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TITLE: Mental Health Disorders, Suicide Risk, and Treatment Seeking Among Formerly Deployed National Guard and Reserve Service Member Seen in Non-VA Facilities

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14. ABSTRACT

The focus of the current study was to assess the prevalence of and risk factors for mental health disorders, variations in service use among National Guard and Reserve service members seem in non-VA facilities following deployments, compared to other era service members. Of the 1,730 veterans surveyed, 95% were male, 44% were under 64 years old, 96% were white race, 40% reported multiple warzone deployments, and 38% (n=665) had served as National Guard/Reserve service members. In addition, 23% (n=396) serviced in Iraq, Afghanistan, or Global War on Terrorism. The prevalence of current PTSD was 5.4% (probable PTSD = 7.6%), current depression was 8%, 23% had used mental health services in the past year and 50% had used the VA in the past year. The most common current disorder was related to alcohol misuse, with 24% screening positive on the AUDIT scale. In addition, 28% reported a history of concussion during military service. Analyses indicated that PTSD, depression, mental health service use, alcohol misuse, suicidality, and stressful life events were more common among National Guard/Reserve veterans, compared to other era veterans (p-values < 0.05). However, other era veterans were more likely to rate themselves in "fair" or "poor" health and to report a service-connected disability (p-values < 0.05). Nevertheless, multivariable analyses that adjusted for demographic differences, level of combat exposure, current life stressors, and current social support, found no differences in mental health status and mental health service use among the veteran groups. To date, analyses suggest that while deployed National Guard/Reserve service members tended to have a higher prevalence of mental health disorders and mental health service use, when the data were adjusted for demographic difference and potential confounders, there were few differences in outcomes between the veteran groups.

15. SUBJECT TERMS
PTSD, Depression, Service Use, Suicidality, Alcohol Misuse, Concussion, Deployment, VA Service Use, National Guard/Reserve

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- **INTRODUCTION:**

The focus of the current study is to assess the prevalence of and risk factors for mental health disorders, variations in service use, and outcomes among National Guard and Reserve service members following warzone deployments. This study is important because most veterans have private and/or other health insurance coverage and often receive their care from non-VA institutions. The knowledge gained from studying National Guard and Reserve veterans in non-VA healthcare systems is highly relevant. The availability of healthcare options for veterans has increased in recent years through changes in VA policy and insurance coverage. Today most veterans are not seen in VA facilities, but in non-VA healthcare systems. The Geisinger Clinic, the community partner for the current study, is a large, non-profit integrated healthcare organization located in central and northeastern Pennsylvania. This system serves more than 3 million residents throughout more than 44 counties in Pennsylvania. Geisinger has more than 30,000 employees, including a 1,600-member multi-specialty group practice, ten hospital campuses, a 551,000-member health plan, and a medical school (Geisinger Commonwealth Medical School), and is one of the largest employers in the state (see: www.geisinger.org). The knowledge gained from studying veterans in non-VA healthcare systems is important for the monitoring the quality of care, diagnostic screening, and for outcomes research. Currently, Geisinger has ~35,000 current and former service members who use this system for their healthcare. Many of these patients currently are or were former members of the National Guard or the Reserves.

- **KEYWORDS:**

Mental Health Disorders, Service Use, Substance Misuse, Deployment, Treatment Outcomes, Traumatic Brain Injury, Concussion, National Guard, Reserves.

- **ACCOMPLISHMENTS:**

  - **What were the major goals of the project?**

YEAR 1

Major Goal 1: Study Start, Instrument/Protocol Finalization, Local IRB, DoD IRB Approval

Subtask 1: Convene initial study meetings with study group (+1 month)
Subtask 2: Review and update study instruments and protocol from pilot study, pilot test revised protocol (+1/2 months)
Subtask 3: Submit revised protocol to Geisinger's IRB and obtain approval (+2 months)
Subtask 4: Submit protocol for DoD's IRB review (+3 months)
Milestone: Finalize study protocol/instruments received required IRB approvals (+3/4 months)

Major Goal 2: Survey Data Collection, Baseline EHR Data Collection, DNA Collection, Data Cleaning, Preliminary Data Analyses

Subtask 1: Pull baseline electronic health record (EHR) data from Geisinger's Information Technology (IT) Systems, including veteran status data, outpatient, inpatient, emergency department, and laboratory data
Subtask 2: Conduct survey data collection
Subtask 3: Collect DNA Samples by Mail
Subtask 4: Conduct preliminary data analyses
Milestones Achieved: Survey data collected, baseline EHR data collected, DNA collected, preliminary analyses being completed

YEAR 2

Major Goal 3: Bio-bank DNA, Complete Genotyping, Merge Survey, EHR, and Genotype Data, Complete Analyses for Study Aim 1 (Prevalence Study) and for Aim 2 (PTSD Study), Prepare Manuscripts for Review

Subtask 1: Complete genotyping of selected study SNPs
Subtask 2: Merge genotype data into survey and EHR datasets
Subtask 3: Continue analyses related to study Aims 1 and 2
Subtask 4: Convene study team conference to review study results

Subtask 4: Prepare and submit posters/manuscripts for peer review
Subtask 5: Complete and review preliminary genetic analyses
Subtask 6: Prepare additional posters/manuscripts for internal review and peer review submission
Milestones Achieved: DNA Bio-banked, complete genotyping, merge survey, EHR, and genotype data, complete additional analyses for study Aims 1 and 2, prepared & submit year 2 posters/manuscripts for peer review

YEAR 3

Major Goal 4: Complete Follow-up EHR data pull from Geisinger IT Systems, Merge Follow-up Data, Complete Analyses for Study Aim 3 (Effectiveness) and for Aim 4 (Genetics), Prepare Final Manuscripts for Review and Submission, Convene Final Conferences and meetings

Subtask 1: Conduct Follow-up data pull from Geisinger's EHR Systems, using outpatient, inpatient, emergency department and laboratory data
Subtask 2: Merge and clean/code data/ and run preliminary analyses
Subtask 3: Complete analyses for Aims 3 and 4
Subtask 4: Prepare final manuscripts for review and submission
Subtask 5: Prepare and submit proposals for additional genetic and follow-up research funding
Subtask 6: Prepare documentation/datasets for bio-banking and data-sharing of study data
Subtask 6: Complete follow-up EHR data pull from Geisinger EHR/IT Systems, merge follow-up data, completed analyses for Aims 3 and 4, Prepare Final manuscripts for review and submission, convene final conference meeting, prepare documentation and datasets for data sharing.

Yearly Patient Enrollment

Table 1. (planned)	**Year 1***			
Target Survey Enrollment (per quarter)	**Q1**	**Q2**	**Q3**	**Q4**
Geisinger Site	1500	200	100	0
Target/Planned Enrollment (cumulative)	**1500**	**1700**	**1800**	**1800**

***Due to recruitment difficulties, only 1,289 veterans were recruited in Year 1.**

- **What was accomplished under these goals?**

YEAR 4

Major Goal 4:

Quarter 1-

- DNA results have been merged with survey data and we are analyzing these results.
- Two posters were submitted to the HCSRN Conference, Portland, OR on April 8-10, 2019:

  Hu, et al., ***Predictors of Current PTSD among Deployed Veterans: Significance of Predisposition, Stress Exposures, and Genetic Factors***

  Boscarino, et al., ***Predictors of Post-deployment Mental Health Treatment-seeking among Iraq and Afghanistan Veterans Seen in non-VA Facilities***

- Data Analyses related to completion of Aims 3 and 4 in process.
- Year 3 Subtasks 3-6 are currently in progress.
- NCE for final year approved

Quarter 2-

- DNA results have been merged with survey data and we are analyzing these results.
- Two posters were accepted for the HCSRN Conference, Portland, OR on April 8-10, 2019:
  Hu, et al., ***Predictors of Current PTSD among Deployed Veterans: Significance of Predisposition, Stress Exposures, and Genetic Factors***

  Boscarino, et al., ***Predictors of Post-deployment Mental Health Treatment-seeking among Iraq and Afghanistan Veterans Seen in non-VA Facilities***
- Three papers were submitted for peer review during this period:

  Adams, et al, Social and Psychological Risk and Protective Factors for Veteran Well-Being: The Role of Veteran Identity and Its Implications for Intervention, *Military Behavioral Health* (in press).

  Guard/Reserve Service Members and Mental Health Outcomes following Deployment: Results from the Veterans' Health Study, *Hospital General Psychiatry* (in press).

  Risk and Protective Factors Associated Mental Health among Female Military Veterans: Results from the Veterans' Health Study. Psychological Trauma (under review).
- Data Analyses related to completion of Aims 3 and 4 in process.
- Year 3 Subtasks 3-6 are currently in progress.

Quarter 3-

- DNA results have been merged with survey data and we are analyzing these results.
- Two posters were presented at the HCSRN Conference, Portland, OR on April 8-10, 2019:

  Hu, et al., ***Predictors of Current PTSD among Deployed Veterans: Significance of Predisposition, Stress Exposures, and Genetic Factors.***

  Boscarino, et al., ***Predictors of Post-deployment Mental Health Treatment-seeking among Iraq and Afghanistan Veterans Seen in non-VA Facilities.***
- Four papers were submitted for peer review during this period:

  Adams, et al., Social and Psychological Risk and Protective Factors for Veteran Well-Being: The Role of Veteran Identity and Its Implications for Intervention, *Military Behavioral Health* (accepted and in press).

  Boscarino, et al., Guard/Reserve Service Members and Mental Health Outcomes following Deployment: Results from the Veterans' Health Study, *Hospital General Psychiatry* (accepted and in press).

Hoffman, et al., Grapheme-Color Synesthesia is Associated with PTSD Among Deployed Veterans: Confirmation of Previous Findings and Need for Additional Research, International *Journal of Emergency Mental Health and Human Resilience*, 2019; 21: (1), pp 1-6 (published).

Risk and Protective Factors Associated Mental Health among Female Military Veterans: Results from the Veterans' Health Study. *Psychological Trauma* (currently under review).

- Data Analyses related to completion of Aims 3 and 4 in process.
- Year 3 Subtasks 3-6 are currently in progress.

Yearly Patient Enrollment

Table 1. (actual)	**Year 2***			
Target Survey Enrollment (per quarter)	**Q1**	**Q2**	**Q3**	**Q4**
Target Enrollment (cumulative)	**1600**	**1800**	**1800**	**1800**

***Due to recruitment difficulties, only 1,730 total veterans were recruited by end of Q2 in Year 2, after which recruitment was stopped.**

- **What opportunities for training and professional development has the project provided?**
- **How were the results disseminated to communities of interest?**
- **What do you plan to do during the next reporting period to accomplish the goals?**
  Our primary goal is to complete data analyses and submit final manuscripts for peer review and publication.

4. **IMPACT:**

- **What was the impact on the development of the principal discipline(s) of the project?**
  Nothing to Report.
- **What was the impact on other disciplines?**
  Nothing to Report.
- **What was the impact on technology transfer?**
  Nothing to Report.
- **What was the impact on society beyond science and technology?**

5. CHANGES/PROBLEMS: The were no substantive changes submitted to the Department of Defense during Year 4. However, the main problem faced related recruitment of Guard/Reserve service members.

- **Changes in approach and reasons for change**:
  With DoD and Geisinger IRB approval, we administered an additional telephone survey asking patients questions we omitted from the original survey due to length. We will continue the collection of remaining DNA samples via US mail. We also plan to continue genotyping of SNPs and to begin our biomedical data pulls from the EHR for this study. We will continue analyses of these data and the dissemination findings through conference presentations and research publications.
- **Actual or anticipated problems or delays and actions or plans to resolve them.**
  The difficulty in the recruitment of Guard/Reserve service members has delayed our data analyses. We plan to add additional data analysis staff and were granted a no cost extension
- **Changes that had a significant impact on expenditures**
  Due to data collection delays, our budget is under spent at this time.
- **Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents**:
  Nothing to Report
- **Significant changes in use or care of human subjects:**
  Nothing to Report
- **Significant changes in use or care of vertebrate animals:**

Nothing to Report

- **Significant changes in use of biohazards and/or select agents:**
  Nothing to Report

6. PRODUCTS:

- **Publications, conference papers, and presentations**
  Journal publications.

  Hoffman, et al., Grapheme-Color Synesthesia is Associated with PTSD Among Deployed Veterans: Confirmation of Previous Findings and Need for Additional Research, International *Journal of Emergency Mental Health and Human Resilience*, 2019; 21: (1), pp 1-6

  Adams, et al., Social and Psychological Risk and Protective Factors for Veteran Well-Being: The Role of Veteran Identity and Its Implications for Intervention, *Military Behavioral Health*

  Boscarino, et al., Guard/Reserve Service Members and Mental Health Outcomes following Deployment: Results from the Veterans' Health Study, *Hospital General Psychiatry*

- **Books or other non-periodical, one-time publications.**
  Nothing to Report
- **Other publications, conference papers, and presentations.**

  Two posters were presented at the HCSRN Conference, Portland, OR on April 8-10, 2019:

  Hu, et al., ***Predictors of Current PTSD among Deployed Veterans: Significance of Predisposition, Stress Exposures, and Genetic Factors.***

  Boscarino, et al., ***Predictors of Post-deployment Mental Health Treatment-seeking among Iraq and Afghanistan Veterans Seen in non-VA Facilities.***

- **Journal publications (in-direct products from pilot study)**

  Hoffman, et al., Grapheme-Color Synesthesia is Associated with PTSD Among Deployed Veterans: Confirmation of Previous Findings and Need for Additional Research, International *Journal of Emergency Mental Health and Human Resilience*, 2019; 21: (1), pp 1-6

  Adams, et al., Social and Psychological Risk and Protective Factors for Veteran Well-Being: The Role of Veteran Identity and Its Implications for Intervention, *Military Behavioral Health*

  Boscarino, et al., Guard/Reserve Service Members and Mental Health Outcomes following Deployment: Results from the Veterans' Health Study, *Hospital General Psychiatry*

- **Website(s) or other Internet site(s)**
  https://www.geisinger.edu/en/research/research-and-innovation/find-an-investigator/2017/04/03/13/38/joe-boscarino
- **Technologies or techniques**
  Nothing to Report
- **Inventions, patent applications, and/or licenses**
  Nothing to Report
- **Other Products**
  See in-direct product publications from pilot study listed above.

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

- **What individuals have worked on the project?**

Name:	***Joseph A. Boscarino***
Project Role:	*Principle Investigator, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	48
Contribution to Project:	*Wrote study application, secured study funding, directed overall study execution, monitored study progress and budget, prepared and reviews study presentations a manuscripts for dissemination. Traveled to regional/national professional meeting to present study results.*
Name:	**Charles Figley**
Project Role:	*Co-Investigator, Tulane University*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	47
Contribution to Project:	Participated in conference calls and personal meetings with PI to discuss study measurements, data analysis, conceptual focus, coordination of IRB approval with Tulane University's IRB, and review of data collection instruments for current stud Prepared and reviews draft manuscripts and presentations related to study. *Traveled to regional/national professional meetings to present study results.*
Name:	**Richard Adams**
Project Role:	*Co-Investigator, Kent State University*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	47
Contribution to Project:	Participated in conference calls and personal meetings with Study PI to discuss planned study measurements, data analysis, conceptual focus of study, coordinatio of IRB approval with Kent State's IRB, and review of data collection instruments planned for current study. Prepared and reviewed draft manuscripts and presentations related to study findings. *Traveled to regional/national professional meetings to present study results.*
Name:	**Thomas Urosevich**
Project Role:	*Co-Investigator, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	47
Contribution to Project:	Participated in conference calls and personal meetings with PI to discuss planned study measurements, data analysis, conceptual focus of study, identification genotypes for study, and identification of key TBI measures to be used in study. Prepared and reviewed draft manuscripts and presentations related to study finding *Traveled to regional/national professional meetings to present study results.*
Name:	**Stuart Hoffman**
Project Role:	*Co-Investigator/Neuroscience Consultant*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	47
Contribution to Project:	Participated in conference calls and personal meetings with PI to discuss planned study measurements, data analysis, conceptual focus of study, identification of key

	genotypes for study, and identification of key neurological and sleep disturbance measures to be used in study. Prepared and reviewed draft manuscripts and presentations related to study findings.
Name:	**H. Lester Kirchner**
Project Role:	*Co-Investigator, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	47
Contribution to Project:	Contribution to Project: Consulted with Study PI regarding biostatistics, study database, and data dictionary planned for study, and met with his study staff assigned to the project. Prepared and reviewed draft manuscripts and presentations related to study findings.
Name:	**Xin Chu**
Project Role:	*Genetic Consultant, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	46
Contribution to Project:	Ordered Inventory of needed supplies and assays for study and oversaw the genotyping and bio-banking of DNA being collected for study. Reviewed draft manuscripts and presentations related to study findings.
Name:	**Carrie Withey**
Project Role:	*Project Manager, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	25
Contribution to Project:	Application and document preparation, regulatory compliance, budgeting, and operational management of study. Prepared and reviewed draft manuscripts and presentations related to study findings.
Name:	**Yirui Hu**
Project Role:	*Biostatistician*
Researcher Identifier (e.g. ORCID ID):	N/A
Nearest person month worked:	16
Contribution to Project:	Conducted biostatistical analyses for this study, prepares and reviews draft manuscripts, and presentations related to study findings.
Name:	**Johanna Hyacinthe**
Project Role:	*Former Project Manager, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	18
Contribution to Project:	Application and document preparation, regulatory compliance, budgeting, and operational management of study. Prepares and reviews draft manuscripts and

	presentations related to study findings. Traveled to regional/national professional meetings to present study results.
Name:	**James Pitcavage**
Project Role:	*Former Project Manager, Geisinger Clinic*
Researcher Identifier (e.g. ORCID ID):	*N/A*
Nearest person month worked:	*3*
Contribution to Project:	Completed study IRB application and document preparation, regulatory compliance, budgeting, and operational management of study.
Name:	**Eric Snover**
Project Role:	*Former Research Assistant, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	*N/A*
Nearest person month worked:	*6*
Contribution to Project:	Did study mailings, mailed and tracks study incentives, DNA kits, consent forms, etc. and was responsible for overall tracking of patient participation. Assisted with the daily operations of study.
Name:	**Brielle Evans**
Project Role:	*Former Research Assistant, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	N/A
Nearest person month worked:	4
Contribution to Project:	Mailed of incentives, DNA kits, consent forms, etc. and was responsible for overal tracking of patient participation. Assisted with the daily operations of study.
Name:	**Melinda Hatt**
Project Role:	*Former Research Assistant, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	*N/A*
Nearest person month worked:	*4*
Contribution to Project:	Mailed incentives, DNA kits, consent forms, etc. and was responsible for overall tracking of patient participation. Assisted with the daily operations of study.
Name:	**Jared Pajovich**
Project Role:	*Former Research Assistant, Geisinger Clinic*
Researcher Identifier (e.g. ORCID II	*N/A*
Nearest person month worked:	*11*
Contribution to Project:	Completed Certificate of Confidentiality application, mailed incentives, DNA kits, consent forms, etc. and was responsible for overall tracking of patient participation Assisted with the daily operations of study.

- **Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?**
  Nothing to Report
- **What other organizations were involved as partners?**
  Nothing to Report

8. SPECIAL REPORTING REQUIREMENTS

- **QUAD CHART:** *Submitted as an attachment*

9. APPENDICES

- **Research Products:** *Submitted as attachment*

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Social and Psychological Risk and Protective Factors for Veteran Well-Being: The Role of Veteran Identity and Its Implications for Intervention

Richard E. Adams[a,a], Thomas G. Urosevich[b], Stuart N. Hoffman[c], H. Lester Kirchner[d], Charles R. Figley[e], Carrie A. Withey[f], Joseph J. Boscarino[g], Ryan J. Dugan[f], and Joseph A. Boscarino[f]

[a]Department of Sociology, Kent State University, Kent, Ohio; [b]Geisinger Clinic, Ophthalmology Service, Mount Pocono, Pennsylvania; [c]Geisinger Clinic, Sleep Disorder Center, Danville, Pennsylvania; [d]Department of Biomedical and Translational Informatics, Geisinger Clinic, Danville, Pennsylvania; [e]Traumatology Institute and School of Social Work, Tulane University, New Orleans, Louisiana; [f]Department of Epidemiology & Health Services Research, Geisinger Clinic, Danville, Pennsylvania; [g]Department of Clinical Psychology, William James College, Newton, Massachusetts

ABSTRACT

Social psychological theory hypothesizes that one's identity, self-definitions, and meanings used for a particular social role fosters individual purpose in life and affects behavior in specific social situations. As such, it can be protective against the onset of psychological disorders. We examined this hypothesis with data collected from 1,730 military veterans recruited to study the health effects of warzone deployments. The sample was primarily male, older, and White. Our key independent variable was a Likert scale rating the prominence of a respondent's veteran identity: how important it is to the person. Outcome variables included posttraumatic stress disorder (PTSD), suicide ideation, depression, alcohol misuse, and use of VA services. Bivariate analysis suggested that veterans with a prominent veteran identity are older, noncollege graduates, have less income, and had their first deployment to Vietnam. In multivariate analyses, study participants with a prominent veteran identity were less likely to exhibit suicide ideation, but more likely to misuse alcohol and use VA services. We found no differences for PTSD, self-rated health, or depression by veteran identity. Veterans who scored higher on the veteran identity scale appeared to be protected from suicidal thoughts, although they had an elevated risk for alcohol misuse.

KEYWORDS

Veteran identity; suicide ideation; depression; alcohol misuse; posttraumatic stress disorder; self-rated health; non-VA medical care; VA medical care; war zone deployment; stressful life events

Over the past 20 years, there have been many studies on risk and protective factors related to veterans' post-deployment physical and mental well-being (Boscarino, 1995; Fontana & Rosenheck, 1994; Hoge et al., 2004; James, Van Kampen, Miller, & Engdahl, 2013; Kline et al., 2010; Kulka et al., 1990; Levy & Sidel, 2009; Thomas et al., 2010). These studies have shown that deployment stressors (e.g., combat exposure, unit cohesion), postdeployment experiences (e.g., social support), demographic factors (e.g., low socioeconomic status, being female), and other life experiences (e.g., adverse childhood events) are related to the physical and psychological health of veterans. Much less attention, however, has been paid to psychosocial factors related to veteran identity as a protective factor for veteran well-being. In this study, therefore, we have examined how veteran identity, or the ways in which individuals view themselves in this role, relates to physical and mental health in a sample of postdeployed veterans receiving services from a large non-VA hospital system.

Much of the research on deployment and postdeployment experiences, as well as their relationship to veteran health and well-being, follows the stress process model (Adams et al., 2017; Pearlin et al., 1981; Thoits, 2013), with extensions made by Adler and Castro (2013; Castro and Adler, 2011) to better reflect military organizational context and combat related events. These models suggest that individuals subjected to disordered or challenging environments, usually assessed in terms of exposure to psychological trauma or negative life events, are typically required to respond both physiologically, through changes in the neuroendocrine and hormone systems (Boscarino,

CONTACT Joseph A. Boscarino jaboscarino@geisinger.edu Department of Epidemiology & Health Services Research, Geisinger Clinic, 100 N. Academy Avenue, MC 44-00, Danville, PA 17822

2004), and psychologically, usually through a revision of cognitive functioning (Thoits, 2013; Wheaton, Young, Montazer, & Stuart-Lahman, 2013). Serious environmental challenges that result in significant biological and/or cognitive alterations are defined as stressful and referred to as stressors (Pearlin, et al., 1981; Thoits, 2013). The consequences of exposure to these stressors can be psychological and physical distress, often in the form of depression and physical health problems (Adams et al., 2002; Adams & Boscarino, 2005; Pearlin, et al., 1981; Thoits, 2013).

Studies employing the stress process model for military personnel show that traumatic and stressful events, both combat (e.g., having members of one's unit killed, killing enemy combatants) and noncombat experiences (e.g., adverse childhood events, getting a divorce) negatively impact their physical and mental health (Adams et al., 2017; Boscarino, 1995, 2006; Hoge et al., 2004; James et., 2013). Adler and Castro's model also places social and psychological resources as key protective factors that reduce the impact of traumatic and negative life events related to military experiences on well-being (Adams et al., 2017; Adler & Castro, 2013). These resources can be unit cohesion, supportive relationships with friends and family, as well as psychological factors, such as self-esteem and mastery (Castro & Adler, 2011; Williams, Brown, Bray, Goodell, Olmsted, & Adler, 2016).

Adler and Castro (2013; Castro & Adler, 2011) argued that professional identity is one occupational resource in their occupational health model for military mental health and acts as a protective factor against trauma and negative life events. Other researchers also use veteran identity in their assessment of risk and protective factors related to physical and mental health among active and formerly deployed military personnel (Di Leone, Wang, Kressin, & Vogt, 2016; Firmin, Luther, Lysaker, & Salyers, 2016). Di Leone et al., for instance, examine centrality and positive regard for veteran identity in a sample of female veterans and found they predicted use of VA mental health and medical services. They also find that centrality and positive regard predicted entitlement to use VA services and perceived fit within the VA. However, most of these studies tend to be limited in that they are qualitative, based on small samples, only examine factors affecting VA service use (e.g., Harada et al., 2002), or focus only on female veterans (Di Leone et al., 2016). Thus, we know relatively little about how veteran identity affects the health and well-being of veterans, more generally.

But why would a strong identification with being a veteran be protective for well-being? From a psychosocial perspective, researchers argue that identities are self-definitions about social roles (e.g., father, friend, coworker, nurse, teacher) that are important to people occupying these roles. These self-definitions and meanings influence behavior, give meaning to people's lives, and provide a sense of purpose, all of which can enhance physical and psychological health by protecting the person from the negative consequences of life events and trauma (Adams & Boscarino, 2015; Stets & Serpe, 2013; Thoits, 2012). In addition, individuals can have multiple identities which are arranged in a hierarchy of importance or centrality, with more central identities higher in the hierarchy. Theoretically, a more central identity should act as a key protective factor for psychological health (Thoits, 2012).

The study of veteran identity is important for several reasons. First, many veterans receive their healthcare from non-VA facilities, and recent changes in healthcare options for veterans will likely increase the use of non-VA providers in the future (Carey et al., 2008; Elbogen et al., 2013; Levy & Sidel, 2009; Liu et al., 2011; Trivedi et al., 2012). Research indicated that veteran identity influences service use (Di Leone et al., 2016; Harada et al., 2002). Further, knowing more about the risk and protective factors in this population is necessary for future policy planning and development of treatment options. Again, effectiveness of treatment or other types of interventions may be influenced by veteran identity (Di Leone et al., 2016; Harada et al., 2002).

Second, research related to veterans deployed during U.S. wars in Afghanistan (Operation Enduring Freedom) and Iraq (Operation Iraqi Freedom) suggests higher rates of physical and mental health problems in this population, again arguing for more research on how veteran identity relates to risk and protective factors for this population of veterans (Kline et al., 2010). As Hack et al. (2017) noted, many outreach and educational interventions that attempt to have veterans engage in healthy behaviors or seek treatment for psychological difficulties use some aspect of the veteran identity. In addition, they conclude that the impact of veteran identity on health behavior and service use is not well understood and has been understudied.

Finally, there is a growing concern over the rise in suicide rates among veterans (Boscarino, 2006; Bossarte et al., 2011; Kline, Ciccone, Falca-Dodson, Black, & Losonczy, 2011; US Department of Veterans Affairs, 2016). Nock et al. (2013) reported that, historically, suicide rates among military personnel were well below rates for the civilian population. However, military suicide rates began to rise in the early 2000s and are now higher than matched civilians. In

addition, in their recent report on suicide rates among veterans and nonveterans, the Veterans Administration shows that after adjusting for age and sex, "The risk for suicide was 22 percent higher among Veterans when compared to U.S. non-Veteran adults" (US Department of Veterans Affairs, 2016, p. 4). If a strong veteran identity supplies military personnel with a sense of purpose and meaning in life, then it should be related to lower suicide ideation and attempts.

In this study, therefore, we focus on veteran identity as one possible protective factor that helps veterans adjust to stressful events. Past research (e.g., Hack, et al., 2017; Harada et al., 2002) defines *veteran identity* as the veteran's self-definitions derived from military experience. We operationalize this concept using a measure of veteran identity centrality or prominence, which is how important the identity is to the person's self-concept (Brenner, Serpe, & Stryker, 2014; Stets & Serpe, 2013). Relying on these theoretical concepts, the stress process model (Wheaton et al., 2013; Thoits, 2013), and the occupational health model for military mental health (Adler & Castro, 2013), we hypothesize that postdeployed veterans with a more central veteran identity are less likely to suffer from physical and mental health problems compared to veterans with a less central veteran identity. We also predict that veterans with a more central veteran identity will use VA services more often than those with a less central identity.

Method

Sample and procedure

The data used in this study come from a random sample of community-based U.S. military veterans recruited as part of a study on the health effects of military service. All participants were outpatients at Geisinger Clinic, the largest multihospital system in central and northeastern Pennsylvania. Geisinger provides comprehensive inpatient, outpatient, and community-based services to about one million residents, with about 30,000 patients reporting that they served in the US armed forces. Using medical electronic records, we randomly selected veterans and attempted to interview them by telephone between February 2016 and March 2017. Inclusion criteria were having at least one warzone deployment during their military career, being under 76 years old, and being able to give informed consent. The final sample size was 1,730, and the survey cooperation rate was estimated to be approximately 55% (American Association for Public Opinion Research, 2008; Groves et al., 2009). The Institutional Review Board at the Geisinger Clinic and the Department of Defense reviewed and approved all study protocols.

Measures

To assess how veteran identity affects well-being, we included both mental and physical health outcomes, as well as service utilization. First, the survey focused on three measures of psychological well-being. Suicidal ideation was assessed using one item asking if there was ever a period of 2 weeks or more "that things were so bad that you thought about hurting yourself or that you'd be better off dead," coded no or yes. Depression was the sum of 10-items used in previous studies (Adams & Boscarino, 2015; Boscarino, Adams, & Figley, 2011). Following *DSM-IV* criteria (American Psychiatric Association, 1994), respondents met criteria for depression if they had five or more depressive symptoms for at least 2 weeks in the past year (Cronbach's alpha = 0.87). To assess PTSD, we used items based on the D*iagnostic and Statistical Manual of Mental Disorders,* 5th ed. (*DSM-5*), the PTSD Checklist (American Psychiatric Association [APA], 2013; Wortmann et al., 2016). To be classified as having probable PTSD in the current study, veterans had to meet criteria A–E and G for *DSM-5* (APA, 2013). These criteria include trauma exposure (criterion A), intrusive symptoms (criterion B), persistent avoidance (criterion C), negative alterations in cognitions/mood (criterion D), increased arousal (criterion E), and reported impairment/distress related to these symptoms (criterion G). Altogether, 77% of our sample of veterans reported that one of the significant lifetime stressors they experienced was warzone or combat exposure.

Our fourth outcome measure was self-rated health, where respondents were asked, "How would you currently rate your overall physical health?" Responses ranged from excellent to poor. Past research shows this one-item question has very good reliability and validity and is a significant predictor of future mortality and disability (Ferraro & Farmer 1999; Idler et al., 2004). We coded these responses into self-ratings of unhealthy (classified as fair or poor) versus healthy (classified as excellent, very good, or good). Fifth, we included a measure of problematic alcohol use based on the three-item AUDIT-C scale (Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998; Crawford et al., 2013). The items inquire about how often respondents drank alcohol in the past year, how many drinks they

have on a typical day when drinking, and how often they have consumed 6 or more drinks on one occasion in the past year. We summed the items and followed standard scoring so that respondents with a higher score (4 for men and 3 for women) were coded as having met criteria for elevated alcohol use. Lastly, the survey asked if the participant had "Ever had any health care coverage or receive health care services through the VA?" (coded yes or no).

Our key independent variable in this study was Centrality of Veteran Identity. This measure was the sum of three survey questions inquiring about how strongly participants agreed or disagreed, on a 0 to 4 scale, with the following statements: "Being a veteran is an important reflection of who I am; I have come to think of myself as a veteran" and "It is important to me that others know about me as a veteran." These items were taken from several studies examining identity centrality (Di Leone et al., 2016; Brenner et al., 2014) and assessed the degree to which respondents view the veteran role as central or important to how they think about themselves and how they want others to view them (Cronbach's Alpha = 0.71). This three-item scale has been widely used in identity research and shows good reported reliability and validity (Brenner et al., 2014). We summed the three-item scale (range = 0 to 12). As with many such scales, it was negatively skewed, with over 50% scoring 11 or 12 (i.e., the veteran identity was very central to how respondents saw themselves). Based on an evaluation of the distribution, we recoded the variable so that those scoring between 0 and 11 were defined as not having high centrality versus those scoring 12 being defined as having high centrality. We used this strategy for highly skewed variables in the past (e.g., Adams & Boscarino, 2015) and argue that veterans who do not score high on all three items in the scale have a less central veteran identity, even if they scored high on most of the items. We did assess this measure using other coding schemes (e.g., coded as an ordinal scale [low, medium, and high centrality]). The results were essentially the same, with high centrality consistently different from lower centrality and are available from Joseph A. Boscarino.

We also included a number of other independent variables known to affect mental and physical health. Age was coded to the nearest year, whereas the other demographic factors were dummy coded such that female, White, married or living together as married, college graduate, and income over $100,000 were coded as 1 and male, all other racial/ethnic groups, not married, and educational status lower than college graduate were coded as 0 for the reference value.

Because our research was guided by both occupational health model (Adler and Castro, 2013) and the stress process model (Pearlin et al., 1981; Wheaton et al., 2013), we included several military service stress-related variables. First, deployment theater was categorized as Vietnam, Persian Gulf, Iraq/Afghanistan/Global War on Terrorism, and other warzone deployments, as currently defined by the Department of Veterans Affairs (VA; http://www.va.gov). We dummy coded this variable, with Vietnam theater as the reference group. We also coded other service-related variables (deployed as National Guard/Reserve, multiple warzone tours, high combat exposure, and low unit support) as indicator variables. More specifically, the survey inquired about whether the respondent had ever served and been deployed as a National Guard or the Active Reserves (coded no or yes). Those respondents who indicated that they had two or more deployments were coded as having multiple deployments versus those with only one deployment coded as the reference group. Combat exposure was based on eight items from the Combat Experiences Scale (Hoge et al., 2004; Janes, Goldberg, Eisen, & True, 1991). A number of military health studies used versions of this scale since the Vietnam war period (Boscarino, 1995). The items (rated on a 1 to 4 scale) asked about encountering dead bodies, being wounded by hostile fire, killing enemy combatants, and other combat related events (Cronbach's alpha = 0.84). We took the mean of these items ($M = 8.8$; $SD = 6.2$) and coded the sample into high combat exposure ($\geq 75^{th}$ percentile) versus not high exposure ($\leq 75^{th}$ percentile) as was done in previous research (Boscarino, Hoffman, Pitcavage, & Urosevich, 2015). Finally, unit support/morale was the mean of six items from the Deployment Risk and Resilience Inventory (King et al., 2006; Vogt et al., 2013) that inquired about a sense of camaraderie in the unit, trust of other unit members, commanding officers being interested in how they felt, feeling like efforts counted in the military, during deployment, etc. (Cronbach's alpha = 0.78). Individual response categories, on a 5-point scale, ranged from 1 (*strongly disagree*) to 5 (*strongly agree*; total M score = 20, $SD = 3.9$). We coded respondents into those who felt a high sense of support and unit morale versus those who did not by using the scale's 25^{th} percentile.

In addition to these military-related events and perceptions of support, the survey, again following both the stress process (Pearlin et al., 1981; Pearlin & Bierman, 2013) and occupational mental health models (Adler & Castro, 2013), asked about nonmilitary

events and psychosocial resources that can affect mental and physical health. The Stressful Life Events Scale was the sum of eight experiences that could have happened to the respondent in the past 12 months (e.g., spouse or close family member died, being injured, having problems as work, getting married, having serious financial problems). Experiencing two or more of these events in the past 12 months (75th percentile) was classified as high exposure to stressful events versus not high exposure. The Traumatic Events Scale was the sum of 12 lifetime extraordinarily stressful events, such as experiencing a natural disaster, forced sexual contact, being physically attacked, being in combat, being seriously injured, etc. Similar to the Stressful Events Scale, we classified this as high traumatic stress exposure versus not high traumatic exposure based 6 or more traumatic events (75th percentile). In addition, both stress exposure measures were extensively used in previous studies, with demonstrated good validity and reliability (Adams & Boscarino, 2015; Boscarino, Adams, & Figley, 2011).

Analyses

We present the bivariate cross-tabular results for centrality of veteran's identity by the demographic characteristics, stress/risk factors, disability and psychological service use, and the six outcome variables (Table 1). Following those analyses, we estimated six multivariate logistic regressions, one each for suicidal ideation, depression, PTSD, self-rated health, alcohol misuse, and lifetime use of VA services, with demographic, stress, resource, use of psychological services, and centrality of veteran's identity as independent variables. We conducted preliminary analyses (available upon request from Joseph A. Boscarino) and only retained independent variables what were statistically related to at least one of the dependent variables. In addition, we only present complete logistic regression results (Table 2) for the three outcomes (suicide ideation, alcohol misuse, and use of VA services) where veteran identity was statistically significant. We do, however, discuss all outcomes in the Results section below. Complete multi-variate results for the PTSD, Depression, and Self-Rated Health are available upon request from Joseph A. Boscarino.

Results

Basic demographic characteristics of the sample and bivariate relationships between centrality of veteran identity and the independent variables are shown in Table 1. This shows that more than half of study veterans are 65 or older (56%), male (95%), and White (96%). Over 75% are married, with about a similar percentage having less than a college degree. In terms of military experiences, 56% had a deployment during the Vietnam War, 38% were deployed as part of the National Guard/Reserve, almost 40% had multiple warzone tours, about 24% experienced high combat exposure, and 21% perceived their unit as having low support/morale. For the other nonmilitary factors the survey measured, noteworthy is that nearly 21% experienced a high number of traumatic life events, and 36% have a current VA service-connected disability. Lastly, about 11% of our survey participants reported ever having suicidal thoughts, 8% met study criteria for depression, almost 8% met criteria for PTSD, 37% rated their current health as fair or poor, 24% scored positive for alcohol misuse on the Audit-C, and over 60% reported to have ever used VA health services.

Table 1 also suggests statistically significant relationships between centrality of veteran identity and the independent and dependent variables of interest. Veterans with a high centrality score for their veteran identity tended to be older ($p = .001$), have less than a college education ($p < .001$), and have lower incomes ($p = .009$). They also were more likely to have had a deployment to Vietnam, and less likely report low unit support/morale ($p < .001$). For the six outcomes of interest, having a high centrality for veteran identity was associated with never having suicidal thoughts ($p < .005$), having fair/poor self-rated health in the past month ($p = .008$), and having ever used VA services ($p < .001$). Centrality of veteran identity was not related to current depression, PTSD, or alcohol misuse.

Although the focus of this study is on the relationship between veteran identity and our mental health outcomes, we did examine identity centrality, and the three individual items comprising this measure, relative to participants' first deployment. Cross-tabulations showed that Vietnam theater veterans tended to have the strongest identification with being a veteran, with 35% of them having high veteran centrality. On the other hand, Iraq/Afghan veterans showed the opposite pattern with only 21.5% scoring high on centrality. Veterans from other theaters fell between these two extremes. With regard to the individual items used to construct our Veteran Identity Centrality Scale, the main difference across theaters was for the question about it being important that others knew the participant was a veteran. Here, again, Vietnam veterans were much more likely to state that it was

Table 1. Sample Characteristics Related to Centrality of Veteran Identity ($n = 1717–1730$).

Sample characteristics	Entire sample, *n* (%)	Veteran identity low, *n* (%)	Veteran identity high, *n* (%)	χ^2 (*p*-value)a
Age				
18–44	264 (15.3)	215 (18.1)	49 (9.2)	
45–64	487 (28.3)	345 (29.1)	142 (26.6)	
65+	969 (56.3)	626 (52.8)	343 (64.2)	28.61 (.001)
Sex				
Male	1,645 (95.1)	1129 (94.7)	516 (95.9)	
Female	85 (4.9)	63 (5.3)	22 (4.1)	1.14 (.337)
Race				
Non-white	75 (4.3)	51 (4.3)	24 (4.5)	
White	1,655 (95.7)	1141 (95.7)	514 (95.5)	0.03 (.899)
Marital status				
Not married	390 (22.5)	270 (22.7)	120 (22.3)	
Married	1,340 (77.5)	933 (77.3)	418 (77.7)	0.03 (.901)
Education				
Noncollege graduate	1,301 (75.2)	860 (72.1)	441 (82.0)	
College graduate	429 (24.8)	332 (27.9)	97 (18.0)	19.18 (<.001)
Income				
Under $100,000	1,344 (77.7)	905 (75.9)	439 (81.6)	
$100,000 or more	386 (22.3)	287 (24.1)	99 (18.4)	6.89 (.009)
First deployment				
Vietnam	964 (56.0)	627 (52.8)	337 (63.1)	
Persian Gulf	252 (14.6)	174 (14.6)	78 (14.6)	
Iraq/Afghanistan/GWOT	338 (19.6)	264 (22.2)	74 (13.9)	
Other combat zones	168 (9.8)	123 (10.4)	45 (8.4)	21.56 (<.001)
Deployed Guard/Reserve				
No	1,065 (61.6)	717 (60.2)	348 (64.7)	
Yes	665 (38.4)	475 (39.8)	190 (35.3)	3.22 (.078)
Multiple warzone tours				
No	1,041 (60.3)	723 (60.8)	318 (59.2)	
Yes	686 (39.7)	467 (39.2)	219 (40.8)	0.37 (.559)
High combat exposure				
No	1,322 (76.4)	905 (75.9)	417 (77.5)	
Yes	408 (23.6)	287 (23.1)	121 (22.5)	0.52 (.501)
Low unit support/morale				
No	1,366 (79.0)	912 (76.5)	454 (84.4)	
Yes	364 (21.0)	280 (23.5)	84 (15.6)	13.84 (<.001)
Stressful events past year				
Low	1,355 (78.3)	935 (78.4)	420 (78.1)	
High	375 (21.7)	257 (21.6)	118 (21.9)	0.03 (.900)
Lifetime traumatic events				
Low	1,373 (79.4)	950 (79.7)	423 (78.8)	
High	356 (20.6)	242 (20.3)	114 (21.2)	0.20 (.653)
Ever apply VA disability				
No	918 (53.1)	657 (55.1)	261 (48.5)	
Yes	812 (46.9)	535 (44.9)	277 (51.5)	6.48 (.006)
Current VA disability				
No	1,101 (63.6)	777 (65.2)	324 (60.2)	
Yes	629 (36.4)	415 (34.8)	214 (39.8)	3.94 (.052)
Lifetime suicide ideation				
No	1,534 (88.7)	1,040 (87.2)	494 (91.8)	
Yes	196 (11.3)	152 (12.8)	44 (8.2)	7.72 (.005)
Lifetime depression				
No	1,349 (91.7)	1,086 (91.1)	501 (93.1)	
Yes	143 (8.3)	106 (8.9)	37 (6.9)	1.13 (.316)
Met criteria PTSD past year				
No	1,598 (92.4)	1,102 (92.4)	496 (92.2)	
Yes	132 (7.6)	90 (7.6)	42 (7.8)	0.04 (.845)
Self-rated health fair/poor				
No	1,094 (63.3)	778 (65.4)	316 (58.7)	
Yes	633 (36.7)	411 (34.6)	222 (41.3)	7.16 (.008)
Alcohol misuse past year				
No	1,313 (75.9)	910 (76.3)	403 (74.9)	
Yes	417 (24.1)	282 (23.7)	135 (25.1)	0.42 (.278)
Lifetime use VA services				
No	657 (38.0)	489 (41.0)	168 (31.2)	
Yes	1,073 (62.0)	703 (59.0)	370 (68.8)	15.10 (<.001)

Note. GWOT = Global War on Terrorism; VA = Veteran's Administration; PTSD = posttraumatic stress disorder.
[a]Fisher's Exact test, except age and first deployment; which used χ^2 test.

Table 2. Logistic Regression Odds Ratios (*OR*) and 95% Confidence Intervals (CI) for Suicide Ideation, Alcohol Misuse, and VA Service Use in the Veterans' Health Study ($N = 1,719$).

Sample characteristics	Lifetime suicide ideation, *OR* (95% CI)	Alcohol misuse past year (AUDIT-C), *OR* (95% CI)	Lifetime use VA services, *OR* (95% CI)
Age	0.99 (0.97–1.02)	0.96 (0.94–0.98)***	1.02 (1.00–1.04)*
Sex			
Female	2.89 (1.61–5.17)***	0.40 (0.23–0.71)**	1.50 (0.92–2.47)
Race			
White	1.11 (0.53–2.35)	0.74 (0.44–1.25)	0.67 (0.40–1.13)
Marital status			
Married	1.06 (0.70–1.47)	0.75 (0.57–0.98)*	1.03 (0.80–1.32)
Education			
College graduate	0.87 (0.60–1.27)	0.89 (0.67–1.18)	1.00 (0.78–1.28)
Income			
$100,000 or more	0.85 (0.57–1.27)	1.19 (0.90–1.58)	0.65 (0.50–0.84)***
First deployment			
Persian Gulf	1.33 (0.74–2.40)	0.90 (0.57–1.41)	0.86 (0.58–1.29)
Iraq/Afghan/GWOT	1.10 (0.52–2.36)	0.90 (0.51–1.58)	1.42 (0.85–2.37)
Other Zone	1.57 (0.83–2.98)	1.32 (0.81–2.14)	0.70 (0.45–1.07)
Deployed Guard/Reserve			
Yes	0.98 (0.69–1.39)	1.12 (0.87–1.45)	1.18 (0.94–1.49)
Multiple tours			
Yes	0.88 (0.64–1.23)	0.84 (0.66–1.07)	1.18 (0.96–1.47)
High combat exposure			
Yes	1.47 (1.03–2.09)*	1.01 (0.76–1.33)	2.22 (1.71–2.88)***
Stress events past Yr.			
High	2.31 (1.64–3.25)***	1.02 (0.77–1.36)	1.40 (1.07–1.84)*
Lifetime trauma			
High	1.56 (1.09–2.22)*	1.16 (0.88–1.55)	1.18 (0.90–1.54)
Centrality vet identity			
High	0.60 (0.42–0.87)**	1.28 (1.00–1.65)*	1.51 (1.21–1.90)***

Note. AUDIT-C = AUDIT alcohol consumption questions; GWOT = Global War on Terrorism; VA = Veterans Administration.
*$p < .05$. **$p < .01$. ***$p < .001$.

very important to them (36.2%), whereas only 22.2% of Iraq/Afghan veterans reported that this was very important to them. All of these differences are statistically significant ($p < .001$). We return to these findings in the Conclusion.

The multivariate logistic regression results for suicide ideation, alcohol misuse, and VA service use are shown in Table 2. We discuss the other outcomes in the text only. These results suggested that the more veterans in our study hold their veteran identity as a central aspect of how they see themselves, the less likely they were to report lifetime suicide ideation (odds ratio [*OR*] = 0.60, $p < .01$), but the more likely they were to meet criteria for alcohol misuse ($OR = 1.28$, $p < .05$) and to have ever used VA services ($OR = 1.51$, $p < .01$). Centrality of veteran identity was not related to depression, PTSD, or self-rated health, after controlling for other demographic, stress, and service use factors.

Demographic associations in the study tended to replicate other research based on the stress process model. More specifically, older veterans were less likely to meet criteria for depression ($OR = 0.97$, $p < .01$) or alcohol abuse ($OR = 0.96$, $p < .001$) but more likely to rate their health as poor/fair ($OR = 1.02$, $p < .01$) and to ever have used VA services ($OR = 1.02$, $p < .05$). Women were more likely to contemplate suicide ($OR = 2.89$, $p < .01$) and meet criteria for depression ($OR = 2.32$, $p < .01$) but less likely to meet criteria for alcohol abuse ($OR = 0.40$, $p < .01$), compared to men. Whites and college educated were less likely to rate their health poor/fair ($OR = 0.52$ and 0.77, respectively, $p < .05$ for both), than other racial groups and the less educated, married participants were less likely to meet criteria for alcohol abuse ($OR = 0.75$, $p < .05$), compared to the nonmarried, and veterans in the high income category were less likely to rate their health fair/poor or use VA services ($OR = 0.57$ and 0.64, $p < .001$ and .01, respectively). Neither deployment theater nor being deployed as a National Guard/Reserve were statistically related to any of the six dependent variables.

The stress variables assessed were also associated with the mental and physical well-being measures in expected directions. Veterans who reported high combat exposure were more likely to meet criteria for depression and PTSD ($OR = 2.20$ and 3.84, $p < .001$, respectively), compared to those who had less exposure to combat. In addition, veterans who scored high in combat exposure were more likely to rate their health as fair/poor and to have used VA services ($OR = 1.42$ and 2.22, $p < .05$ and .001, respectively). Experiencing many stressful life events over the past year had a significant association with most of our outcomes, with high stress related to suicide ideation, depression, PTSD, and poor health (*OR*s = 2.31, 2.58,

4.03, and 2.56, all $p < .001$). The outcomes related to lifetime traumatic events were suicide ideation ($OR = 1.56$, $p < .05$), depression ($OR = 1.65$, $p < .001$), and PTSD ($OR = 1.91$, $p < .01$).

Discussion

In this study, we focused on a number of variables deemed to be significant risk and protective factors for physical and mental health problems among a sample of formerly deployed veterans. All of them experienced deployment to combat zones and all received health care from the Geisinger Clinic in Pennsylvania. We used the stress process model and occupational mental health model to guide our variable selection. We also used social psychological theory (i.e., identity theory) to guide our discussion about associations between having a strong belief in the importance of one's veteran identity and measures of well-being. The main findings of our multivariate analyses suggested that the more central or important the veteran identity is to our study participants, the less likely they are to report suicide ideation, but the more likely they are to meet criteria for alcohol misuse. This suggests that veteran identity is not uniformly protective for this population and may have a complex relationship with well-being. The analysis also indicated that a prominent or important veteran identity was associated with ever receiving treatment services from the VA. As suggested, many veterans receive their healthcare from non-VA facilities, and recent changes in healthcare options for veterans will likely increase the use of non-VA providers in the future. Thus, understanding the risk and protective factors for veterans in non-VA healthcare delivery environments is critical (Boscarino et al., 2015). Further research is planned.

Although the use of veteran identity to better understand the general well-being of veterans has rarely been used (Hack, DeForge, & Lucksted, 2017), the few which have (Di Leon et al., 2016; Harada, et al., 2002) report results similar to ours for VA service use. More specifically, the more central or important the veteran identity was to the veteran, the more likely he or she used VA services. Although their measures of veteran identity were different from ours, Harada et al. (2002) also found lower suicide ideation among African American and Latino veterans who strongly identified as a veteran. Another point from our study is that Vietnam theater veterans are more likely to have a central veteran identity related to their military service. Hack et al. (2017) argued that VA outreach efforts that try to lower barriers to services, often use the veteran identity in their messages. An implication of our study is that the VA, and other service providers, may increase access among younger veterans, especially those serving in the Iraq/Afghan wars, by increasing the centrality of their veteran identity.

However, our results are not uniform in showing veteran identity as a protective factor. Alcohol misuse has been a longstanding concern among military healthcare providers and policy makers (Institute of Medicine[IOM], 2013), and as the results indicate, there is a slightly elevated risk of meeting criteria for alcohol misuse among those with high centrality for their veteran identity. Social psychological theory suggests several reasons for why this might be the case. Thoits (2013) has noted that some negative events can be related to valued identities and that these events can be particularly harmful to well-being. Given that over 50% of our sample scored very high on our veteran identity measure (11 or 12), it is possible that negative responses related to homecoming or inadequate social support for combat related trauma may be harmful to military personnel. This aspect of military personnel self-concept and self-definitions clearly warrants greater study.

We focus on centrality or importance of the veteran identity in this article, since almost all perspectives in psychiatry and clinical psychology contend that people's mental health is at least partially the result of positive self-definitions and possession of valued social identities (Thoits, 2013). Thus, having a strong, positive view of oneself as a veteran is a potential protective factor in this population. Additionally, the veteran identity connects veterans to other people and to military organizations which have provided support and care to them in the past during training and deployment (Greenberg & Jones, 2011). Finally, in their Occupational Mental Health Model, Adler and Castro (2013) argue that occupational resources can include the professional identity, which they describe as, "the willingness to embrace military values and culture" (pg. 43). In our study, military values and cultures are incorporated into the veteran identity, which provides one source of self-meaning and of mattering to others. (See Adams & Boscarino, 2015; Thoits, 2012, for an application of these ideas to the volunteer identity.)

As with any research project, our study has several strengths and limitations. In terms of strengths, we recruited a large random sample of community-based veterans receiving at least some of their treatment

from a non-VA facility. We also used standardized and validated scales and measures in our study from previous research (Boscarino et al., 2015; Boscarino et al., 2011). In addition, we included veterans from Vietnam to current conflicts and included multiple post-deployment outcomes, including PTSD, depression, suicidality, and use of VA health and mental health services. We used an explicit model (stress process and occupational mental health models) and social psychological theory to identify key variables affecting veteran well-being. Lastly, our study is one of the few to examine veteran identity and its relationship to health and service use outcomes. It adds to the growing, body of research on veteran identity and, hopefully, will encourage more studies on this -social psychological concept (Hack et al., 2017).

Nevertheless, our study has several limitations, including that it was based on a cross-sectional survey. It is possible that the associations found could be reversed in their causal ordering, such that those with postdeployment mental health issues may have a more negative recall of past events related to military service. In addition, although our sample was large and randomly selected, it was predominantly White male patients in s single multihospital system located in central and northeastern PA. We also specifically focused on veterans deployed to combat zones. Therefore, our results may not generalize to other geographic areas and other veteran populations. Our measure of suicide was only one item. Finally, we only examined one identity. Most people will have multiple identities (Stets & Serpe, 2013) and future research should explore how veteran identity relates to other identities that military personnel might have when examining their well-being. Despite these limitations, our study findings are consistent with the recent literature on military experiences (Adams et al., 2017; Adler & Castro, 2013; Bossarte et al., 2011; Boscarino et al., 2015; Fontana & Rosenheck, 1994; Hoge et al., 2004; Hoge, Auchterlonie, & Milliken, 2006; James et al., 2013; Kulka et al., 1990; Smith, Wang, Vaughn-Coaxum, Di Leone, & Vogt, 2017; Thomas et al., 2010), which suggests that veterans face a complex set of physical and mental health issues upon returning to civilian life. Veteran identity and postdeployment experiences related to that identity may have a significant impact on mental health outcomes and the utilization of both VA and non-VA healthcare services.

In conclusion, we argue that incorporating identity theory into the stress process (Thoits 2013) and occupational mental health model offers one way to use social psychological theory to increase our understanding of how military experiences impact the health and well-being of veterans. We are not the first to suggest merging identity theory and stress process (e.g., Thoits 1991) and hope that this study stimulates other research on veteran identity.

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Mental Health Impact of Homecoming Experience Among 1730 Formerly Deployed Veterans From the Vietnam War to Current Conflicts: Results From the Veterans' Health Study

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Abstract: We examined the effects of homecoming support on current mental health among 1730 deployed veterans from Vietnam, Iraq/Afghanistan, Persian Gulf, and other conflicts. The prevalence of current posttraumatic stress disorder (PTSD) was 5.4%, current depression was 8.3%, and 5.4% had suicidal thoughts in the past month. Overall, 26% of veterans had low homecoming support, which was more prevalent among Vietnam veterans (44.3%, $p < 0.001$). In multivariable logistic regressions, controlling for demographics, combat exposure, number of deployments, trauma history, and operational theater, low postdeployment support was associated with PTSD (odds ratio, 2.13; $p = 0.032$) and suicidality (odds ratio, 1.91; $p < 0.030$), but not depression. For suicidality, an interaction was detected for homecoming by theater status, whereby Iraq/Afghanistan veterans with lower homecoming support had a higher probability of suicidal thoughts ($p = 0.002$). Thus, years after deployment, lower homecoming support was associated with current PTSD and suicidality, regardless of theater and warzone exposures. For suicidality, lower support had a greater impact on Iraq/Afghanistan veterans.

Key Words: Veterans, health status, psychosocial factors, PTSD, suicidality

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"How was your homecoming experience?" is a common question asked by mental health practitioners caring for military veterans. In the current study, we examined the impact of homecoming support on mental health outcomes among community-based veterans, including Vietnam, Iraq/Afghanistan, Persian Gulf, and other recent veterans. Consistent with previous research (Adams et al., 2017; Boscarino et al. 2015), the objective of this study is to assess the impact of predeployment and postdeployment psychosocial factors on the mental health status of US veterans. Research related to service in Iraq and Afghanistan suggested that significant numbers of these service members developed mental health disorders after their deployments (Booth-Kewley et al., 2010; Hoge et al., 2004; Jacobson et al., 2008; Kok et al., 2012; Polusny et al., 2017). Earlier studies suggested significant rates of posttraumatic stress disorder (PTSD) and other health problems among former service members after the Vietnam War (Boscarino, 2006, 2007; Kulka et al., 1990b). In addition, a recent follow-up study among these veterans suggested that negative homecoming experiences predicted warzone-related PTSD symptoms up to 40 years postdeployment (Steenkamp et al., 2017).

Given previous research (Boscarino, 1995), our hypothesis was that the prevalence of mental disorders among veterans would be higher among those who experienced negative homecoming experiences, independent of warzone theater, and other variables, such as combat exposure and demographic factors. In the past, knowledge of the mental health impact of the homecoming experience on veterans' mental health had been limited (Frey-Wouters and Laufer, 1986; Lifton, 1973; Polner, 1971). However, more recent studies have confirmed that the homecoming experiences of Vietnam (Fontana and Rosenheck, 1994; Johnson et al., 1997; Koenen et al., 2003; Steenkamp et al., 2017; Schnurr et al., 2004), Croatian (Vuksic-Mihaljevic et al., 2000), and Israeli veterans (Neria et al., 1998), as well as the homecoming experiences of peace-keepers (Bolton et al., 2002), has had an impact on the mental health of veterans. A limitation of past research has been that these studies have primarily assessed the support of family and friends, which may be confounded. In addition, past studies typically assessed a single generation of veterans exposed to the same conflict. As discussed later, our assessment was primarily focused on postdeployment community support, which has been a significant issue among Vietnam veterans since the 1960s (Bowden, 2017). Furthermore, we assessed this homecoming impact among several generations of veterans from different conflicts, which to our knowledge, has not been previously investigated in the same study. As noted later, analysis of different cohorts of veterans has challenges, because these groups have unique differences but also overlap because some veterans have served in multiple conflicts. Nevertheless, understanding of deployment-related risk factors among former service members is important for prevention and treatment of mental health disorders among returning veterans (Adler and Castro, 2013).

METHODS

Sample

The population for the current study included a sample of community-based US military veterans recruited for a study of the health effects of military service (Adams et al., 2017; Boscarino et al., 2015; Lent et al., 2017). All veterans in the study were outpatients in the Geisinger Clinic, the largest multihospital system located in central and northeastern Pennsylvania (Boscarino et al., 2016). In 2007, Geisinger initiated a veterans' registry for patients receiving outpatient care and adult patients since then have been asked to complete a military history questionnaire. To date, over 30,000 patients have provided this information, and this database was used to select a random sample of veterans for the current study. Geisinger is an integrated health services organization with an advanced electronic health record system

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(www.geisinger.org). This system serves more than 3 million residents throughout 45 counties in central, south-central, and northeast Pennsylvania and encompasses a 25,000 square mile service area. The Geisinger system includes 30,000 employees, 1600 employed physicians, 9 hospital campuses, and a 551,000-member health plan (Boscarino et al., 2016).

With patient consent, trained and supervised interviewers administered structured health interviews by telephone from February 2016 through February 2017. All veterans recruited had one or more warzone deployment. Veteran status and deployment history were confirmed based on military records provided by the veteran. Among the ~10,000 veterans initially selected for the surveys, all were younger than 76 years and served in Vietnam or in another post-Vietnam conflict (*i.e.*, Iraq/Afghanistan, Global War on Terrorism [GWOT], Persian Gulf, or other recent conflict). After 10 telephone calls, we were able to complete 1730 interviews, for an estimated survey cooperation rate of 55% among those eligible for the survey (American Association for Public Opinion Research, 2008; Groves et al., 2009). Deceased patients, nursing home patients, institutionalized patients, those who did not serve in Vietnam, Iraq, Afghanistan, GWOT, Persian Gulf, or other recent post-Vietnam conflict were excluded from this study, as were those who were cognitively impaired, and those unavailable during the survey period.

Measures

To assess PTSD in our study, we used a questionnaire based on the *Diagnostic and Statistical Manual of Mental Disorder, Fifth Edition* (*DSM-5*), the PTSD Checklist (Blevins et al., 2015; Bovin et al., 2016). To receive a diagnosis of PTSD, veterans had to meet the *DSM-5* diagnostic criteria A through G within the past 12 months (American Psychiatric Association, 2013). This PTSD scale has been used in several recent studies (Cox et al., 2014; Hoge et al., 2014, Wortmann et al., 2016), although there has been debate related to the changes in *DSM-5* (Hoge et al., 2016). Nearly 80% of the veterans in the current study reported that the most significant lifetime stressor they experienced was warzone exposure. In addition to PTSD, the survey collected data related to the veteran's military history, concussion exposure, combat exposure, and demographic background. Concussion history was assessed based on reported concussions experienced during military service (*e.g.*, ever dazed, confused, saw stars, or knocked out), a concussion scale that has been widely used and validated in previous research (Boscarino et al., 2015; Schwab et al., 2006).

Depression was assessed using a major depressive disorder scale based on the *DSM-4* diagnostic criteria (First and Tasman, 2004; First et al., 1997; Spitzer et al., 1992), which has been used extensively in previous trauma studies (Acierno et al., 2000; Boscarino et al., 2004a, 2014, 2015; Kilpatrick et al., 2003). This measure has been used in telephone-based surveys of World Trade Center Disaster survivors (Boscarino et al., 2006; Galea et al., 2002). Data related to the validity of this depression scale were previously reported and suggest that this scale can be used to diagnose depression in population studies (Boscarino et al., 2004b; Kilpatrick et al., 2003). To meet criteria in the study, subjects had to meet the full *DSM-4* criteria for major depression within the past 12 months.

Other postdeployment health outcomes assessed included a measure of suicidality from the Brief Symptom Inventory-18 (BSI-18) scale (Derogatis, 2001). This symptom was assessed for the past 30 days ("please tell me how much thoughts of ending your life distressed or bothered you in the past 30 days"), which was consistent with the current PTSD and depression timeframes used (*i.e.*, past 12 months). The BSI-18 scale is a widely used psychological symptom scale, originally developed from the Hopkins Symptom Inventory, which has a long history in psychiatric research (Adams et al., 2006a; Derogatis and Cleary, 1977; Derogatis et al., 1973, 1976; Franke et al., 2011; Prinz et al., 2013).

Potential mental health risk and protective factors also assessed in the study included demographic factors (*e.g.*, age, sex, race, marital status, and education), multiple warzone deployments, and combat exposure, which were all derived from the survey instruments and used in previous research (Adams et al., 2017; Boscarino et al., 2015). Warzone exposures included the Vietnam War, Persian Gulf War, Afghanistan/Iraq War, and "other" recent warzone deployments, as currently defined by the VA, which encompasses four veteran cohorts of interest: Vietnam, Persian Gulf, Iraq/Afghanistan, and other post-Vietnam deployed veterans. Global War on Terrorism (GWOT) veterans ($n = 70$) were combined with Iraq/Afghanistan veterans, because these deployments were during the same timeframe and were in supporting theaters of operations. Combat exposure was based on the Combat Experience Scale, which is a widely used measure of combat exposure first used in the Vietnam Legacy Study (Frey-Wouters and Laufer, 1986; Laufer et al., 1984). Versions of this scale have been used in key studies since the Vietnam War, including the Vietnam Experience Study, the National Vietnam Veterans Readjustment Study, the Vietnam Twin Registry, among others (Centers for Disease Control, 1988; Boscarino, 1996; Boscarino et al., 2010; Kulka et al., 1990a; McLeod et al., 2001). The Combat Experience Scale used in the current study was updated for recent conflicts (Adams et al., 2017; Boscarino et al., 2015; Lent et al., 2017). Based on previous research, scale measures for combat exposure were divided into cut-points described elsewhere (Adams et al., 2017; Boscarino et al., 2015).

Our study also assessed the occurrence of 12 lifetime traumatic events (*e.g.*, forced sexual contact, domestic abuse, a serious accident, served in a warzone, experienced a major disaster) (Freedy et al., 1993). As we had no a priori method to judge the severity of these events, based on previous research, we collapsed these exposures into three categories: less than three traumatic events, three to five events, and six or more events. A total of 21% of respondents experienced six or more lifetime traumatic events in the current study. This traumatic event scale was developed from other trauma studies, was used in previous research, and had good reported reliability and validity (Adams and Boscarino, 2006; Boscarino et al., 2004a, 2012, 2013, 2014, 2015; Galea et al., 2002; Freedy et al., 1993; Resnick et al., 1993).

Homecoming support was assessed by four Likert survey items (rated "strongly agree" to "strongly disagree") from the postdeployment section of the Deployment Risk & Resilience Inventory (DRRI), which asked veterans to report their homecoming experiences (*e.g.*, "when I retuned, people made me feel proud to have served," "the reception I received when I returned from deployment made me feel appreciated," "the American people made me feel at home," etc.) (Vogt et al., 2008). The Cronbach's alpha for this DRRI subscale in the current study was 0.86. Those scoring in the lowest quartile were classified as having low homecoming support. Total scores on this scale ranged from 0 to 16 (mean, 9.36; SD, 5.20).

Our study also included measures of current life stressors, current social support, deployment unit support, and VA service use, all of which were based on survey questions (Adams et al., 2017; Boscarino et al., 2015). Current life stressors included a count of eight experiences that could have happened to the respondent in the past 12 months (*e.g.*, death of spouse or close family member, being injured, problems at work, getting married, having financial problems, etc.). Experiencing two or more of these events in the past 12 months (~22% of the survey sample) was classified as high exposure to stressful life events. As with the traumatic event scale, this life stress scale was developed from other trauma studies, used in previous research, and had good reported reliability and validity (Adams and Boscarino, 2006; Boscarino et al., 2004a, 2012, 2013, 2014, 2015; Galea et al., 2002; Freedy et al., 1993; Resnick et al., 1993). Unit support was based on survey items from the DRRI, which asked the veterans to report on their unit experiences during deployment (*e.g.*, "felt a sense of camaraderie between myself and others in my unit") (Vogt et al., 2008).

Cronbach's alpha for this scale in the current study was 0.78. Those scoring in the lowest quartile were classified as having low unit support during deployment. The social support scale used was a version included in the Medical Outcomes Study (Sherbourne and Stewart, 1991) that was used in past trauma research (Boscarino et al., 2004a, 2014; Galea et al., 2002; Freedy et al., 1993). Items for this scale were based on a 4-point Likert scale rated "none of the time" to "all the time" (*e.g.*, someone available to help you if you were confined to bed?) (Boscarino et al., 2014). This scale has been used in previous trauma studies and is considered a reliable and valid measure of current social support (Boscarino et al., 2004b; Galea et al., 2002). This scale was used as a categorical measure in the current study, with low social support defined as the lowest quintile (Boscarino et al., 2014). Cronbach's alpha for this scale in the current study was 0.84. Finally, for descriptive purposes we included several questions related to VA service use and VA disability status used in previous research (Boscarino et al., 2015).

It is noted that our study was guided, in part, by a psychosocial stress model, which is focused on the availability of psychosocial resources and the impact of environmental factors in the onset and course of mental disorders (Adams and Boscarino, 2011; Adams et al., 2006a, 2006b; Rosen et al., 2012; Yamashita, 2012). This model guided our instrument selection and data analyses (Adams et al., 2017).

Data Analyses

Statistical analyses included descriptive statistics depicting the study population and testing the association between mental health status and the postdeployment homecoming experience. For descriptive purposes, we present the characteristics of the study population and show these results in Tables 1 and 2. Because there were differences expected between the Vietnam and post-Vietnam cohorts, we present these results in Table 3 and discuss these differences. To minimize bias, we also describe these results using pairwise comparisons of column proportions, with a Bonferroni correction for multiple comparisons (Statistical Package for the Social Sciences, 2012; Dawson and Trapp, 2004). For multivariate analyses, we used logistic regression, whereby key risk/protective factors (*e.g.*, combat exposure, cohort status, lifetime trauma exposure, number of deployments, other mental disorders, etc.) were used to estimate the likelihoods (*i.e.*, odds ratios) for PTSD, depression, and suicidality, respectively, controlling for age, sex, marital status, level of education, and other factors that might affect these associations by including these variables in the regression analyses (Table 4).

All the variables shown in the final multivariate models are included in the analyses presented, otherwise footnoted in Table 4. Because previous reports suggest that the postdeployment homecoming experiences might vary by theater status (Bowden, 2017; Frey-Wouters and Laufer, 1986; Polner, 1971), in our final analyses, we assess interaction effects for homecoming by warzone theater as a final analysis step. We did this by using cross-product terms (*i.e.*, theater × homecoming score) entered in the final regression step that also included the main effects (Harrell, 2001; Hosmer and Lemeshow, 2000). For this interaction assessment, homecoming used as a continuous scale (range, 0–16). Finally, in the discussion section of the article, we discuss study results as they relate to similar studies. Analyses were conducted using Stata, version 13.1 software (Stata Corporation, 2013).

Review Board Approval

This study was approved by the Institutional Review Boards of the Geisinger Clinic and the Department of Defense. All patients provided their informed consent to participate in the study and were offered small monetary incentives for participation.

RESULTS

Using the medical and demographic data included in the patient's electronic medical records, we examined the differences between survey respondents and nonrespondents in terms of sex, race, age, marital status, having a primary care physician, employment status, smoking status, and the prevalence of major health conditions (Boscarino et al., 2015). The only significant differences found were that survey respondents tended to be younger and married ($p < 0.05$).

Most veterans studied were older than 65 years (56.6%), male (95.1%), white (95.7%), and were currently married (77.5%). In addition, 23.6% were deployed guard/reserve service members, 56.2% were Vietnam veterans, and 49.8% were US Army veterans (Table 1). Furthermore, 28.4% reported experiencing a concussion during deployment,

TABLE 1. Demographic Profile of Veterans in Veterans' Health Study ($N = 1730$)

Variables	(*n*) %	(95% CI)
Age, yrs		
18–39	(177) 10.2	8.9–11.8
40–64	(574) 33.2	31.0–35.4
65 or older	(979) 56.6	54.2–58.9
Sex		
Female	(85) 4.9	4.0–6.0
Male	(1645) 95.1	94.0–96.0
Race		
Nonwhite	(75) 4.3	3.5–5.4
White	(1655) 95.7	94.6–96.5
Married		
No	(390) 22.5	20.6–24.6
Yes	(1340) 77.5	75.4–79.4
College grad or higher		
No	(1301) 75.2	73.1–77.2
Yes	(429) 24.8	22.8–26.9
Deployed as guard/reserve		
No	(1322) 76.4	74.4–78.4
Yes	(408) 23.6	21.6–25.6
Multiple warzone tours		
No	(1041) 60.3	58.0–62.6
Yes	(686) 39.7	37.4–42.1
Warzone*		
Vietnam	(972) 56.2	53.8–58.5
Persian Gulf	(275) 15.9	14.3–17.7
Iraq/Afghanistan/GWOT	(396) 22.9	21.0–24.9
Other post-Vietnam conflict	(245) 14.2	12.6–15.9
Combat exposure		
Low	(535) 30.9	28.8–33.2
Moderate	(633) 36.6	34.4–38.9
High	(562) 32.5	30.3–34.7
Service branch*		
Air force	(288) 16.7	15.0–18.5
Army	(861) 49.8	47.4–52.1
Navy	(374) 21.6	19.7–23.6
Marines	(194) 11.2	9.8–12.8
Services used*		
Ever used VA	(1073) 62.0	59.7–64.3
Currently use VA	(864) 49.9	47.6–52.3
Ever applied for VA disability	(812) 46.9	44.6–49.3
Currently have VA disability	(629) 36.4	34.1–38.7

*Multiple responses allowed.
CI, confidence interval.

5.4% met the criteria for current PTSD, 8.3% met criteria for current major depression, and 5.4% had suicidal thoughts in the past 30 days (Table 2). Examination of veteran cohort status by deployment history, risk/protective factors, and deployment outcomes suggests that, compared with other veterans, Vietnam veterans appeared to be older, more often male, more often white, more often married, and less often served on multiple deployments (Table 3). Conversely, Vietnam veterans appeared less likely to have high current stress, current PTSD, and current depression. However, Vietnam veterans were more likely to report low homecoming support postdeployment, compared with other veterans (44.3%, $p < 0.001$) (Table 3). Using pairwise comparisons of column proportions for these different veteran cohorts, with a Bonferroni correction for multiple comparisons, generally confirmed these associations with two noteworthy exceptions. Gulf War veterans had significantly lower combat exposure and significantly lower rates of concussion.

In multivariable analyses, significant predictors of current PTSD were high lifetime trauma exposure ($p < 0.001$), high combat exposure ($p < 0.01$), current depression ($p < 0.001$), current suicidality ($p < 0.05$), and low homecoming support ($p < 0.05$) (Table 4). The significant predictors of current depression included moderate ($p < 0.01$) and high ($p < 0.01$) lifetime trauma exposure, high combat exposure ($p < 0.001$), current PTSD ($p < 0.001$), and recent suicidality ($p < 0.001$). However, low homecoming support was not significant for this outcome. In addition, for veterans, significant predictors of recent suicidality were current PTSD ($p < 0.01$), current depression ($p < 0.001$), and low homecoming support ($p < 0.05$) (Table 4). Of note, guard/reserve status, serving on multiple tours, and theater status were not associated with any of these three study outcomes, nor were the demographic factors we assessed. Because there was a significant difference found for current stressful life events between the veteran groups assessed (Table 3), we added this measure to the regression models for PTSD and suicidality, but this did not change these results. We also assessed interactions effects for theater status by homecoming support score and these were nonsignificant, except for current suicidality among the Iraq/Afghanistan veterans. In this case, a significant interaction was detected, whereby Iraq/Afghanistan veterans with low homecoming support scores were more likely to experience suicidality than other the veterans ($p < 0.002$), as shown in the effects plot presented in Figure 1.

TABLE 2. Psychosocial Profile of Veterans in Veterans' Health Study ($N = 1730$)

Variables	(N) %	(95% CI)
Lifetime trauma exposure		
Low	(608) 35.2	33.0–37.5
Moderate	(765) 44.3	41.9–46.6
High	(356) 20.6	18.8–22.6
Current social support		
High	(1416) 81.9	80.0–83.6
Low/moderate	(314) 18.1	16.4–20.0
Current stress exposures		
Low/moderate	(1355) 78.3	76.3–80.2
High	(375) 21.7	19.8–23.7
History of deployment concussion		
No	(1239) 71.6	69.4–73.7
Yes	(491) 28.4	26.3–30.6
Low unit support during deployment		
No	(1366) 79.0	77.0–80.8
Yes	(364) 21.0	19.2–23.0
Low home support after deployment		
No	(1273) 73.6	71.5–75.6
Yes	(457) 26.4	24.4–28.6
Current PTSD (past year)		
No	(1637) 94.6	93.5–95.6
Yes	(93) 5.4	4.4–6.5
Current depression (past year)		
No	(1587) 91.7	90.3–92.4
Yes	(143) 8.3	7.1–9.7
Current suicidality (past month)		
No	(1636) 94.6	93.4–95.5
Yes	(94) 5.4	4.5–6.6

CI, confidence interval.

TABLE 3. Veteran Cohort Status by Postdeployment Risk Factors and Health Outcomes ($N = 1722$)*

	Veteran Cohort Status				
	Vietnam	Gulf	Iraq/Afghan	Other	
Variables	%	%	%	%	p
Male sex	99.8	89.7	87.9	91.1	<0.001
Age 45+ yrs	100.0	90.8	40.4	76.2	<0.001
White race	97.4	91.3	93.5	96.4	<0.001
Married	80.2	74.6	72.5	76.8	0.017
Multiple deployments	30.9	49.6	50.3	53.9	<0.001
High combat exposure	26.7	14.3	25.4	16.1	<0.001
Concussion history	29.9	19.0	30.2	30.4	0.005
High current stress	15.5	30.2	27.8	30.4	<0.001
Low unit support	22.5	15.5	19.8	23.8	0.071
Low current support	17.7	19.4	18.0	19.6	0.888
Low home support	44.3	2.0	2.1	9.5	<0.001
Current PTSD	5.9	7.5	12.1	8.9	0.003
Current depression	4.8	11.9	13.0	13.7	<0.001
Current suicidality	4.8	6.3	6.2	6.5	0.567
n	(964)	(252)	(338)	(168)	—

*Veteran status based on first deployment mentioned, because veterans may have had multiple deployments.

DISCUSSION

Given previous research (Boscarino, 1995, 2007; Steenkamp et al., 2017), our premise was that the prevalence of mental disorders among veterans would be higher among those who experienced negative homecoming experiences, regardless of the theater of deployment. Until recently, the impact of the homecoming experience on veterans' mental health status has been mostly anecdotal (Polner, 1971; Frey-Wouters and Laufer, 1986). However, investigators for the National Vietnam Veterans Longitudinal Study (NVVLS) reported that postdeployment risk factors, including the homecoming experience, predicted warzone-related PTSD up to 40 years postdeployment (Steenkamp et al., 2017). There have been previous studies that have examined the impact of homecoming on mental health outcomes among veterans (Fontana and Rosenheck, 1994; Johnson et al., 1997; Koenen et al., 2003; Neria et al., 1998; Vuksic-Mihaljevic et al., 2000), but these mostly assessed the support of family and friends, which may be confounded.

As shown, low postdeployment community homecoming support was associated with PTSD and suicidality, but not depression. Thus, our PTSD finding is consistent with the NVVLS findings (Steenkamp et al., 2017). Recently, there has been an increased focus on psychosocial factors occurring in the predeployment, deployment, and postdeployment periods for service members to minimize the adverse impact of warfighting among veterans (Adler and Castro, 2013; Vogt et al., 2013). We note that

TABLE 4. Multivariable Logistic Regressions Predicting Current PTSD, Depression, and Suicidality Among Veterans (N = 1730)[a]

	PTSD		Major Depression		Suicidality[b]	
Variables	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Life time trauma low (ref)	1.00	—	1.00	—	1.00	—
Life time trauma moderate	1.72	(0.80–3.71)	2.39**	(1.35–4.24)	1.47	(0.82–2.63)
Life time trauma high	4.40***	(2.04–9.50)	2.42**	(1.30–4.53)	1.50	(0.77–2.92)
National guard/reserve	1.24	(0.62–2.51)	0.78	(0.45–1.35)	1.31	(0.66–2.57)
Multiple tours	0.95	(0.56–1.60)	0.87	(0.56–1.35)	0.75	(0.46–1.24)
Iraq/Afghan/GWOT deployment	1.01	(0.35–2.90)	1.56	(0.73–3.34)	1.30	(0.50–3.38)
Persian Gulf deployment	0.90	(0.34–2.36)	1.40	(0.69–2.82)	1.74	(0.74–4.09)
Vietnam deployment	0.82	(0.22–3.00)	0.65	(0.25–1.71)	2.76	(0.84–9.07)
Other deployment	0.75	(0.34–1.67)	1.62	(0.90–2.93)	1.98	(0.99–3.97)
Combat low (ref)	1.00	—	1.00	—	1.00	—
Combat moderate	1.66	(0.67–4.12)	1.85	(0.99–3.43)	0.99	(0.54–1.82)
Combat high	4.24**	(1.79–10.01)	3.07***	(1.65–5.69)	0.86	(0.45–1.63)
Current PTSD	—	—	8.35***	(4.97–14.04)	2.43**	(1.27–4.65)
Current depression	8.79***	(5.18–14.90)	—	—	6.36***	(3.67–11.00)
Current suicidality	2.34*	(1.19–4.61)	6.39***	(3.70–11.04)	—	—
Homecoming support low	2.13*	(1.07–4.25)	1.16	(0.65–2.08)	1.91*	(1.06–3.42)

[a]Regressions also included age, sex, race, marital status, education level in the final models, none were statistically significant.

[b]Interaction effect detected for suicidality and Iraq/Afghan/GWOT × homecoming score: OR = 0.81, p = 0.002 (see Figure 1 for interaction results in this model).

*p < 0.05. **p < 0.01. ***p < 0.001.

OR, odds ratio; GWOT, Global War on Terrorism.

similar research efforts emerged after the terrorist attacks in New York City on September 11, 2001, among trauma-exposed civilian populations (Adams and Boscarino, 2006; Hobfoll et al., 2009; Norris et al., 2009; Pietrzak et al., 2014). The detection of an interaction effect for homecoming support score by Iraq/Afghanistan veteran status is an intriguing finding, given that Vietnam veterans were known to have received lower homecoming support postdeployment, compared with more recent veterans (Bowden, 2017), as was shown in Table 3.

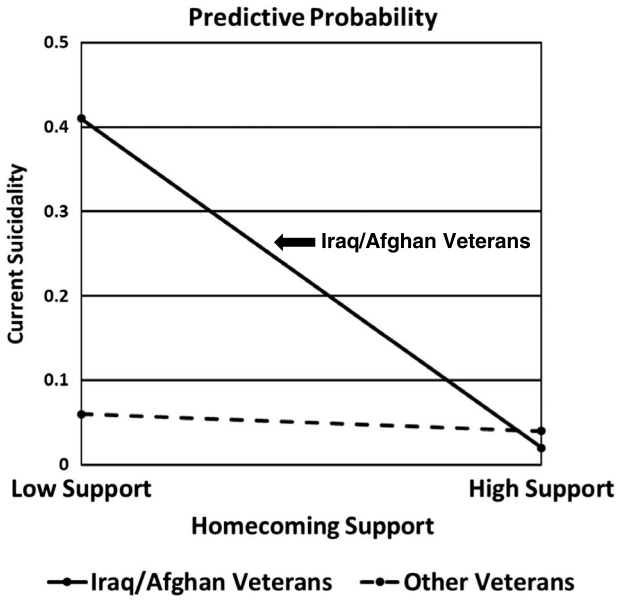

FIGURE 1. Current suicidality by homecoming support score and veteran status (N = 1730).

Nevertheless, Iraq/Afghanistan veterans with lower homecoming support scores were more likely to experience recent suicidal thoughts (Fig. 1).

The current study has several strengths. First, we recruited a large sample of community-based veterans. Second, we used validated scales and measures from previous research (Adams and Boscarino, 2006; Boscarino et al., 2015). Third, we included veterans from Vietnam through to current conflicts in Iraq and Afghanistan, something not typically done in the same study. Fourth, we examined several postdeployment outcomes, including current PTSD, depression, and current suicidality. Fifth, our homecoming measure was focused on community-level support not just family-level support, which may be confounded. Sixth, our multivariable analyses included all the mental health outcomes studied in the final models, considered a conservative approach, because these outcomes tend to be interrelated (Boscarino et al., 2004a). Nevertheless, the results for PTSD and suicidality remained statistically significant (Table 4).

However, our study has several limitations, including that the study was based on a cross-sectional survey. Because of this limitation, it is possible that the associations found in our study could be reversed (Hulley et al., 2013), such that those with postdeployment mental health issues may have a more negative recall of community homecoming support. In addition, although our study was based on a large survey, the study was conducted among mostly white patients in a multihospital system located in central and northeastern Pennsylvania. Furthermore, we found some survey response differences, whereby survey respondents tended to be younger compared with nonrespondents (p < 0.05). Thus, it may not be possible to fully generalize these findings to other geographic areas and study populations. As noted elsewhere, however, there are few stable national samples of veterans available, because this population is dynamic, given different deployments, ongoing conflicts, and the aging of the veteran population (Boscarino, 2007; Hynes et al., 2007; Shen et al., 2003). In addition, most veterans do not use the VA system for health care (Boscarino et al., 2015), which complicates identifying representative samples of veterans for clinical research. Nevertheless, although there were significant differences found between the

veteran cohorts in bivariate analyses (Table 3), there were no differences detected in the final multivariable analyses (Table 4).

CONCLUSIONS

Despite these limitations, our findings are consistent with a recent 40-year follow-up study conducted by NVVLS investigators (Steenkamp et al., 2017). Those researchers reported that the service members' homecoming experiences had an adverse impact on mental health decades after deployment. To our knowledge, this postdeployment risk factor has not been previously studied among a multigenerational sample of community-based veterans. We suggest that services to returning veterans that result in a positive and sustained homecoming experiences are important. Further research is advised to both confirm our findings and improve "welcome home" programs that enhance mental health among retuning veterans and their families. Although our sample is limited, it is interesting that Iraq/Afghanistan veterans with low homecoming support scores were more likely to experience recent suicidality (Fig. 1). This was unexpected and warrants further investigation. Although some have advocated a broad occupational health model for service members (Adler and Castro, 2013), it has been suggested that there are few specific behavioral health models to improve the "homecoming" experience for veterans (Bolton et al., 2002; Boscarino, 2007). Although recent research progress has been made (Steenkamp et al., 2017), the reasons why veterans with low homecoming support are at greater risk for both current PTSD and recent suicidality are unclear. Given ongoing conflicts, better understanding of the "active ingredients" of the homecoming experience need to be further delineated, to prevent the onset of mental illness among the next generation of returning service members.

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The study team acknowledges the efforts of the 1730 veterans who took part in this study. The study Principal Investigator dedicates this research to his twin brother, a Vietnam veteran who never had a homecoming and never found peace, but motivated him to conduct trauma studies so others may avoid his outcome (https://vimeo.com/235786674/e758e9b34c).

DISCLOSURE

The authors declare no conflicts of interests related to this research.

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Grapheme-Color Synesthesia is Associated with PTSD Among Deployed Veterans: Confirmation of Previous Findings and Need for Additional Research

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ABSTRACT: *Post-traumatic stress disorder (PTSD) is related to alteration in neuropsychological functioning, including visual and other cognitive processes. Grapheme-color synesthesia is a phenomenon in which a letter or number elicits response of a concurrent image or color perception. Since we earlier reported an association between grapheme-color synesthesia and PTSD, our objective in the current study was to validate this association among a new study group and assess risk factors. For this, we surveyed 1,730 military veterans who have been outpatients in the Geisinger Clinic, a multi-hospital system in Pennsylvania, USA. All the study veterans served in a warzone deployment. The association between PTSD and Grapheme-color synesthesia was evaluated. The average age of veterans was 59.6 years among whom 95.1% were male. Current PTSD prevalence rate was observed to be 7.6% (95% C.I. = 6.5-9.0) and in 3.4% of veterans (95% C.I. = 2.7-4.4) grapheme-color synesthesia was found to be positive. Initial bivariate analyses suggested that synesthesia was associated with current PTSD [odds ratio (OR) = 3.3, p<0.001]. Multivariable stepwise logistic regression evaluating the age, sex, education, trauma exposure, current psychological stress, psychotropic medication use, combat exposure, history of concussion, and current depression, confirmed this association (OR = 2.33, p = 0.019). The present study corroborated that Grapheme-color synesthesia was linked to PTSD among a second cohort of deployed military veterans. Further research is recommended in order to validate this observation and to determine whether synesthesia is a risk factor for PTSD.*

KEYWORDS: *Post-traumatic stress disorder, Depression, Synesthesia, Veterans, Risk factors, Trauma exposure*

ABBREVIATIONS

CES: Combat Experience Scale; DSM-IV: Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; DSM-5: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition; GC: Geisinger Clinic; PTSD: Post-traumatic Stress Disorder

INTRODUCTION

Synesthesia represents a phenomenon in which sensations arise in an unrelated sense modality upon presentation with one sensory modality (Brang & Ramachandran, 2011). Previous studies suggests that synesthesia is prevalent at the rate of about 3-4% among the general population (Asher et al., 2009) with an increased prevalence in first-degree relatives (Baron-Cohen, Burt, Smith-Laittan, Harrison, & Bolton, 1996). Grapheme-color synesthesia is the most common form of synesthesia (Simner & Carmichael, 2015), whereby a number or a letter elicits a concurrent image or a specific color perception (Niccolai, Jennes, Stoerig, & Van Leeuwen, 2012).

Synesthesia may be a marker for underlying neurophysiologic and neuroanatomic changes resulting in cross activation of brain maps (Ramachandran & Hubbard, 2001). Recently it has been suggested that certain mechanisms associated with synesthesia and associated processes may reflect psychopathological symptoms related to enhanced temporo-limbic excitability (Neckar & Bob, 2016). Since brain activity during synesthetic color experiences appears to develop from within the ventral temporal lobe, it has been proposed that the phenomenon of grapheme-color synesthesia manifests from abnormal cross-wiring or feedback between different regions of the brain engaged in extracting visual characteristics of form and color (Mattingley, 2009), although this hypothesis has been questioned (Hupe & Dojat, 2015).

Synesthesia has also been linked to some medical conditions, such as irritable bowel syndrome (IBS), migraine headache, and Asperger syndrome (Alstadhaug & Benjaminsen, 2010; Carruthers, Miller, Tarrier, & Whorwell, 2012; Neufeld et al., 2013). Individuals with synesthesia also appear to have particular personality traits (Hoffman et al., 2018; Rouw & Scholte, 2016), but further systematic research is required to validate this association.

Nevertheless, synesthesia may confer a benefit to some individuals, noting that synesthetes are more commonly engaged in the arts and that increased creativity has been associated with grapheme- and sound-color synesthesia (Lunke & Meier, 2018). Heightened associative learning (Bankieris & Aslin, 2016) and enhanced visual memory have been found in grapheme-color synesthetes, particularly for visual recognition of abstract images where color can be used to discriminate changes (Rothen, Tsakanikos, Meier, & Ward, 2013). In addition, research indicates that synesthetes have superior visual perception and cognition, as well as increased cortical excitation potential in the primary visual cortex (Banissy et al., 2013; Terhune, Wudarczyk, Kochuparampil, & Cohen Kadosh, 2013; Terhune et al., 2015).

However, when a synesthete is exposed to stressful conditions, such as military combat or other potentially traumatic experiences, we suggest that synesthesia could become a liability. For example, the disturbing sights, sounds, and other sensations experienced during combat could be intensified in synesthetes and thereby increase their risk for developing PTSD. Furthermore, enhanced associative learning, visual perception, and visual memory could predispose synesthetes to flashbacks and rumination about the traumatic exposure. An earlier study conducted among 700 deployed veterans was the first to suggest the association of synesthesia and PTSD, reporting an adjusted odds ratio (OR) of 3.2 (95% CI = 1.3-8.1. p = 0.015) (Hoffman, Zhang, Erlich, & Boscarino, 2012). In the current study, our objective was to confirm this association among a second cohort of deployed veterans and to assess additional factors that could confound this association.

METHODS

The population in the present study was obtained by random sampling from a military veterans' community, who were

recruited for an even larger study pertaining to the evaluation of health effect of military service. All the veterans in the study population were outpatients in the Geisinger Clinic (GC), which is one of the largest multi-hospital systems in Pennsylvania (Boscarino et al., 2016). Based upon the medical record numbers, 1,730 previously identified veterans were recruited randomly for interviews in the present study. With patient consent, trained and supervised interviewers conducted structured and diagnostic telephonic interviews from February 2016 through February 2017, for evaluation of mental health. All veterans recruited had one or more warzone deployments and were under 76 years old. Veteran status and deployment history were confirmed based on military records. In the survey, the cooperation rate was estimated to be 55% (Boscarino et al., 2018).

Based on twin and family studies, it was suggested that PTSD is moderately heritable, with genetic factors accounting to about 30% of this disorder (Stein, Jang, Taylor, Vernon, & Livesley, 2002). So far, genetic variations associated with the biological pathways of hypothalamic-pituitary-adrenal (HPA), locus coruleus/noradrenergic and the limbic system were identified (Boscarino, Erlich, Hoffman, & Zhang, 2012; Broekman, Olff, & Boer, 2007). However, further systematic research is needed to decipher the key risk factors for the manifestation of PTSD (Duncan et al., 2018).

To assess PTSD in the present study, we used a questionnaire based on the Diagnostic and Statistical Manual of Mental Disorder, Fifth Edition (DSM-5) and the checklist of the PTSD (Blevins, Weathers, Davis, Witte, & Domino, 2015; Wortmann et al., 2016). In order to receive the diagnosis of PTSD, veterans had to meet the DSM-5 diagnostic criteria (American Psychiatric Association, 2013). This PTSD scale was used in previous studies (Hoge, Riviere, Wilk, Herrell, & Weathers, 2014). However, since our previous study was based on the DSM-IV PTSD criteria (Hoffman et al., 2012), for consistency in the current study, we converted the DSM-5 diagnostic criteria to DSM-IV criteria, using a formulation developed by (Rosellini et al., 2015). For the current study, the Kappa statistic for DSM-5 vs. DSM-IV was very high (Kappa = 0.893), suggesting strong agreement between these two PTSD scales.

Survey questions described in the studies of Hoffman et al. (2012) as well as Rouw & Scholte (2007) were used in the present study for the assessment of synesthesia. These questions were related to most common form of synesthesia. For example, whether they saw any color upon looking at a certain number or letter. Responses to this question were categorized on a 4-point Likert scale, coded as "strongly disagree," "disagree," "agree," and "strongly agree" (Rouw & Scholte, 2007). Those who responded "strongly agree" or "agree" to this question were classified as synesthesia positive cases. Data pertaining to the military history, medical history, demographic factors, as well as current depression PTSD based on DSM diagnostic criteria (Boscarino, Adams, & Figley, 2011; Boscarino, Hoffman, Pitcavage, & Urosevich, 2015) and combat exposure using Combat Experience Scale (CES) (Boscarino, 1995; Boscarino et al., 2015) and concussion (e.g., ever dazed, confused, saw stars, or knocked out) history (Schwab et al., 2006) during military service were also collected. Use of the mental health service, medication, psychological stress, and trauma exposures measures were evaluated based on standard mental health scales described in previous studies (Boscarino et al., 2011; Boscarino et al., 2015; Boscarino et al., 2018)

Statistical Analysis

Statistical analyses included descriptive statistics and testing of hypothesis. Descriptive statistics of the study population were presented. Multivariable logistic regression was applied for testing the hypothesis whether there is any association between PTSD and synesthesia. Synesthesia was used as a factor to predict PTSD first independently in bivariate analyses and then evaluating the effects of age, gender, marital status, education, psychotropic medication use, current life stress, traumatic stress exposure, combat exposure, depression, and history of concussion using logistic regression.

For descriptive purposes, we review the characteristics of the study population and present these results in Table 1. For analyses testing the study hypothesis that there is an association between PTSD and synesthesia, we used multivariable logistic regression, whereby synesthesia was used to predict PTSD, first, independently in bivariate analyses and then assessing for the effects of age, gender, marital status, education, psychotropic medication use,

Table 1.
Profile of Deployed Veterans in Geisinger Clinic Study (N=1,730)*

Variable (Demographic/health)	(N)†	Percentage (%) or Mean	95% CI
Age (average)	(1729)	59.6	58.9-60.2
Male sex	(1645)	95.1	94.0-96.0
White race	(1655)	95.7	94.6-96.5
Married	(1340)	77.5	75.4-79.4
College graduate or higher	(429)	24.8	22.8-26.9
High combat exposure	(408)	23.6	21.6-25.6
High lifetime trauma exposure	(357)	20.6	18.8-22.6
High current life stressors	(375)	21.7	19.8-23.7
History of in-service concussion	(491)	28.4	26.3-30.6
Use psychotropic meds-Past year	(384)	22.2	20.3-24.2
Major depression-Past year	(143)	8.3	7.1-9.7
PTSD-Past year	(132)	7.6	6.5-9.0
Synesthesia positive	(59)	3.4	2.7-4.4

*The study veterans were comprised of Vietnam veterans (56.2%), Gulf War (15.9%), Afghanistan/Iraq (22.9%), and other warzone veterans (14.2%). Note, some veterans had multiple deployments.
†The N represents the total number of subjects with the demographic or health characteristic.

current life stress, traumatic stress exposure, combat exposure, depression, and history of concussion using a backwards stepwise logistic regression (Table 2). Data analyses were conducted using Stata, version 13.1 software (College Station, Texas). This study was approved by the Institutional Review Boards of the Geisinger Clinic and US Department of Defense.

RESULTS

In the present study, examination of the recruited veterans revealed that 56.2% were Vietnam veterans, 15.9% belonged to Gulf War, 22.9% were veterans of Afghanistan/Iraq, and the rest (14.2%) represented other warzone veterans (Table 1, footnote). As shown in Table 1, the average age of veterans was 59.6 years among which, 95.1% were males, while 95.7% belonged to White race. Also, 77.5% were married, 24.8% had an educational level equivalent to college graduate or higher education and 23.6% of the study group was categorized as having high combat exposure. A total of 28.4% of veterans were screened positive for concussive injury during military service and 22.2% reported taking psychotropic medications in the past year. In the present study, the prevalence rate of current PTSD was 7.6% (95% C.I. = 6.5-9.0) and the prevalence rate of current depression was found to be 8.3% (95% C.I. = 7.1-9.7). Among the veterans of the current study, the prevalence of grapheme-color synesthesia was 3.4% (95% C.I. = 2.7-4.4) (Table 1).

The top row in Table 2 shows the unadjusted bivariate results for the association between PTSD and synesthesia. It is evident that the unadjusted odds ratio (OR) for the association between PTSD and synesthesia was significant statistically, with an OR = 3.3 ($p<0.001$) for PTSD. Multivariable logistic regression results were based on backwards stepwise logistic regression. The model was assessed for age, female sex, marital status, education, current psychotropic use, concussion history, combat exposure, trauma exposure, current life stress, and current depression, with age and sex forced into the final model. As shown, the final regression model resulted in an adjusted OR = 2.33 ($p = 0.019$) for PTSD. These final adjusted results were similar to those reported for our original synesthesia study with a previous cohort of veterans (Hoffman et al., 2012).

DISCUSSION

Based on past research outcomes (Hoffman et al., 2012), we hypothesized that prevalence of current PTSD among veterans with grapheme-color type synesthesia would be higher. This hypothesis was confirmed in the current study, which assessed additional potential confounding variables. To the best of our knowledge, this study constitutes only the second one in the research literature to report the association of PTSD and synesthesia. As suggested, synesthesia was associated with specific medical conditions (Alstadhaug & Benjaminsen, 2010; Carruthers et al., 2012; Neufeld et al., 2013), as well as symptoms of psychopathology linked to enhanced temporo-limbic excitability (Neckar & Bob, 2016). In addition, research indicates that individuals with synesthesia have superior visual perception and cognition as well as elevated cortical excitability in the primary visual cortex (Banissy et al., 2013; Terhune et al., 2013; Terhune et al., 2015). Previous research, however, suggests that PTSD is related to the opposite traits, including lower intelligence, mixed handedness, attention disorders, and schizophrenia (Boscarino, 2006; Boscarino & Adams, 2009; Boscarino et al., 2012; Duncan et al., 2018; Gurvits et al., 2006). Thus, the reasons for the PTSD-synesthesia association are currently unclear. In the research literature, female sex was observed to be associated with PTSD (Boscarino & Adams, 2009; Boscarino et al., 2012) and synesthesia is reported to be more common among females (Simner & Carmichael, 2015), so this association might be worthy of examination. However, only 5% of veterans in our study were female, so this assessment was not possible in the current study.

Limitations of the current research includes that the interview response data were based on self-reporting and could possibly include recall bias. In addition, there have been inconsistencies in the literature with regard to the underlying bases for synesthesia (Hupe & Dojat, 2015; Melero et al., 2013). Also, estimation of synesthesia was based on a single survey question. However this question was used in the past and our prevalence estimate is consistent with past studies (Hoffman et al., 2012). Moreover, the current study included only deployed veterans constituted predominately with white males. These factors have the potential to induce bias in the results. Another issue is that this study was based on patients from a single multi-hospital system, possibly limiting study generalization. Further, since the present study was cross-sectional, PTSD could not be ruled out as a cause of synesthesia. The prevalence of current PTSD within this sample of veterans was about 8%, which is consistent with

Table 2.
Unadjusted & adjusted results of the association between synesthesia and PTSD: (N=1730)

Logistic Regression Results Predicting Synesthesia*	**OR**	**OR 95% CI**	**p-value**
PTSD-Past year	3.3	1.71-6.40	<0.001
*Unadjusted regression results.			
Stepwise Logistic Regression Results Predicting Synesthesia**	**OR**	**OR 95% CI**	**p-value**
Age (years)	1.0	0.98-1.02	0.84
Female Sex	2.15	0.76-6.08	0.151
College grad or higher	0.44	0.21-0.96	0.038
Concussion history	2.07	1.19-3.61	0.01
PTSD-Past year	2.33	1.15-4.72	0.019
**Final adjusted regression results based on backwards stepwise logistic regression. Model was assessed for age, female sex, marital status, education, current psychotropic use, concussion history, combat exposure, trauma exposure, current life stress, and current depression. The final selected regression results included education level, concussion history, and PTSD, with age and sex forced into the final model results.			

the rate observed in previous studies of community-based veterans (Boscarino et al., 2015). Finally, both PTSD and synesthesia are known to be associated with genetics and these need to be further explored (Boscarino et al., 2012; Brang & Ramachandran, 2011).

In spite of these limitations, grapheme-color synesthesia was found to be associated with PTSD in a second larger community-based group of veterans. It is suspected that the PTSD-synesthesia association is probably not specific to combat trauma per se, but may likely be related to noncombat traumas as well. Among these veterans, it is a notable fact that the median age of PTSD onset was 28 years (Hoffman et al., 2012). As evident from Table 1, the average age of veterans in the present study was 59 years, therefore most veterans had PTSD for decades. Recognition of the association between synesthesia and PTSD might lead to new approaches for PTSD diagnosis, such as using the "New York PTSD risk score," which combines psychosocial risk-factor data with genotype data (Boscarino, Kirchner, Hoffman, & Erlich, 2013). Further longitudinal research is planned to explore these recent discoveries and to determine if this association for PTSD is also present among nonveterans.

CONCLUSION

Based on our study findings, we conclude that grapheme-color synesthesia is likely associated with PTSD. Further research is now planned using the full version of the grapheme-color synesthesia scale, together with longitudinal data. This research may open up neurological windows into a better understanding of PTSD risk, its onset, and its course.

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DECLARATION

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Visual Dysfunction and Associated Co-morbidities as Predictors of Mild Traumatic Brain Injury Seen Among Veterans in Non-VA Facilities: Implications for Clinical Practice

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ABSTRACT Introduction: Traumatic brain injury (TBI) and post-traumatic stress disorder are considered the signature injuries of the Iraq and Afghanistan conflicts. With the extensive use of improvised explosive devices by the enemy, the concussive effects from blast have a greater potential to cause mild TBI (mTBI) in military Service Members. These mTBI can be associated with other physical and psychological health problems, including mTBI-induced visual processing and eye movement dysfunctions. Our study assessed if any visual dysfunctions existed in those surveyed in non-Veterans Administration (VA) facilities who had suffered mTBI (concussive effect), in addition to the presence of concussion-related co-morbidities. Materials and Methods: As part of a larger study involving veterans from different service eras, we surveyed 235 Veterans who had served during the Iraq and/or Afghanistan conflict era. Data for the study were collected using diagnostic telephone interviews of these veterans who were outpatients of the Geisinger Health System. We assess visual dysfunction in this sample and compare visual dysfunctions of those who had suffered a mTBI (concussive effect), as well as co-morbidities, with those in the cohort who had not suffered concussion effects. Results: Of those veterans who experienced visual dysfunctions, our results reflected that the visual symptoms were significant for concussion with the subjects surveyed, even though all had experienced a mTBI event greater than five years ago. Although we did find an association with concussion and visual symptoms, the association for concussion was strongest with the finding of greater than or equal to three current TBI symptoms, therefore we found this to be the best predictor of previous concussion among the veterans. Conclusions: Veterans from the Iraq/Afghanistan era who had suffered concussive blast effects (mTBI) can present with covert visual dysfunction as well as additional physical and psychological health problems. The primary eye care providers, especially those in a non-military/VA facility, who encounter these veterans need to be aware of the predictors of mTBI, with the aim of uncovering visual dysfunctions and other associated co-morbidities.

INTRODUCTION

Traumatic brain injury (TBI) is a significant public health issue in both the civilian population and the U.S. military forces,[1] including Warfighters serving in a Reserve or National Guard unit. As these Service Members return to their civilian lives, the concern exists that they do not have the same level of visibility for their injuries as those who are treated in a military treatment facility or Veterans Administration (VA) clinical facility.

TBI is delineated as a brain trauma resulting from an external force and/or acceleration–deceleration mechanism, including blasts, falls, direct impacts, and motor vehicle accidents, often with an alteration in mental status. Warfighters who have sustained a mild TBI (mTBI) and associated co-morbid somatic, cognitive, and affective symptoms, including post-traumatic stress disorder (PTSD), can be more difficult to diagnose than those who have suffered moderate to severe TBI.[2] Therefore, the proper identification of milder forms of TBI is important when providing optimal care for this population.

Over the course of time, the conflicts in Iraq (Operation Iraqi Freedom; Operation New Dawn), Afghanistan (Operation Enduring Freedom), and the joint campaign in Iraq and in Syria (Operation Inherent Resolve) have accounted for a significant increase in the occurrence of concussive TBI (cTBI) and mTBI among military personnel as a result of contact with enemy forces or weapon systems – mortars, improvised explosive devices (IEDs), rocket-propelled grenades – and from head impacts from accidents caused by enemy action, equipment failure, or other factors.

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The Department of Veterans Affairs/Department of Defense define TBI as "a traumatically induced structural injury and/or physiological disruption of brain function as a result of an external force that is indicated by new onset or worsening of at least one of the following clinical signs, immediately following the event—any period of loss of or a decreased level of consciousness (LOC), any loss of memory for events immediately before or after the injury (post-traumatic amnesia [PTA]), any alteration in mental state at the time of the injury (confusion, disorientation, slowed thinking, etc.), neurological deficits (weakness, loss of balance, change in vision, praxis, paresis/plegia, sensory loss, aphasia, etc.) that may or may not be transient, and/or intracranial lesion".[3]

The Department of Defense reported 370,688 cases of clinically confirmed TBI from 2000 to the second quarter of 2017, with mTBI accounting for 82.3% of all cases.[4] Similarly, the Centers for Disease Control and Prevention reported that TBI affects approximately 1.7 million people in the USA annually. The total combined rates of TBI-related hospitalizations, emergency department visits, and deaths climbed from a rate of 521.0 per 100,000 in 2001 to a rate of 823.7 per 100,000 in 2010, with mTBI accounting for at least 75% of all TBIs in the USA.[5]

Warfighters with mTBI are often identified only when overt head injuries are present, leaving the more subtle mTBI cases to go undiagnosed by the medical community, primarily due to the lack of objective assessment tools. Valid and objective biomarkers of acute mTBI are of particular importance in forward deployed situations for military clinicians to make accurate and immediate determination of return to duty status or evacuation for further evaluation. As such, mTBI continues to be a diagnostic challenge for the medical community primarily due to the lack of objective assessment tools.[6] Health care providers have also noted issues with diagnosing self-reported brain injury/concussion symptoms.[7]

Recent studies have examined objective assessments and subjective evaluations of visual functions as potential biomarkers for mTBI. A 2010 military mTBI diagnostics workshop highlighted the importance of finding biomarkers or diagnostic tests to expedite the diagnosis of warfighters suspected of having a concussion/mTBI.[8] Undiagnosed mTBI/concussions can jeopardize veterans' health, and expose injured warfighters to the potential effects of further concussions/brain injuries which have been shown to lead to further detrimental sequelae.[9]

Mild traumatic brain injuries are linked to visual impairment, even beyond the acute stage of injury, with the potential for long-term chronic effects to manifest. One of the first clinical studies which compared visual dysfunction in soldiers exposed to blast-related mTBI to deployed controls without TBI, found significant early visual dysfunction in these soldiers. The assessment was completed in the short term (15–45 d) after the blast-related mTBI occurred. The most common reported symptoms in this study were binocular vision problems, eye fatigue, and photophobia, although there were minimal or no reductions in visual acuity.[10] Visual symptoms have been found to persist in patients up to 2 yr after combat-related TBI.[11,12] In a retrospective study of routine eye exams in 31 veterans with blast-related mTBI, significant visual dysfunction was found in 68% of patients almost 6 yr after injury.[13]

Post-deployment members of the National Guard, Reserve and Individual Mobilization Augmentees (IMAs) may choose to not seek care in a VA clinical facility, due to employer provided health insurance, geographic, and other considerations. Injured Warfighters can face visual, mental and physical challenges after deployment, compounded if exposed to blast trauma, and these infirmities may be unreported by the patient. During a routine eye examination, which can also serve as a potential screening for mTBI, subtle or subclinical visual dysfunctions, as a consequence of mTBI, may go unrecognized.

In an effort to further assess this group in question, the present study was designed to assess the prevalence of visual symptoms, as well as co-morbidities, in Veterans of the Iraq and Afghanistan conflicts who suffered mTBI and were treated outside of either a VA clinical facility or a military treatment facility. One goal of our study was to see if a predictive model could be developed that could be useful in a clinical practice setting.

METHODS

As part of a larger study involving veterans from several service eras, we surveyed 235 veterans by telephone who had served during the Iraq and/or Afghanistan conflict.[14] As with the baseline survey, data for the TBI study were collected using diagnostic telephone interviews of these veterans who were outpatients of the Geisinger Clinic, a large, integrated health care organization in Pennsylvania, and one of largest integrated health services organizations in the USA involved in public health research.[15] Outcome measures were assessed for those who had a history of service related concussion, compared to veterans who did not using the 3-Question TBI Screen from Schwab et al.[16] Additional questions related to when they experienced the concussion and whether they ever received a deployment-related medical diagnosis of TBI or not (Appendix 1). As a previous study found five significant factors associated with PTSD, depression, and mental health service use among a group of veterans, (low self-esteem of the veteran, veteran's use of alcohol/drugs to cope, veteran's history of childhood adversity, high combat exposure, and low psychological resilience) our survey data were also collected related to PTSD, military history, combat exposure, mental health, perceived health status, sleep problems, and on other measures during the baseline survey.[17] The TBI interview also included 13 specific vision related questions (Appendix 2) based on The Brain Injury Vision Symptom Survey (BIVSS) Questionnaire, a 28-itemscaled survey designed to query vision behaviors related to: clarity, comfort, diplopia, depth perception, dry-eye, peripheral vision, and reading with individuals who have suffered mild-to-moderate brain injury.[18]

Statistical analyses include descriptive statistics and analyses assessing the association between TBI and potential risk/

protective factors. For initial multivariable analyses, we used logistic regression, whereby key risk/protective factors (e.g., combat exposure, multiple deployments, etc.) were used to estimate the likelihood (i.e., odds ratios, ORs) for mTBI controlling for age, gender, marital status, and other factors that might confound these associations by including these variables in the analyses. We also present descriptive statistics related to vison and concussion symptom scales we used in our study. All the variables shown in the final multivariate models (Tables II–IV) represent the final analysis results after nonsignificant variables were removed. Analyses were conducted using Stata, version 13.1 and SPSS version 20 software. The Geisinger Health System's, as well as the DoD's Institutional Review Boards (Geisinger IRB #2015-0441; DoD IRB #A-18989) approved the study protocol and all participants provided verbal informed consent.

RESULTS

The 13-item vision scale we used included 5-point scale items (rated "never" to "always"), which resulted in an average vision score of 23.5 (SD = 9.4) and a Cronbach's alpha = 0.85 for the Veterans. The Veterans also reported current symptoms they were experiencing related to their concussion, including headaches, dizziness, and memory problems. The presence of memory problems was minimally screened for in the interview (Appendix A1, TB3c.) to alert for effects on the questionnaire, but no specifically designed neuropsychological tests were administered. The mean concussion symptom count for Veterans was 2.3 (SD = 1.84). Since a goal of our study was to develop a predictive model useful in clinical practice, we used receiver operating curve (ROC) analyses to determine the optimal cut-off point for the vision and concussion symptom scales.[19] Based on these analyses, the optimal cut-point for the vision scale was 24 or higher (ROC area = 0.71); the optimal cut-point for the concussion symptom scale was 3 or higher (ROC area = 0.80). We used these cut-points in our statistical analyses discussed below.

Table IA (Appendix 3) presents the demographic characteristics of the study sample. As can be seen, the mean age of the veterans is 42 (SD = 9.2) and over 58% are less than 45 yr old. The data also suggest that 87.2% of the participants were males, 94.0% were of white race, 84.6% were enlisted military personnel, 75.6% were National Guard/Reserve service members, 39.7% were college graduates, 73.5% were married, and 33.8% had a yearly household income over $100,000. Furthermore, it is noteworthy to add that 54.3% of participants reported multiple warzone tours, and 30.8% had a history of high combat exposure. In addition, 30.6% (95% CI = 25.0–36.9) screened positive for TBI, 10.2% (95% CI = 6.9–14.8) reported a TBI diagnosis during deployment, and 14.9% (95% CI = 10.9–20.1) reported sustaining a TBI during deployment, but that this was not diagnosed (Table IB (Appendix 3). In terms of present TBI symptoms reported, 31.9% (95% CI = 26.2–38.2) of veterans in this study reported presently having greater than or equal to 3 TBI symptoms. Moreover, the prevalence of PTSD in this cohort within the past year was 11.1% (95% CI = 7.7–15.9). Additionally, the prevalence of current depression disorder among the veterans was 14.1% (95% CI = 10.2–19.2) (Table IB (Appendix 3).

Table I presents the associations between sample characteristics and concussion screen results. As seen, the following study variables were found to have a significant association with a positive concussion screen: male sex ($p = 0.008$), difficulty falling asleep during the past 12 mo ($p = 0.040$), multiple warzone tours ($p = 0.005$), high combat exposure ($p < 0.001$), a high BSI-Global Severity Index ($p < 0.001$), multiple current TBI symptoms reported ($p < 0.001$), higher vision dysfunction ($p < 0.001$), current depressive disorder ($p = 0.001$), met criteria for PTSD in the past year ($p = 0.001$), and fair or poor self-rated health ($p < 0.001$).

Following this, multivariate logistic regression analyses were computed to determine the predictive validity of several variables regarding history of concussion during deployment ($n = 72$). Based on the bivariate analyses, the variables investigated were multiple combat tours, high combat exposure, vision score greater than 24, and the presence of three or more current TBI symptoms. Table II lists the results of multivariate analyses conducted for a positive concussion screen. In particular, reporting three or more current TBI symptoms (OR = 5.51, $p < 0.001$), high combat exposure (OR = 2.39, $p = 0.014$), and a vision score greater than 24 (OR = 2.15, $p = 0.025$) all demonstrated significant relationships with deployment concussions. Notwithstanding these results, multiple tours was not statistically associated with concussion in this present veteran sample, when all the variables were included (OR = 1.74, $p = 0.113$).

Table III depicts the findings of the multivariate prediction analysis that evaluated the variables described in predicting having a concussion diagnosis during deployment ($n = 24$). The results of this revealed slightly different predicative findings. Consistent with the first model, reporting of greater than or equal to three current TBI symptoms was found to be positively associated with reporting a concussion diagnosis (OR = 4.93, $p = 0.006$). In line with this, high combat exposure demonstrated another significant variable in predicting concussion diagnosis (OR = 4.05, $p = 0.010$). Multiple combat tours also exhibited analogous results relative to the previous model, as it was found to be not significantly associated with concussion diagnosis (OR = 2.37, $p = 0.128$). Having a concussion diagnosis was found to be unrelated to vision scores greater than 24 within this cohort (OR = 1.87, $p = 0.226$), which also varied from its previous association with concussion (Table II).

To assess which variables were sensitive in predicting the presence of a concussion with no diagnosis reported ($n = 35$), a subsequent multivariate analysis was conducted using the same variables. Table IV displays the results of this predictive model, which evidenced some differences from previous analyses. The only variable found to be significant for predicting concussion with no diagnosis reported was having

TABLE I. Sample Characteristics Related to Concussion Symptoms ($N = 234–235$)

Sample Characteristics	Concussion Positive *N* (%)	Not Concussion Positive *N* (%)	Odds Ratio (95% CI)	X^2 (*p*-Value)
Age				
18–44	43 (59.7)	94 (58.0)	0.93 (0.53–1.64)	0.059 (0.808)
45+	29 (40.3)	68 (42.0)		
Total	72 (100)	162 (100)		
Sex				
Male	69 (95.8)	135 (83.3)	4.60 (1.35–15.7)	6.968 (0.008)
Female	3 (4.2)	27 (16.7)		
Total	72 (100)	162 (100)		
Race				
Non-White	3 (4.2)	11 (6.8)	1.68 (0.45–6.20)	0.610 (0.435)
White	69 (95.8)	151 (93.2)		
Total	72 (100)	162 (100)		
Education				
Non-college graduate	44 (61.1)	97 (59.9)	0.95 (0.54–1.68)	0.032 (0.859)
College graduate	28 (39.9)	65 (40.1)		
Total	72 (100)	162 (100)		
Difficulty falling asleep past 12 mo				
No	30 (41.7)	91 (56.2)	1.79 (1.02–3.15)	4.201 (0.040)
Yes	42 (58.3)	71 (43.8)		
Total	72 (100)	162 (100)		
Multiple Warzone Tours				
No	23 (31.9)	84 (51.9)	2.29 (1.28–4.11)	7.960 (0.005)
Yes	49 (68.1)	78 (48.1)		
Total	72 (100)	162 (100)		
High combat exposure				
No	33 (45.8)	129 (79.6)	4.26 (2.53–8.43)	26.727 (<0.001)
Yes	39 (54.2)	33 (20.4)		
Total	72 (100)	162 (100)		
BSI-Global Severity Index				
Not High	47 (65.3)	145 (90.1)	4.82 (2.37–9.79)	21.076 (<0.001)
High	25 (34.7)	16 (9.9)		
Total	72 (100)	162 (100)		
Multiple current TBI symptoms reported (≥3)				
Less than 3	25 (34.7)	135 (82.8)	9.06 (4.81–17.08)	53.173 (<0.001)
3 or more	47 (65.3)	28 (17.2)		
Total	72 (100)	163 (100)		
High vision dysfunction symptom score				
Less than 24	29 (40.3)	112 (68.7)	3.26 (1.83–5.79)	16.823 (<0.001)
24 or higher	43 (59.7)	51 (31.3)		
Total	72 (100)	163 (100)		
Current depression disorder				
No	54 (75.0)	147 (90.7)	3.27 (1.54–6.94)	10.195 (0.001)
Yes	18 (25.0)	15 (9.3)		
Total	72 (100)	162 (100)		
Met criteria for PTSD with impairment past year				
No	53 (73.6)	147 (90.7)	3.51 (1.67–7.41)	11.777 (0.001)
Yes	19 (26.4)	15 (9.3)		
Total	72 (100)	162 (100)		
Self-rated health fair/poor				
No	39 (54.2)	127 (78.4)	3.07 (1.69–5.57)	14.194 (<0.001)
Yes	33 (45.8)	35 (21.6)		
Total	72 (100)	162 (100)		

greater than or equal to three current TBI symptoms (OR = 3.94, $p = 0.002$). Across all three multivariate models, greater than or equal to three current TBI symptoms was found associated with predicting concussion in an array of diagnostic presentations. As such, this variable was the best predictor of concussion among this sample of veterans. Despite prior relationships with concussion prediction, high combat exposure was not associated with having a concussion with no diagnosis reported (OR = 2.12, $p = 0.082$). Multiple combat tours were also not associated with predicting concussion with no diagnosis as well (OR = 0.88, $p = 0.770$). In addition, having a vision score greater than 24 was also not significantly associated to concussion with no diagnosis (OR = 2.14, $p = 0.070$).

TABLE II. Multivariate Logistic Regression Predicting Positive Concussion Screen ($n = 72$)[a]

Variables	*B*	SE	Wald Statistic	*p*-Value	Odds Ratio (95% CI)
Multiple Combat Tours	0.552	0.349	2.506	0.113	1.74 (0.877–3.443)
High combat exposure	0.872	0.355	6.028	0.014	2.39 (1.192–4.798)
Vision score >24	0.763	0.341	4.999	0.025	2.15 (1.099–4.188)
Current TBI symptoms ≥3	1.706	0.349	23.890	<0.001	5.51 (2.778–10.908)
Constant	−2.458	0.352	48.725	<0.001	—

[a]$N = 235$.

TABLE III. Multivariate Logistic Regression Predicting Concussion Diagnosis ($n = 24$)[a]

Variables	*B*	SE	Wald Statistic	*p*-Value	Odds Ratio (95% CI)
Multiple Combat Tours	0.864	0.568	2.312	0.128	2.37 (0.779–7.232)
High combat exposure	1.398	0.541	6.680	0.010	4.05 (1.402–11.692)
Vision score >24	0.627	0.518	1.467	0.226	1.87 (0.679–5.168)
Current TBI symptoms ≥3	1.596	0.579	7.593	0.006	4.93 (1.585–15.339)
Constant	−4.630	0.692	44.814	<0.001	—

[a]$N = 235$.

TABLE IV. Multivariate Logistic Regression Predicting Concussion with No Diagnosis ($n = 35$)[a]

Variables	*B*	SE	Wald Statistic	*p*-Value	Odds Ratio (95% CI)
Multiple Combat Tours	−0.123	0.419	0.086	0.770	0.88 (0.389–2.010)
High combat exposure	0.750	0.431	3.028	0.082	2.12 (0.910–4.928)
Vision score >24	0.760	0.420	3.282	0.070	2.14 (0.940–4.869)
Current TBI symptoms ≥3	1.382	0.446	9.615	0.002	3.94 (1.663–9.541)
Constant	−3.001	0.429	48.838	<0.001	—

[a]$N = 235$.

DISCUSSION

TBI and PTSD are understood as the signature injuries of the Iraq and Afghanistan conflicts. With the extensive use of IED by the enemy, the concussive effects from blast can cause mTBI in Military Service Members. However, mTBI and the associated co-morbidities can go unrecognized, particularly when service members are seen outside of military or VA medical facilities that have less familiarity with this condition.[20] Mild TBI can also go undiagnosed due to the clinical attention given to other more obvious injuries. In addition, the ocular and visual processing dysfunctions manifest in mTBI can be subclinical, highlighting the need for more detailed evaluation in the ocular and visual processing examinations.

Visual processing and eye movements are frequently affected by mTBI. Common problems among patients presenting with mTBI include pupillary response deficit, visual processing delays (poor attention to detail, poor visual attention, and poor visual memory), photosensitivity, impaired oculomotor convergence (difficulty focusing on nearby objects or images), and related oculomotor-based reading dysfunctions.[21] Nearly 70% of sensory processing in the brain is vision related[22] and 7 of the 12 cranial nerves are utilized by the visual system. Brain structures most vulnerable to mTBI that are vision related include the frontal, occipital, temporal, and parietal lobes as well as the long axonal fibers connecting the midbrain to the cortex. It has been established that autonomic nervous system dysfunctions can occur in those with mTBI/concussion-type injuries,[23] including the pupillary light reflex.[24] Given that certain neurological deficits might lead to impairment of the oculomotor system, accommodation, and pupillary light reflex, it is not surprising that patients with a brain trauma typically present with a myriad of visual dysfunctions.

After assessment for those who had a history of service related concussion using the 3-Question TBI Screen, our study examined thirteen self-reported questions relative to changes or loss in vision, diplopia, light or glare sensitivity, balance and dizziness, and visual changes with computer and hand held device usage. The vision score was derived from Likert scale responses to 13 specific questions, (ranging from 1 to 5, coded "Never" to "Always"). Based on ROC analyses, a vision score greater than 24 demonstrated a significant capability in predicting deployment concussions, based on the TBI screener (ROC area = 0.71). For example, data in Table II suggest that in a logistic regression model that included number of combat tours, high combat exposure, and current TBI symptoms >3, a vision score >24 still significantly predicted deployment TBIs (OR = 2.15, $p = 0.025$). However, a vision score >24 is neither significant in predicting self-report of

having a medical diagnosis of TBI nor is this significant in predicting self-report of TBI without a medical diagnosis of TBI (Tables III and IV).

Several studies imply that most of the symptoms of mTBI will resolve or become subclinical within 6 mo of the trauma.[25–27] Our results did suggest that the visual symptoms were significant for a positive mTBI screen among the subjects surveyed, even though all had experienced an mTBI event greater than five years ago. Considering that the self-reporting of visual symptoms does not equate with a more detailed assessment of the visual system, a full ocular structural and visual functional assessment is warranted for deployed veterans, with specific attention directed to any afferent visual dysfunction, efferent visual defects and/or higher order deficits, as outlined by Barnett and Singman.[28]

Although we did find an association with concussion and visual symptoms, the association for concussion was strongest with having greater than or equal to three current TBI symptoms. By far, this variable was the best predictor of concussion among this sample of veterans. Surprisingly, experiencing multiple combat tours was not a predictor of concussion in the current study (Tables II–IV). By contrast, reporting >3 TBI symptoms was significant in all the models assessed (p-values < 0.01).

The limitations for this study include the accuracy of the patients in reporting visual symptoms relative to recall due to the time elapsed since the concussive event, as well as the unrecognized presence of subclinical symptoms. Additionally, the study included only previously deployed U.S. veterans who were predominantly white, male, and outpatients in a large, multihospital health care system located in Pennsylvania. Thus, it may not be possible to generalize these finding to other clinical populations in different regions and among different demographic groups. Another limitation is that the sample size in this study was limited to 235 veterans. Consequently, the statistical power to detect statistical differences was limited.

CONCLUSION

Although many visual dysfunctions associated with mTBI can resolve in time, chronic or subclinical visual problems can go unrecognized by the patient. Eye care providers, especially outside of a VA or military facility, need to be vigilant with combat veterans for underlying structural and functional visual issues related to mTBI. A complete patient history, to include military service, deployments, TBI or exposure to blast should be accomplished prior to the visual examination. A dilated fundus examination, including full binocular and oculomotor assessments should be the standard of care for this patient population. In addition, awareness of and recognition for the co-morbidities of mTBI is essential for this group, especially if the veteran reports a history of high combat exposure, TBI, and reports the presence of current TBI symptoms. Communication with the patient's primary care provider or specialist with the findings of the visual examination will help facilitate further evaluation and appropriate referral for any co-morbidities associated with these veterans.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Military Medicine* online.

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CONFLICTS OF INTEREST

None of the authors have any potential conflicts of interest or financial interests in the topic covered by this manuscript.

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Letter to the editor

Guard/Reserve service members and mental health outcomes following deployment: Results from the veterans' health study☆

Letter to the Editor

Research related to service in Iraq and Afghanistan suggests that significant numbers of service members developed mental health disorders following deployment [1]. Our hypothesis was that mental disorders would be higher among Guard/Reserve members due to lower unit support, social support, and preparedness [2,3]. Our study included 1730 veterans recruited to study the effects of military service [4]. All veterans were outpatients in the Geisinger Clinic, the largest multi-hospital system located in Central and Northeastern Pennsylvania.

Geisinger serves residents throughout 45 Pennsylvania counties, which includes a 25,000 mile^2 service area and serves ~30,000 veterans and more than one-million non-veterans [4]. Trained and supervised interviewers administered structured health interviews among veterans by telephone from February 2016 through February 2017. Veteran and deployment status were confirmed based on military records. This study was approved by the Institutional Review Boards of Geisinger Clinic and Department of Defense. All patients provided informed consent and were offered small monetary incentives for participation.

To assess PTSD, we used an instrument based on the Diagnostic and Statistical Manual of Mental Disorder, Fifth Edition (DSM-5) [4,5]. To receive a PTSD diagnosis, veterans had to meet the diagnostic criteria within the past 12 months. The survey also collected data on current depression. Depression was assessed using a scale based on DSM-IV criteria [4], which has been used in previous studies [6]. To assess alcohol misuse, the AUDIT-C scale was also used [6]. Additional assessments included demographic factors (age, gender, race, and marital status), warzone deployments, and combat exposure, all measures used in previous research [4,6]. Warzone exposure included the Vietnam War, Persian Gulf War, Afghanistan/Iraq War, and "other" recent warzone deployments [4,6]. Combat exposure was based on the Combat Experience Scale [4,7,8].

Our study also included a lifetime traumatic events scale, a measure used in previous studies [4,8,9]. Additionally, the study included measures of current life stressors, social support, unit support, social capital, and mental health service use, all based on validated instruments [4,6,8]. As with the trauma scale, the stress scale has been used in previous research [9]. Unit support was based on survey questions that asked about experiences during deployment [4]. The social support scale used was also based on past trauma research [6,9]. Our approach was to first assess bivariate associations for Guard/Reserve status, followed by multivariable analysis that included Guard/Reserve status, in addition to common risk and protective factors for post-deployment outcomes.

Most veterans studied were over 65 years old (56.6%), male (95.1%), and White (95.7%). In addition, 38.4% served as Guard/Reserve members. Bivariate analysis suggested that Guard/Reserve members were significantly more likely to be college graduates, have served on multiple tours, have served in Iraq/Afghanistan, and have high current life stress, but less likely to be male or Caucasian. However, Guard/Reserve members were also significantly more likely to have PTSD, current depression, alcohol misuse, and to use mental health services in the past year.

In multivariable analyses (Table 1), significant predictors of PTSD included female sex (OR = 2.39), high combat exposure (OR = 3.77), high current life stress (OR = 5.11), high lifetime trauma exposure (OR = 2.60), low current social support (OR = 1.88), and low social capital (OR = 2.29), while serving on multiple tours (OR = 0.63) and officer rank (OR = 0.23) were protective. The results for current depression were similar. The results for recent mental health service use were also comparable, but alcohol misuse was not. For the latter, older age (OR = 0.96) and female sex (OR = 0.40) were protective. In summary, while Guard/Reserve status was associated with several adverse mental health outcomes in initial analyses, none of these outcomes were significant when potential confounders and common risk factors were controlled (Table 1).

Since Guard/Reserve service members were reported to be less prepared and have lower support [2–4], our assumption was that Guard/Reserve members would have higher rates of mental disorders than comparable non-Guard/Reserve service members. However, while Guard/Reserve status was associated with several mental health outcomes in bivariate analyses, none were significant after confounders and common risk factors were controlled. The best predictors of current mental health status were combat exposure, lifetime traumatic stress exposures, current life stressors, and current social support.

In summary, Guard/Reserve personnel did have worse mental health outcomes, but this relationship disappears when controlling for known risk factors. Thus, military service providers should be aware that the risk of post-deployment mental health disorders will be more common in Guard/Reserve personnel, but this relationship disappears when controlling for factors that are more common in those who serve in the Guard/Reserve. Thus, military service providers should be aware that mental health disorders, while not intrinsic to this service line, may be more common in Guard/Reserve personnel post-deployment and plan their services accordingly.

Study limitations include that our research was cross-sectional and was conducted among mostly White, male patients in a private Pennsylvania health system. However, we note, many veterans today

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Table 1
Multivariable logistic regressions predicting current PTSD, major depression, alcohol misuse, and mental health service use among veterans ($N = 1730$).

Variables	Posttraumatic Stress Disorder		Major Depression		AUDIT-C Positive		Service Use	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Age (years)	1.00	(0.97–1.03)	0.99	(0.97–1.02)	0.96[§]	(0.95–0.98)	0.99	(0.97–1.01)
Female	2.39[†]	(1.08–5.29)	1.88	(0.94–3.75)	0.40[‡]	(0.22–0.70)	2.30[‡]	(1.36–3.88)
White	1.47	(0.53–4.11)	0.79	(0.36–1.75)	0.74	(0.44–1.24)	1.14	(0.63–2.06)
Married	1.26	(0.78–2.04)	0.87	(0.57–1.32)	0.79	(0.60–1.04)	0.88	(0.66–1.19)
Vietnam deployment	1.46	(0.58–3.67)	0.63	(0.28–1.41)	0.92	(0.56–1.50)	0.91	(0.54–1.55)
Iraq/Afghan deployment	2.05	(0.95–4.42)	1.38	(0.71–2.66)	1.02	(0.67–1.55)	1.35	(0.86–2.14)
Persian gulf deployment	0.87	(0.41–1.83)	1.12	(0.61–2.08)	0.98	(0.66–1.45)	1.08	(0.70–1.66)
Multiple tours	0.63[†]	(0.40–0.97)	0.90	(0.61–1.33)	0.85	(0.67–1.09)	1.01	(0.78–1.31)
High combat exposure	3.77[§]	(2.46–5.76)	2.71[§]	(1.81–4.07)	0.99	(0.75–1.30)	2.72[§]	(2.06–3.58)
Officer rank	0.23[‡]	(0.08–0.64)	0.73	(0.36–1.48)	0.88	(0.59–1.32)	0.80	(0.51–1.24)
High Current life stressors	5.11[§]	(3.36–7.79)	3.11[§]	(2.10–4.61)	1.01	(0.76–1.34)	2.91[§]	(2.21–3.83)
High lifetime trauma	2.60[§]	(1.71–3.95)	1.35	(0.89–2.03)	1.20	(0.90–1.59)	2.06[§]	(1.55–2.74)
Low current support	1.88[‡]	(1.19–2.96)	3.29[§]	(2.20–4.92)	1.22	(0.91–1.64)	1.55[‡]	(1.14–2.11)
Low social capital	2.29[§]	(1.49–3.52)	1.29	(0.85–1.96)	0.94	(0.71–1.26)	1.85[§]	(1.39–2.47)
Guard/Reserve service	1.26	(0.80–1.99)	0.94	(0.62–1.42)	1.11	(0.86–1.44)	1.07	(0.80–1.41)

[†] $p < 0.05$.
[‡] $p < 0.01$.
[§] $p < 0.001$.

have private healthcare coverage and do not use government facilities [4,10]. Our study suggests that National Guard/Reserve veterans do have poorer mental health outcomes post-deployment than other veterans, given their exposure history, current social support, and demographic background. Further research is advised.

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Disclosure

The authors declare no conflicts of interests related to this research.

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Predictors of Current PTSD among Deployed Veterans: Significance of Predisposition, Stress Exposures and Genetic Factors

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Geisinger

Background/Introduction

- Previously we reported that a genetic risk model improved PTSD predictions among a trauma-exposed civilian population, 69% were female (mean population age = 55.4 [SD=13.4]) *(Boscarino et al., Higher FKBP5, COMT, CHRNA5 and CRHR1 Allele Burdens are associated with PTSD and Interact with Trauma Exposure.* ***Neuropsychiatric Research and Treatment*** *2012; 8: 131-139).*
- We sought to identify the risk factors associated with PTSD using this prediction model among a trauma-exposed military population.
- *As in our previous study, we used a genetic risk score approach, which included 4 SNP genetic variants.*

Study population

- We examined post-deployment PTSD status and other factors among a cross-sectional survey of 1,074 community-based veterans of Vietnam, Persian Gulf, Iraq/Afghanistan and other recent conflicts, who were receiving care in a large non-VA multihospital system in Pennsylvania. Approximately 95% of these veterans were male (mean age = 61.4 [SD=12.1]). For this study, 60-minute diagnostic interviews were conducted and DNA sample were collected. To avoid confounding due to genetic admixture, non-Caucasian veterans (n=40) were excluded from analysis.
- Based on DSM-5 criteria, the prevalence of PTSD was 7.1 in past 12 months (95% CI = 5.6-8.8).
- Mean DSM-5 PTSD symptom severity score in past 12 months was 9.5 (95% CI = 8.8-10.3).

Table 2. Baseline Sample Characteristics

Table 2: Baseline characteristics (categorical variables)

Study Variable*	PTSD (no) N %%	PTSD (yes) N %%	Total N %%	p-value
Age				0.0002
18-55	43 (4.31)	8 (10.33)	51 (4.57)	
56-35	227 (22.73)	30 (39.67)	257 (23.05)	
36-64	76 (7.62)	2 (2.63)	78 (7.26)	
65-73	652 (65.33)	36 (47.37)	688 (64.06)	
Sex of Respondent (female)				0.0440
0=male	936 (95.79)	69 (90.79)	1025 (95.44)	
1=female	42 (4.21)	7 (9.21)	49 (4.56)	
Currently married (married				0.2084
0=Not Married	214 (21.44)	21 (27.63)	235 (21.88)	
1=Yes	784 (78.56)	55 (72.37)	839 (78.12)	
Had high combat exposure (combat_hi)				<0.0001
0=No	801 (80.26)	41 (53.95)	842 (78.40)	
1=Yes	197 (19.74)	35 (46.05)	232 (21.60)	
Had multiple warzone tours (multi_hi)				0.8225
0=No	617 (61.82)	46 (60.53)	663 (61.73)	
1=Yes	381 (38.18)	30 (39.47)	411 (38.27)	
High childhood abuse & neglect score (ngli_hi)				0.0002
No	839 (84.07)	51 (67.11)	890 (82.87)	
Yes	159 (15.93)	25 (32.89)	184 (17.13)	
Lifetime traumatic events: high vs low (trauma2)				<0.0001
0=no	830 (83.17)	44 (37.89)	874 (81.38)	
1=yes	168 (16.83)	32 (42.11)	200 (18.62)	
Had high stressful events past year (stress_hi)				<0.0001
0=no	825 (82.67)	32 (42.11)	857 (79.80)	
1=yes	173 (17.33)	44 (57.89)	217 (20.20)	

Table 2: Baseline characteristics (categorical variables)

Study Variable*	PTSD (no) N %%	PTSD (yes) N %%	Total N %%	p-value
Current social support low (social_supp_low)				<0.0001
0=No	832 (83.37)	48 (63.16)	880 (81.94)	
1=Yes	166 (16.63)	28 (36.84)	194 (18.06)	
Probable adhd case (adhdcase)				<0.0001
0=No	825 (82.67)	34 (44.74)	859 (79.98)	
1=Yes	173 (17.33)	42 (55.26)	215 (20.02)	
Extraverted personality high (extravert_hi)				<0.0438
0=No	721 (72.24)	63 (82.89)	784 (73.00)	
1=Yes	277 (27.76)	13 (17.11)	290 (27.00)	
agreeable_hi				0.0001
0=No	686 (68.74)	68 (89.47)	754 (70.20)	
1=Yes	312 (31.26)	8 (10.53)	320 (29.80)	
stable_emotions_hi				<0.0001
0=No	763 (76.43)	74 (97.37)	837 (77.93)	
1=Yes	235 (23.55)	2 (2.63)	237 (22.07)	
History of concussion in the Service (concuss_hx)				<0.0001
0=No	744 (74.55)	23 (32.89)	769 (71.60)	
1=Yes	254 (25.45)	51 (67.11)	305 (28.40)	
Current TBI symptoms 4+ (tbi_symp_hi)				<0.0001
0=No	775 (77.66)	16 (21.05)	791 (73.65)	
1=Yes	223 (22.34)	60 (78.95)	283 (26.35)	
PTSDrisk	31 (3.10)	1 (1.32)	32 (2.98)	0.1920
High	489 (49.00)	43 (59.21)	534 (49.72)	
Low	478 (47.90)	30 (39.47)	508 (47.30)	

Methods

Since current results using the full DSM-5 PTSD diagnostic criteria were limited, we assessed use of PTSD symptom severity scores, which are not normally distributed (Figure 1).

Four single nucleotide polymorphisms (SNPs) included in PTSD genetic risk model

SNP	Gene	Position (GRCh38.p12)	MAF (minor/common)	Functional annotation	PTSD Risk Allele
rs110402	CRHR1	chr17:45802681	44.4% (A/G)	Intron	G
rs16969968	CHRNA5	chr15:78590583	26.6% (A/G)	Missense (D <-> N)	A
rs8042149	RORA	chr15:60832754	44.9% (G/T)	Intron	G
rs9470080	FKBP5	chr6:35678658	37.4% (T/C)	Intron	T

MAF: Minor Allele Frequency

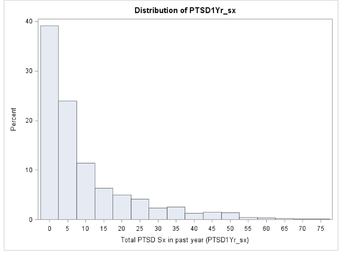
Table 1. Mean age and PTSD genetic Risk Score by PTSD Status in Past 12 Months

Table 1: Baseline characteristics (continuous variables)

Study Variable*		PTSD (no) N=998	PTSD (yes) N=76	Total	p-value
Age					
	N	998	76	1074	
	Mean (std)	62 (11.9)	56 (13.5)	61 (12.1)	<0.0001
PTSDriskscore4					
	N	967	75	1042	
	Mean (std)	3.5 (1.4)	3.9 (1.6)	3.6 (1.4)	0.03

Figure 1. PTSD symptoms severity in past 12-months (PTSD1yr_sx)

- *The unconditional mean of our outcome variable is much lower than its variance (mean: 9.5, standard deviation: 12.8).*



Statistical analysis

Negative binomial regression was implemented to evaluate the association between PTSD genetic risk score and PTSD symptom severity (PTSD1yr_sx), adjusting for demographic factors (age, sex) trauma exposures (combat, lifetime trauma, stress exposures), history of concussion, current traumatic brain injury (TBI) symptoms, current life stressors, and history of attention deficit disorders (ADD) using stepwise variable selection. Interaction terms for trauma exposures by genetic risk score were assessed in the regression. Incidence rate ratios (IRRs) with corresponding 95% confidence intervals (CIs) were presented. P values of less than 0.05 were regarded as statistically significant. All analyses were conducted using SAS software (Version 9.4).

Results

The final binomial regression prediction model for PTSD symptom severity included the genetic risk score (PTSD score), plus demographic factors (age, sex) trauma exposures (combat, lifetime trauma, stress exposures), history of concussion, current traumatic brain injury (TBI) symptoms, current life stressors, and history of attention deficit disorders (ADD), based on stepwise variable selection. Significant variables in the final PTSD symptom severity model included current TBI symptoms (IRR=1.86, 95% CI: 1.78-1.95, p<0.001), history of ADD (IRR=1.74, 95% CI: 1.67-1.82, p<0.001), current life stressors (IRR=1.24, 95% CI: 1.10-1.39, p=0.0004), lifetime trauma exposure (IRR=1.84, 95% CI: 1.63-2.08, p<0.001), history of concussion (IRR=1.32, 95% CI: 1.26-1.38, p<0.001), and PTSD risk allele count (IRR=1.03, 95% CI: 1.01-1.05, p=0.0048). Interaction effects were detected for trauma exposures (COMBAT, STRESS, TRAUMA) by genetic risk score, as expected.

Negative binomial regression for PTSD symptom severity (PTSD1yr_sx)

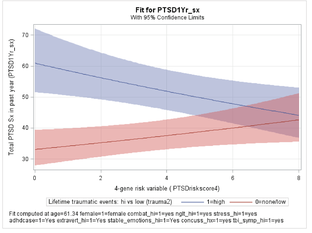
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq	IRR	95% CI	
Intercept	1	1.7949	0.0689	1.66	1.9299	679.23	<.0001			
age	1	-0.0074	0.0008	-0.0091	-0.0058	78.33	<.0001	0.99	0.99	0.99
female	1	0.245	0.0426	0.1616	0.3284	33.14	<.0001	1.28	1.18	1.39
PTSDriskscore4	1	0.0307	0.0109	0.0093	0.052	7.95	0.0048	1.03	1.01	1.05
combat_hi	1	0.5929	0.057	0.4812	0.7047	108.15	<.0001	1.81	1.62	2.02
Trauma_hi	1	0.6105	0.0626	0.4879	0.7331	95.26	<.0001	1.84	1.63	2.08
stress_hi	1	0.2127	0.0595	0.096	0.3294	12.76	0.0004	1.24	1.10	1.39
adhdcase	1	0.5543	0.0222	0.5108	0.5977	625	<.0001	1.74	1.67	1.82
extravert_hi	1	-0.2414	0.0243	-0.289	-0.1938	98.73	<.0001	0.79	0.75	0.82
stable_emotions_hi	1	-0.3742	0.0338	-0.4405	-0.3079	122.34	<.0001	0.69	0.64	0.73
concuss_hx	1	0.2773	0.0231	0.232	0.3227	143.81	<.0001	1.32	1.26	1.38
tbi_symp_hi	1	0.622	0.0228	0.5772	0.6667	743.09	<.0001	1.86	1.78	1.95
ngli_hi	1	0.2727	0.0234	0.2268	0.3186	135.7	<.0001	1.31	1.25	1.38
PTSDriskscore*combat_hi	1	-0.0588	0.0145	-0.0872	-0.0305	16.54	<.0001			
PTSDriskscore*trauma_hi	1	-0.072	0.0164	-0.1041	-0.0399	19.33	<.0001			
PTSDriskscore*stress_hi	1	0.0598	0.0153	0.0297	0.0899	15.19	<.0001			

nteraction: TRAUMA by PTSD genetic risk score

PTSD genetic score = 1, TRA high are expected to have 1.7 times in PTSD1yr_sx than low p<0.0001.

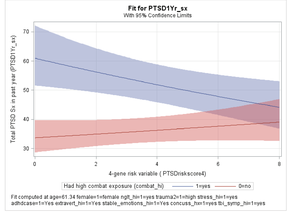
PTSD genetic score = 4, TRAUM high are expected to have 1.5 times in PTSD1yr_sx than low p<0.0001.

PTSD genetic score = 7, TRA high are expected to have 1.3 times in PTSD1yr_sx than low p<0.001



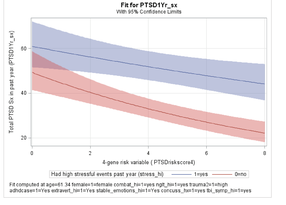
Interaction: COMBAT by PTSD genetic risk score

- PTSD genetic score = 1, COMBAT high are expected to have 1.76 times in PTSD1yr_sx than low, p<0.0001.
- PTSD genetic score = 4, COMBAT high are expected to have 1.62 times in PTSD1yr_sx than low, p<0.0001.
- PTSD genetic score = 7, COMBAT high are expected to have 1.49 times in PTSD1yr_sx than low, p<0.0001.



Interaction: STRESS by PTSD genetic risk score

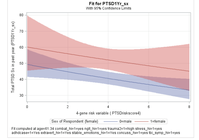
- PTSD genetic score = 1, STRESS high are expected to have 1.35 times in PTSD1yr_sx than low, p<0.0001.
- PTSD genetic score = 4, STRESS high are expected to have 1.78 times in PTSD1yr_sx than low, p<0.0001.
- PTSD genetic score = 7, STRESS high are expected to have 2.33 times in PTSD1yr_sx than low, p<0.0001.



Conclusions

Our study partially replicated our previous results with a trauma-exposed civilian population. After deployment, both warzone and non-warzone factors predicted current PTSD symptoms severity among US veterans seen in non-VA facilities, including a genetic risk score for PTSD. Interaction effects were detected for trauma exposures (COMBAT, STRESS, TRAUMA) by genetic risk scores. Further research is planned.

Appendix: PTSD symptoms - sex by genetic risk (p=ns)



Abbreviations

DSM-5 = Diagnostic and Statistical Manual of Mental Disorder, ver. 5
PTSDrickscore4 = PTSD genetic risk score (PTSD genetic score)
PTSD_Yr1_2 = PTSD case (based on DSM-5) in past 12 months
PTSD1yr_sx = PTSD symptoms severity in past 12-month
trauma2 = High lifetime trauma exposure history
ngli_hi = High abuse/neglect exposure history
adhdcase = History of ADHD
tbi_symp_hi = High current TBI symptoms

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Predictors of Post-deployment Mental Health Treatment among Iraq and Afghanistan Veterans Seen in non-VA Facilities

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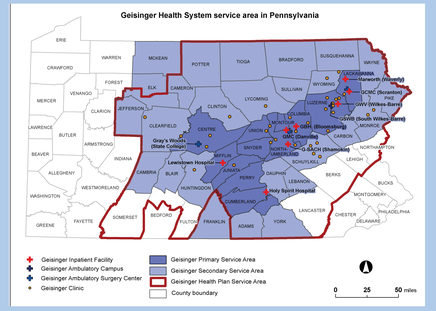
Geisinger

Objectives

- Our primary objective was to assess the prevalence of post-deployment treatment seeking among US military veterans seen in non-VA facilities.
- Our secondary objective was to assess risk and protective factors for the onset of post-traumatic stress (PTSD).
- Our previous research found an association between PTSD and treatment seeking among non-veterans; we sought confirmation of these findings among veterans.

Methods

- We studied a random sample of 234 veterans who were outpatients patients in large, multi-hospital system located in Central & Northeastern PA to assess post-deployment health outcomes.
- The study included patients identified as veterans from several cohorts, including recent veterans of Iraq and Afghanistan.
- Our hypothesis was that veterans with PTSD and other mental disorders, such a service-related concussive injury, would have a higher prevalence of post deployment treatment seeking.



Main Study Assessments

- Combat exposure & trauma history
- Mental health services use
- Psychotropic medication use
- Alcohol use/abuse
- Post-traumatic stress disorder (based on DSM-5)
- Major depression
- Insomnia
- Suicide
- Concussion history
- Traumatic brain injury symptoms

Table 1. Mental Health Treatment past 12 months Post-deployment: Iraq/Afghan Veterans (N=234)

Study Variables	(N)	% Total	Any Treatment 12 Months Post-deploy. % No	%Yes	OR	p-value
Age: 18-44	(137)	58.5	59.0	57.4	1.00	--
Age: 45+	(97)	41.5	41.0	42.6	1.07	0.829
Male	(204)	87.2	90.2	78.7	1.00	--
Female	(30)	12.8	9.8	21.3	2.49	0.027
White Race	(220)	94.0	93.1	96.7	2.20	0.272
Non-White Race	(14)	6.0	6.9	3.3	1.00	--
Married	(172)	73.5	77.5	62.3	0.48	0.024
Not Married	(62)	26.5	22.5	37.7	1.00	--
High Combat Exposure	(72)	30.8	26.0	44.3	2.26	0.009
Low Combat Exposure	(162)	69.2	74.0	55.7	1.00	--
Lifetime Trauma High	(63)	26.9	25.4	31.1	1.33	0.392
Lifetime Trauma not High	(171)	73.1	74.6	68.9	1.00	--
Abuse & Neglect	(35)	15.0	10.4	27.9	3.33	0.002
No Abuse & Neglect	(199)	85.0	89.6	72.1	1.00	--
Used Alcohol/Drugs to Cope	(51)	21.8	16.2	37.7	3.13	0.001
Not used Alcohol/Drugs	(183)	78.2	83.8	62.3	1.00	--
Lifetime PTSD	(52)	22.2	16.8	37.7	3.01	0.001
No Lifetime PTSD	(182)	77.8	83.2	62.3	1.00	--
Low Social Support	(42)	17.9	15.0	26.2	2.01	0.057
Not Low Social Support	(192)	82.1	85.0	73.8	1.00	--
Low Psychological Resilience	(84)	35.9	27.2	60.7	4.13	<0.001
Not Low Psych Resilience	(150)	64.1	72.8	39.3	1.00	--
History Deployment Concussion	(77)	32.9	29.5	42.6	1.78	0.064
No History Deployment Concuss.	(157)	67.1	70.5	57.4	1.00	--
Current TBI Symptoms 4+	(66)	28.2	20.8	49.2	3.68	<0.001
Current TBI Symptoms < 4	(168)	71.8	79.2	50.8	1.00	--
Insomnia Past Year	(139)	59.1	51.1	82.0	4.34	<0.001
No Insomnia Past Year	(96)	40.9	48.9	18.0	1.00	--
Psych Treatment Past Year	(79)	33.8	24.9	59.0	4.35	<0.001
No Psych Treatment Past Year	(155)	66.2	75.1	41.0	1.00	--
Psych Meds Past year	(64)	27.4	17.9	54.1	5.40	<0.001
No Psych Meds Past Year	(170)	72.6	82.1	45.9	1.00	--
VA disability	(95)	40.6	34.1	59.0	2.78	0.001
No VA Disability	(139)	59.4	65.9	41.0	1.00	--
% (N=)			73.9(173)	26.1(61)		

Table 2. Mental Health Treatment past 12 months among Iraq/Afghan Veterans (N=234)

Study Variables	(N)	% Total	Any Treatment In Past 12 Months % No	%Yes	OR	p-value
Age: 18-44	(137)	58.5	56.1	63.3	1.00	--
Age: 45+	(97)	41.5	43.9	36.7	0.74	0.291
Male	(204)	87.2	87.7	86.1	1.00	--
Female	(30)	12.8	12.3	13.9	1.16	0.720
White Race	(220)	94.0	93.5	94.9	1.29	0.668
Non-White Race	(14)	6.0	6.5	5.1	1.00	--
Married	(172)	73.5	78.1	64.6	0.51	0.029
Not Married	(62)	26.5	21.9	35.4	1.00	--
High Combat Exposure	(72)	30.8	21.3	49.4	3.61	<0.001
Low Combat Exposure	(162)	69.2	78.7	50.6	1.00	--
Lifetime Trauma High	(63)	26.9	19.4	41.8	2.99	<0.001
Lifetime Trauma not High	(171)	73.1	80.6	58.2	1.00	--
Abuse & Neglect	(35)	15.0	11.0	22.8	2.40	0.019
No Abuse & Neglect	(199)	85.0	89.0	77.2	1.00	--
Used Alcohol/Drugs to Cope	(51)	21.8	13.5	38.0	3.91	<0.001
Not used Alcohol/Drugs	(183)	78.2	86.5	62.0	1.00	--
Lifetime PTSD	(52)	22.2	5.8	54.4	19.38	<0.001
No Lifetime PTSD	(182)	77.8	94.2	45.6	1.00	--
Low Social Support	(42)	17.9	9.0	35.4	5.53	<0.001
Not Low Social Support	(192)	82.1	91.0	64.6	1.00	--
Low Psychological Resilience	(84)	35.9	21.9	63.3	6.14	<0.001
Not Low Psych Resilience	(150)	64.1	78.1	36.7	1.00	--
History Deployment Concussion	(77)	32.9	23.9	50.6	3.27	<0.001
No History Deployment Concuss.	(157)	67.1	76.1	49.4	1.00	--
Current TBI Symptoms 4+	(66)	28.2	19.4	45.6	3.49	<0.001
Current TBI Symptoms < 4	(168)	71.8	80.6	54.4	1.00	--
Insomnia Past Year	(139)	59.4	45.8	86.1	7.31	<0.001
No Insomnia Past Year	(95)	40.6	35.9	13.9	1.00	--
Psych Treatment Past Year	(61)	26.1	16.1	45.6	4.35	<0.001
No Psych Treatment Past Year	(173)	73.9	83.9	54.4	1.00	--
Psych Meds Past year	(64)	27.4	8.4	64.6	19.90	<0.001
No Psych Meds Past Year	(170)	72.6	91.6	35.4	1.00	--
VA disability	(95)	40.6	31.0	59.5	3.27	<0.001
No VA Disability	(139)	59.4	69.0	40.5	1.00	--
% (N)			66.2(155)	33.8(79)		

Table 3. Predictors of Mental Health Treatment within 12 Months Post Deployment in Stepwise Regression using Backwards Elimination

```
Logistic regression                               Number of obs   =        234
                                                  LR chi2(6)      =      57.09
                                                  Prob > chi2     =     0.0000
Log likelihood = -105.71721                       Pseudo R2       =     0.2126

------------------------------------------------------------------------------
Treat Post-Deploy| Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
             Age |   1.03186   .0215147     1.50   0.133     .9905416    1.074901
          Female |    5.0746   2.604189     3.17   0.002     1.856014    13.87466
     TBI Symptoms |  2.787995   1.033159     2.77   0.006     1.348524    5.764018
   Use Psych Meds |  3.113856   1.195796     2.96   0.003     1.466953    6.609682
Low Psych Resil. |   2.216465   .8426867     2.09   0.036     1.052056    4.669631
Used Alc./Drugs  |   2.882578   1.183531     2.58   0.010     1.289122    6.445672
           _cons |   .0189017   .0191663    -3.91   0.000     .0025905    .1379168
------------------------------------------------------------------------------
```

TBI = Traumatic Brain Injury; Used alcohol/drugs to cope post deployment.
Age and sex were forced into the regression.

Table 4. Predictors of Mental Health Treatment in Past 12 Months in Stepwise Regression using Backwards Elimination

```
Logistic regression                               Number of obs   =        234
                                                  LR chi2(6)      =     138.85
                                                  Prob > chi2     =     0.0000
Log likelihood = -80.202057                       Pseudo R2       =     0.4640

------------------------------------------------------------------------------
 Psych Services
 in Past Year    | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
             Age |   .9519685   .0234008    -2.00   0.045     .907191    .9989561
          Female |   .8669087   .5948748    -0.21   0.835     .2258796    3.32713
Low Social Supp  |   5.266226   2.720981     3.22   0.001     1.912918    14.49782
Psychotropic Rx  |   13.06955   5.90128      5.69   0.000     5.394092    31.6667
       Concussion |   2.712885   1.163664     2.33   0.020     1.170354    6.288478
   PTSD-Lifetime |   12.97531   6.531426     5.09   0.000     4.837771    34.80086
           _cons |   .4888237   .5117088    -0.68   0.494     .0628203    3.803682
------------------------------------------------------------------------------
```

Age and sex were forced into the regression.

Table 5. Predictors of PTSD in Stepwise Regression using Backwards Elimination

```
Logistic regression                               Number of obs   =        234
                                                  LR chi2(5)      =      90.89
                                                  Prob > chi2     =     0.0000
Log likelihood = -78.507005                       Pseudo R2       =     0.3666

------------------------------------------------------------------------------
PTSD-Lifetime| Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         Age |   .9885123   .0251818    -0.45   0.650     .9403687    1.039121
      Female |    2.00645   1.207478     1.16   0.247     .6168463    6.526491
Recent Treat.|  11.96832   5.312227     5.59   0.000     5.014425    28.56572
   Insomnia  |   4.0827    2.455583     2.34   0.019     1.255982    13.27124
 TBI Symptoms|  3.442298   1.469212     2.90   0.004     1.491235    7.946042
       _cons |   .0245087   .0299632    -3.03   0.002     .0022319    .2691292
------------------------------------------------------------------------------
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Age and sex were forced into the regression

Study Findings

- Study population was 87.2% male, 94% Caucasian, and 58.5% were less than 45 years old.
- Prevalence of lifetime PTSD was 22.2%.
- Prevalence of in-service concussion was 32.9%.
- Current TBI symptoms were prevalent in 28.2%.
- Nearly one-third, 30.8%, had high combat exposure.
- After deployment, 21.8% used alcohol/drugs to cope.
- A majority, 59.4%, had insomnia in the past year.
- A total of 27.4% used psychotropic medications in the past year.
- A significant number, 40.6%, reported a current service-connected disability.

Study Limitations

- Veterans identified in a regional healthcare system.
- Survey response rate was 55%.
- Institutionalized/impaired veterans not surveyed.
- Survey based on self-report and was cross-sectional
- Medical records were not complete on all veterans.
- Study sample was 94% white race.
- Study sample was 87.2% male sex.

Multivariable Analyses Suggested

- Significant predictors of mental health treatment within 12 months post-deployment were female sex, TBI symptoms, use of psychotropic medications, low psychological resilience, and use of alcohol/drugs to cope post-deployment.
- Best predictors of mental health treatment in the past 12 months was associated with low social support, psychotropic medication use, history of concussion, and lifetime PTSD.
- Insomnia, TBI symptoms, and recent mental health treatment were significant predictors of Lifetime PTSD.

Conclusion

- Our research suggests that both warzone and non-warzone factors predicted mental health service use 12 months post-deployment, in the past 12 months, and lifetime PTSD among veterans seen in non-VA facilities.
- It is critical for clinicians to be mindful of these common predictors in order to improve mental health treatment planning for veterans in non-VA settings.
- Further research on this topic is advised to determine the strongest predicators of mental health issues both following deployment and afterwards in non-VA facilities.

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Study Findings

U.S. ARMY MEDICAL RESEARCH AND MATERIEL COMMAND (USAMRMC), PRINCIPAL INVESTIGATOR: Joseph A. Boscarino, PhD, MPH, Psychological Health and Traumatic Brain Injury Research Program (PHTBIRP) - Community Partners in Mental Health Research, Award # W81XWH-15-1-0506.

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Mental Health Disorders, Suicide Risk and Treatment seeking among Formerly Deployed National Guard and Reserve Service Member seen in Non-VA Facilities

Log Number: PT140183; Data analyses and study dissemination phase Award Number: W81XWH-15-1-0506

PI: Joseph A. Boscarino, PhD, MPH **Org:** Geisinger Clinic, Danville, PA **Award Amount: $ 2,261,852**

Study Aims

Aim 1: To estimate the prevalence of and risk factors for mental health disorders, substance use disorders, TBI, and suicide among National Guard and Reserves personnel who have returned from recent combat.

Aim 2: To identify protective factors for the onset and course of posttraumatic stress disorder (PTSD) and related disorders among service members after combat operations.

Aim 3: To assess the outcome of interventions received by National Guard and Reserves members during/after recent combat operations, including brief interventions.

Aim 4: To conduct genetic research related the risks for mental disorders, including the development of a DNA repository and research panel for future studies related to the genetics and consequences of PTSD and related disorders.

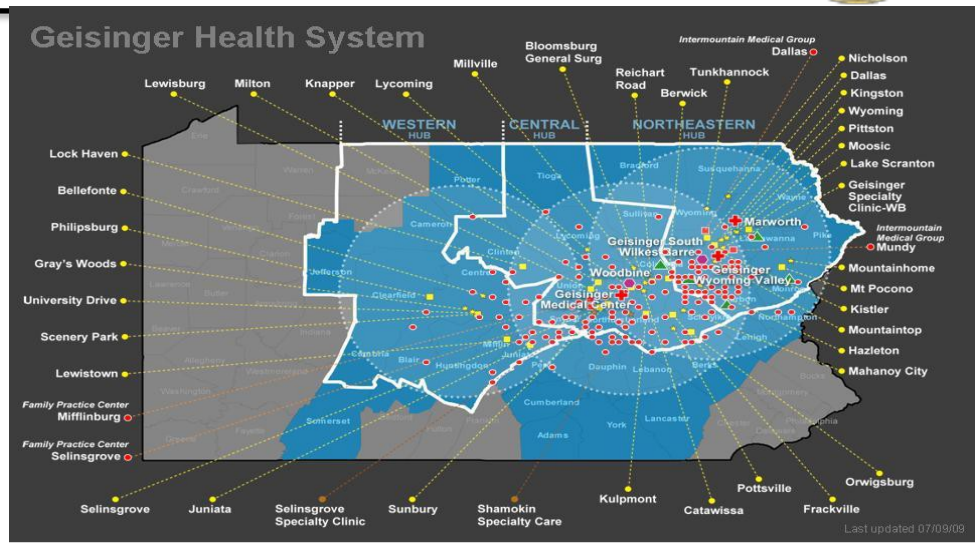
Method

A cohort study that includes multivariable analyses of diagnostic interviews with 900 deployed National Guard/Reverse veterans and 900 deployed veterans from other service eras, plus longitudinal clinical data from electronic health record (EHR) and DNA samples from Geisinger Clinic veterans.

Timeline and Cost

Activities	CY 15	16	17	18
Setup, IRB, recruit, data collection				
Merge survey, EHR data, DNA				
Conduct data analyses				
Complete analyses & disseminate				
Estimated Budget ($K)	**$857K**	**$804K**	**$601K**	

Updated: 09-30-2019 (CAW)



Geisinger ProvenHealth Navigator Sites
Contracted ProvenHealth Navigator Sites
Geisinger Medical Groups
Geisinger Specialty Clinics
Geisinger Inpatient Facilities
Ambulatory Care Facilities
Geisinger Health System Hub and Spoke Market Area
Geisinger Health Plan Service Area
Careworks Convenient Healthcare
Non-Geisinger Physicians With EHR

Goals/Milestones

CY15 Goals – Study preparation, and set-up, IRB phase

- ☑ Hired 2 personnel key to study operation
- ☑ Conducted initial meeting, updated veteran registry, and revised phone survey
- ☑ Submitted protocol and supporting documents to Geisinger & DoD IRB and National Institute of Mental Health (NIMH) for Certificate of Confidentiality
- ☑ Received Geisinger/DoD IRB approval & Certificate of Confidentiality from NIMH

CY16 Goals – Recruit study subjects from Geisinger Clinic

- ☑ Using the veterans' registry, conducted data pull for veteran status and demographics
- ☑ Began survey interviewing and collection of DNAs
- ☑ Conducted preliminary data analyses
- ☑ Prepared and submitted abstracts to professional meetings and began writing manuscripts
- ☑ Began genotyping of selected SNPs
- ☑ Presenting findings at regional & national conferences
- ☑ Extracted DNA & genotyped candidate genes for PTSD/addiction disorders, etc.
- ☑ Held local town hall meeting for ~100 veterans who participated in survey
- ✓ Completed extraction of relevant clinical data from EHR
- ✓ Merged & clean final dataset, complete analyses

CY17-CY18 Goals – Complete data analyses & disseminate results

- ☑ Submission of papers/posters for publication/presentation to key medical journals/organizations

Comments/Challenges/Issues/Concerns

- ✓ Delayed timeline due to ceding IRBs and having a survey time of >60 minutes
- ✓ Had to increase recruitment efforts for National Guard/Reserve cohort to meet study objectives

Budget Expenditure to Date

Projected Expenditure: $ 2,261,852; Actual Expenditure: 1,833,805