Dr. Jennifer Newman, clinical supervisor, conducted weekly calibration meetings across sites to establish clinical consensus in scoring the frequency and intensity of symptoms on the CAPS and clinical assessment. Each discrepancy from the evaluation of participants was resolved by group consensus during these meetings.

2. Institutional Review Board (IRB)

Female subject recruitment has been challenging due to the differences in combat exposure and involvement that female veterans face compared to male veterans (i.e., females do not participate in direct combat). In order to increase enrollment of female veterans, we expanded inclusion criteria. Instead of only including female veterans with Civilian Administered PTSD Scale (CAPS) scores ≥ 40 , we expanded the inclusion criteria to include female subjects who have a current CAPS score ≥ 30 , and endorsed at least the minimum number of items in Cluster B and Cluster C or D on the CAPS. The proposed changes have been approved by the IRBs at all sites and were verbally approved by Karen Eaton, Human Subjects Protection Scientist of the Department of Defense (DOD).

This new strategy will allow for the inclusion of all OIF/OEF/OND women veterans, except if they meet criteria for psychosis, suicidality, homicidality, drug dependence, and/or pregnancy. This will give us a real world sample which is scientifically interesting because of the difficulty in enrolling women in research. The new criteria will provide valuable information for the future and will include biomarkers from a sample that is more representative of this population.

The study was reviewed by the NYU IRB and annual continuation approval was granted on September 2, 2015. Annual continuation approval was also granted by the Bronx VA IRB on September 3, 2015. Currently under review by the NYU IRB is a proposal to aid recruitment of female participants by increasing flexibility regarding scheduling and appointments. For example, allowing participants to complete the baseline clinical interview by phone after mailing in a signed consent form, or completing the blood draw and MRI scan in the same day, could potentially make enrollment and completion of study procedures more feasible.

3. Outreach and Recruitment Activities

In an effort to recruit more women to the study, our outreach team attended several women-oriented military events to explain our studies and their participation. The team has continued to work with Dr. Nancy Lutwak, an Emergency Medicine doctor and women veterans' advocate at the Manhattan VAMC. The outreach team also developed a new partnership with Dr. Veronica Ades, a VA gynecologist involved in developing a women's reproductive health clinic at the Manhattan VA, to help aid recruitment of female participants. The study team has displayed posters and recruitment materials at the Manhattan VA in the women's Emergency Room and mental health clinics, targeting women veterans specifically.

Additionally, connections have been made with women's veteran groups through facebook, such as "Service: When Women Come Marching Home," organized by a NYC filmmaker and The Women's Veterans Network, a non-profit organization in Brooklyn, as well Team Red, White and Blue, which includes a large percentage of women veterans. Efforts have also been made to collaborate with SWAN (Service Women's Action Network) and other female veteran groups regarding recruitment and ways of addressing enrollment challenges.

Our outreach staff has continued to participate in recruitment events, such as those listed below, to distribute recruitment materials.

- ❖ SAMSHA meetings
- ❖ Institute for Community Living Veteran Resource Fair
- ❖ SWAN meeting
- ❖ Veterans Mental Health Coalition Meeting
- ❖ NYU Military Veterans Club Luncheon
- ❖ Columbia MilVets Ball
- ❖ SSVF meeting
- ❖ MOVA event downtown
- ❖ Tom Murphy's Edge 4 Vets program
- ❖ Words of War Event with Weill Cornell & HeadStrong
- ❖ Dr. Marmar's grand rounds at Brooklyn VA
- ❖ Veteran Civilian Dialogue: Moral Injury
- ❖ Bronx Veterans' Appreciation Day Breakfast with Ruben Diaz
- ❖ Women in the Military: Unseen Battles Panel @ Manhattan VA
- ❖ Mayor's Office of Veterans Affairs Employment Fair
- ❖ Meeting at Manhattan VA Mental Hygiene Clinic

- ❖ Veterans Mental Health Coalition Meeting
- ❖ Stand Up For Women Veterans @ Westchester Community College
- ❖ Veteran/Civilian Dialogue
- ❖ Army Birthday Celebration – 4th Infantry Division’s Family Picnic Day
- ❖ Manhattan Single Stop Veterans Resource Fair
- ❖ Manhattan VA PTSD Clinic Meeting

4. Recruitment of Research Participants, Enrollment and Acquisition of Biomarkers

According to the Statement of Work, the goal of this grant is to enroll 80 OIF/OEF female veterans. One hundred and twenty-three female participants provided consent and were enrolled in the study. Of the 123 enrolled participants, 47 met all study criteria and were eligible for ascertainment of biomarkers.

Of those eligible, 36 participants are actively enrolled: 16 were positive for PTSD and 20 were negative for PTSD. To date 36 female participants successfully completed the Day 2 blood study procedure, 34 completed the Day 3 blood procedure, 37 completed the self-report questionnaire, 28 completed the MRI and 35 completed the neurocognitive testing. See Table 1 below for details.

The MRI scans were processed through FreeSurfer v5.1. Manual Hippocampal Subfield Markings were conducted on selected scans. The study transitioned from using the Bruker 3.0 Tesla MR scanner to the Siemens Magnetom Prisma in February, 2015. The machine was appropriately calibrated before being used for data collection.

Table 1. Biomarkers Enrollment and Participation of Females

Biomarkers for PTSD in Female OIF/OEF Veterans	
Procedure	N
Consented	123
Baseline Clinical Interview	101
Total Eligible	47
PTSD+	20
PTSD-	27
Total Blood Draw	36
PTSD+	16
PTSD-	20
Total Self Report	37
PTSD+	17
PTSD-	20
Total Neurocognitive Testing	35
PTSD+	16
PTSD-	19
Total MRI	28
PTSD+	10
PTSD-	18

All participants were reimbursed for their time and effort after completing study procedures.

5. Standard Operating Procedure (SOP) Manuals & Procedure Manual for Handling of Samples

Our research operations team met many milestones during this reporting period. All cores including those who are collecting specimens and acquiring and processing the MRI scans developed detailed SOP manuals for all study procedures. We anticipate that the finalized SOPs will be stored in the Datacube. Regulatory binders documenting all study procedures and progress to date have been maintained.

6. Data Management

All Clinical Assessment data from the baseline interview, self-report and neurocognitive measures for all study participants were completed and entered as digital data directly into the study secure SQL database server. Data from all cores is also shared with NYU and saved into a single centralized database.

We identified a sample of 10 cases and 10 controls that is matched on ethnicity and age and we will begin data analysis on this sample and circulate the data to the cores next month.

We conducted preliminary analysis on the demographical characteristics of 47 eligible Iraq and Afghanistan female veterans in the study. Results of this analysis are listed in tables 2-5 below.

Table 2. Race/Ethnicity distribution of female veterans.

Race/ethnicity	Frequency	Percent
Hispanic	14	29.79
Non-Hispanic Asian	1	2.13
Non-Hispanic Black	17	36.17
Non-Hispanic Other	3	6.38
Non-Hispanic white	10	21.28
Unknown	2	4.26

Table 3. Summary statistics of age among female veterans.

Analysis Variable : age				
N	Mean	Standard Deviation	Minimum	Maximum
45	32.24	6.21	24.00	52.00

Table 4. Education level of female veterans.

Education Level	Frequency	Percent
up to 12th grade	1	2.13

High school diploma	11	23.4
2 years college A.A. degree	14	29.79
4 years college Bachelor's Degree	13	27.66
Master degree	6	12.77
Unknown	2	4.26

Table 5. Military branch information of female veterans.

Military branch	Frequency	Percent
Air Force	3	6.38
Army	21	44.68
Marine	3	6.38
National Guard	1	2.13
Navy	7	14.89
Reserve	1	2.13
Army and Reserve	6	12.77
Army and National Guard	1	2.13
Navy and National Guard	1	2.13
Unknown	3	6.38

7. Shipment of Material to cores

Shipments of Blood samples were transferred to all collaborating sites, Integrative Systems Biology: Mouse Models of PTSD (Principal Investigator Dr. Jett), and Institute for Systems Biology (ISB): Genetics, Metabolomics (Principal Investigator Dr. Hood), Genetics Core at Emory University (PI: Dr. Kerry Ressler), and to the Metabolism Core at UCSF (PI: Dr. Owen Wolkowitz).

Data transfer from NYU to the imaging core at UCSF is running smoothly and Q & A procedures indicate high quality of data collection.

8. Request for No Cost Extension

Due to the complexity of recruitment of Iraq and Afghanistan female veterans and the acquisition of all the biomarkers we do not expect to accomplish all the milestones listed on the statement of work and the recruitment goals within this period. As a result, we submitted a request for a one year no cost extension in September, 2015 to complete this work. No additional funds were requested since we have sufficient funds to complete this work.

KEY RESEARCH ACCOMPLISHMENTS:

- Refined recruitment materials for the study.
- Obtained IRB approvals for the continuation process across all sites and submitted to the DOD for final review.
- Conducted targeted outreach and networking with various veterans and community organizations. IRB approved recruitment material (brochures, flyers and advertisements) were distributed at job fairs, colleges, female clinics, VA Medical Centers and female veterans' organizations.
- Submitted a proposal to the NYU IRB to allow for additional flexibility in scheduling/enrolling female participants, such as completion of the baseline interview by phone and completing the blood draw and MRI scan in the same day, with the goal of reducing barriers and increasing recruitment and retention.
- Enrolled 123 OIF/OEF female participants. Of those 47 were found eligible and met study criteria.
- Study team from all sites participated in bi-weekly study meetings
- Entered, cleaned all data into a centralized database and ran reports and queries for tracking progress.
- Completed biomarkers study procedures on 27 eligible participants including blood draws, MRIs and urine collection.
- Completed shipments of blood samples from JJPVAMC to all cores including Metabolism, Multi-omics and Genetics cores. Neuroimaging data was transferred successfully from NYU center of brain imaging to UCSF.
- Developed Standard Operating Procedures Manuals (SOPs) and will store this in the data cube. Developed and maintained regulatory binders for documentation and organization of study procedures.

REPORTABLE OUTCOMES:

- The major development during the timeframe of this annual report for this project is that all cores are still active and working on the implementation phase.
- Recruitment and data collection is being accelerated and participants are completing all study procedures.
- Data and samples are being transferred across sites and several specimen shipments were sent to the metabolism, multi-omics and genetics cores.
- In September, 2015 we submitted a request for a one year no-cost extension to finish this work and accomplish the milestones listed in the statement of work.
- Tasks to complete for the next reporting period include:
 - (1) Continue to recruit and enroll subjects for the study.
 - (2) Run study participants through all procedures.

- (3) Continue data collection and data management.
- (4) Analyze demographic data for enrolled participants for the purpose of matching controls with PTSD positive participants.
- (5) Continue to process and ascertain biomarkers.
- (6) Test biomarkers for 20 cases/20 controls (Discovery Phase).
- (7) Replicate the most promising biomarkers in the next 20 cases/20 controls (Replication phase).
- (8) Continue to ship samples to UCSF, Emory University, Drs. Marti Jett and Lee Hood for analysis.
- (9) Develop an analysis strategy to disseminate results.

CONCLUSION:

The study has received IRB approval from recruiting sites to include Iraq and Afghanistan female veterans with CAPS score > 30, which will allow us to accelerate the recruitment process. Recruitment material for the study was refined and the team started targeted outreach effort to recruit female OIF/OFE veterans. We completed baseline clinical interviews on 103 female veterans. Acquisition of biomarkers was completed on those who met the study criteria and biological samples were shipped to the collaborating sites. In the coming year we aim to increase enrollment and completion of study procedures by expanding recruitment efforts and allowing for increased flexibility in scheduling.

Data collection and data management are running smoothly. All data is maintained in a centralized database at NYU.

We will be examining the first batch of data analysis with a sample size of 10 cases/10 controls. The most promising biomarkers will be replicated and compared with female mouse model.

REFERENCES:

- 1 Seal, K. H., et al. Getting beyond "Don't ask; don't tell": an evaluation of US Veterans Administration postdeployment mental health screening of veterans returning from Iraq and Afghanistan. *Am J Public Health* **98**, 714-720 (2008).
- 2 Breslau, N., Davis, G. C., Andreski, P., Peterson, E. L. & Schultz, L. R. Sex differences in posttraumatic stress disorder. *Archives of general psychiatry* **54**, 1044-1048 (1997).
- 3 Frans, O., Rimmo, P. A., Aberg, L. & Fredrikson, M. Trauma exposure and post-traumatic stress disorder in the general population. *Acta Psychiatr Scand* **111**, 291-299 (2005).
- 4 Kessler, R. C., Sonnega, A., Bromet, E., Hughes, M. & Nelson, C. B. Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry* **52**, 1048-1060 (1995).
- 5 Stein, M. B., Walker, J. R. & Forde, D. R. Gender differences in susceptibility to posttraumatic stress disorder. *Behav Res Ther* **38**, 619-628, doi:S0005-7967(99)00098-4 [pii] (2000).
- 6 Olf, M. d. V., G. J. in *International Society for Traumatic Stress Studies*.
- 7 Hoge, C. et al. Mental disorders among U.S. military personnel in the 1990s: association with high levels of health care utilization and early military attrition. *The American Journal of Psychiatry* **159**, 1576-1583 (2002).
- 8 Riddle, J. et al. Millennium Cohort: the 2001-2003 baseline prevalence of mental disorders in the U.S. military. *Journal of clinical epidemiology* **60**, 192-201 (2007).
- 9 Hourani, L. L. & Yuan, H. The mental health status of women in the Navy and Marine Corps: preliminary findings from the Perceptions of Wellness and Readiness Assessment. *Military medicine* **164**, 174-181 (1999).
- 10 Hoge, C., Clark, J. & Castro, C. Commentary: women in combat and the risk of post-traumatic stress disorder and depression. *International Journal of Epidemiology* **36**, 327-329 (2007).
- 11 Peirce, J., Newton, T. L., Buckley, T., & Keane, T. M. in *Gender and PTSD* (ed P. Ouimette R. Kimerling, & J. Wolfe) (Guilford Press, 2002).
- 12 Bryant, R. Acute stress reactions: can biological responses predict posttraumatic stress disorder? *CNS spectrums* **8**, 668-674 (2003).
- 13 Olf, M., Langeland, W., Draijer, N. & Gersons, B. P. R. Gender differences in posttraumatic stress disorder. *Psychol Bull* **133**, 183-204 (2007).
- 14 Cohen, H. & Yehuda, R. Gender differences in animal models of posttraumatic stress disorder. *Disease Markers* **30**, 141-150 (2011).

- 15 Boscarino, J. A. Psychobiologic predictors of disease mortality after psychological trauma: implications for research and clinical surveillance. *Journal of Nervous and Mental Disease* **196**, 100-107 (2008).