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The Post-Deployment Mental Health (PDMH) study and repository: A multi-site study of US Afghanistan and Iraq era veterans

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Abstract

The United States (US) Department of Veterans Affairs (VA) Mid-Atlantic Mental Illness Research, Education, and Clinical Center (MIRECC) Post-Deployment Mental Health (PDMH) multi-site study examines post-deployment mental health in US military Afghanistan/Iraq-era veterans. The study includes the comprehensive behavioral health characterization of over 3600 study participants and the genetic, metabolomic, neurocognitive, and neuroimaging data for many of the participants. The study design also incorporates an infrastructure for a data repository to re-contact participants for follow-up studies. The overwhelming majority (94%) of participants consented to be re-contacted for future studies, and our recently completed feasibility study indicates that 73–83% of these participants could be reached successfully for enrollment into longitudinal follow-up investigations. Longitudinal concurrent cohort follow-up studies will be conducted (5–10+ years post-baseline) to examine predictors of illness chronicity, resilience, recovery, functional outcome, and other variables, and will include neuroimaging, genetic/epigenetic, serum biomarker, and neurocognitive studies, among others. To date, the PDMH study has generated more than 35 publications from the baseline data and the repository has been leveraged in over 20 publications from follow-up studies drawing from this cohort. Limitations that may affect data collection for a longitudinal follow-up study are also presented.

KEYWORDS

Afghanistan, Iraq, mental health, post-deployment, veterans

1 | INTRODUCTION

The terrorist attacks of September 11, 2001 (9/11) profoundly affected United States (US) civilians and the US military, which rapidly mobilized intensive efforts to combat this threat. It became increasingly evident in subsequent years that the wars in Afghanistan and Iraq would increase the demand for health care by service members and veterans to be met in the US by the Veterans Health Administration (VHA, Department of Veterans Affairs [VA]) and the Department of Defense (DoD). (For this paper, note that VHA, VA, DoD, and other agencies refer to groups supporting US military service members and veterans which may differ in infrastructure and mission from other similar agencies around the world.) In the US, VHA needed to determine the most effective assessment and treatment approaches for US Afghanistan- and Iraq-era veterans, in addition to improving the understanding of the neurobiology of mental health conditions. Optimizing community-reintegration strategies also required attention and research.

As of March 2015, approximately 2.7 million US troops have served, or are serving, in Iraq or Afghanistan; over 1.9 million have become eligible for VA health care since 2002, and nearly 1.2 million have subsequently obtained VA health care (Epidemiology Program, Post-Deployment Health Group, Office of Public Health, VHA, & VA, 2015). These numbers continue to climb. Mental health disorders were among the top three diagnoses of veterans obtaining VA care, with approximately 57.6% having at least one mental health diagnosis. The most prevalent mental health diagnoses were posttraumatic stress disorder (PTSD; 55%), depressive disorders (45%), anxiety (43%), and alcohol dependence (13%; Epidemiology Program et al., 2015).

Much remains to be learned about whether and how post-deployment mental health may be a function of genetic or biopsychosocial risk and resilience factors combined with the stress and trauma of combat or war-zone exposure. Work is needed to (1) develop post-deployment mental illness phenotypes across biological, clinical, and behavioral traits; (2) examine variations in critical genes, proteins, neurosteroids or other small molecules, brain structures, epigenetic, mRNA, and other biological data within symptom clusters and phenotypes identified to be pathognomonic for mental illness; (3) understand the relationship between pre-military/pre-deployment mental health and biological factors and post-deployment mental health conditions; (4) understand associated health and health risk behaviors for this particular cohort; (5) identify health care service utilization and outcomes for this cohort and subgroups within this cohort; (6) update psychometric properties of mental health assessments utilized with this cohort; and (7) examine gender differences and similarities in the etiology and manifestation of mental health conditions and associated health sequelae. Above all, there remains tremendous unmet demand for developing effective, evidence-based assessment and treatment options.

Iraq- and Afghanistan-era veterans report deployment experiences that are distinct from veterans who served in prior eras. These differences include an all-volunteer military, multiple combat deployments, a high percentage of women and parents of young children, and a high number of veterans who have sustained severe injuries that would have resulted in death in previous wars (Institute of Medicine, 2013). The need for a substantial infrastructure to facilitate comprehensive and broad-based research programs that investigate the behavioral and medical health needs of this cohort quickly became apparent.

1.1 | Objectives

The study of Post-Deployment Mental Health (PDMH), developed and funded by the VA Mid-Atlantic Mental Illness Research, Education and Clinical Center (MIRECC), was established in 2005 as a comprehensive multi-site regional mechanism to create such a research infrastructure. The study had two primary goals. First, it was to serve as a *baseline study* to characterize mental health risk and resiliency factors in these veterans. The second goal was to create a data repository to serve as (a) a central "subject registry" or re-contact database and (b) a "data warehouse". The "subject registry" would collect and store contact information of participants who consented to be recruited for additional follow-up research studies. The "data warehouse" would store data collected from the baseline as well as other follow-up studies of the same participants. The intent of the PDMH baseline study was to address the gaps in research noted earlier. This extensive multi-site effort now houses one of the most comprehensive, large, planned databases of post-9/11 US veterans currently available for collaborative research endeavors. The purpose of this paper is to describe its design and methodology, enumerate its strengths and limitations, and communicate the challenges of establishing a large repository of multi-site data.

2 | METHODS

2.1 | Participating facilities

Management and operations of the PDMH study and repository have been headquartered at the Durham VA Medical Center (VAMC) in Durham, North Carolina. Data collection occurred at the Durham (North Carolina), McGuire (Richmond, Virginia), Hampton (Virginia), and W.G. (Bill) Hefner (Salisbury, North Carolina) VA Medical Centers. The Duke University Physiological and Molecular Institute (previously Center for Human Genomics) served as a collaborator in blood sample analysis and several affiliate academic institutions at each data collection site served as additional collaborators.

2.2 | Study population

Inclusion criterion entailed serving in the US military (i.e. veterans, active-duty personnel), and/or reserve forces (National Guard members and Reservists) on or after September 11, 2001. Exclusion criteria included primary language other than English, difficulty comprehending the informed consent form or process, and/or inability to travel to one of the participating data-collection sites. Neither deployment nor health care treatment-seeking were required for study enrollment.

2.3 | Study recruitment

Participants were recruited through mailings (all VA patients who met criteria), advertisements, and VA clinician referrals. The combination of recruitment methods produced a purposive convenience sample of individuals largely served by the VA medical centers in the Mid-Atlantic region of the US. Participants verbally confirmed their period of military service during an initial phone screening prior to participation and verified service status with a copy of their military service documentation form at enrollment into the study. Starting in 2015, recruitment was modified to oversample women for baseline and follow-up studies. A target goal of recruiting 67% women was set for each site in order meet a target goal of 1000 female veteran participants by 2017.

2.4 | Enrollment and informed consent

The PDMH study protocol was approved by the Durham VAMC Institutional Review Board (IRB) and subsequently approved by local review boards of each participating site. Each enrolled study participant was asked to separately consent to baseline data collection and to repository data collection. Written informed consent specifically requested permission to (1) use blood samples for DNA/RNA analyses, protein characterization, neurosteroid, and other small molecule analyses; (2) retrieve health care information from VA electronic medical records; (3) contact a friend or family member in the event that he/she could not be reached for future studies or for emergencies; and (4) add blood, questionnaire data, neuroimaging, contact information (for him/herself and friend/family member), and/or medical record information to a repository for future analyses or follow-up studies. Participants were provided the opportunity to consent or decline consent/access for each of these items separately.

Table 1 and the Methods section describe the data collected for the baseline study. For repository data collection, participants who consented had their baseline data and contact information added to the data repository. Researchers interested in further investigating various mechanisms among target populations could subsequently select participants based on the data collected to recruit into follow-up studies (see Appendix Table A1).

Participants were compensated $175 for completion of the full-day study (prorated for partial completion) plus a travel stipend based on distance traveled (between $8–$75 for 25–200+ miles).

2.5 | Data collection and management procedures

Initially data were collected via paper-and-pencil forms using double-entry techniques for data capture. Following the first year, a website was developed that allowed participants and study staff to enter study data directly into a back-end Microsoft Structured Query Language (SQL) Server Database. The system was developed to reduce human data entry errors and increase efficiency. The website featured data validation and skip-pattern logic to ensure that study data were collected as accurately as possible. The website interface could be accessed simultaneously by both participants and study staff. This arrangement allowed study staff to concurrently review questionnaires for completeness, as well as to provide alerts regarding potential for risk-of-harm questionnaire items (e.g. suicidal ideation) that may require study clinician risk assessment follow-up (Brown, Strauss, et al., 2014). Participants were made aware of these features prior to participating in the study.

2.6 | Measures

2.6.1 | Demographic and re-contact information

Demographic information included data about military service, discharge, time/place of service, combat exposure, theater of engagement, sex, date of birth, marital status, education level, highest military rank, current military rank, military service of family members, smoking status, and military discharge status (see Supporting Information). Re-contact information included addresses (current, permanent, temporary, email, next of kin or close friends), telephone numbers, and any re-deployment or re-assignment plans.

2.6.2 | Medical history and medications

Participants were asked to complete a medical questionnaire that was also used by the National Vietnam Veterans Readjustment Study (NVVRS; Kulka et al., 1990). Information also included prescription and non-prescription medications, dose, and length of use. Objective medical service utilization and laboratory data values are planned to be retrieved from medical record data for participants who used VA health care services. The Corporate Data Warehouse (CDW) will be accessed for this purpose. The CDW contains data on every outpatient and inpatient visit by a veteran to a VA community clinic or medical center. The CDW also contains data on every outpatient medication dispensed to a veteran by any VA facility. In addition to objective measures of health service utilization, the CDW contains validated patient reported outcomes, such as the Alcohol Use Disorders Identification Test (AUDIT-C), an alcohol screen for misuse, and may contain multiple data points for measures administered at more than one patient visit.

2.6.3 | Blood and serum samples

Blood samples were obtained between 10:30 a.m. and 2:30 p.m. via venipuncture by a member of the research team trained in phlebotomy. Blood samples from collaborating sites were transported to the main storage site (Durham VAMC) by vehicle or certified shipping on dry ice. All blood was stored in -80°C freezers until analyzed. Blood was allocated for DNA extraction and analysis, mRNA and epigenetic studies, and serum investigations of neurosteroids, other small molecules, and proteins to investigate possible biomarker candidates for psychiatric disorders and therapeutic targets. Genomic DNA was extracted from peripheral blood samples via alcohol and salt

TABLE 1 Self- and clinician-administered measures

Domain	Assessment measure(s)	Date initiated	References
Demographics	Demographic Questionnaire	2005	Developed internally, VISN 6 MIRECC workgroup (see Supporting information)
PTSD Symptoms & Severity	Structured Clinical Interview for DSM-IV-TR Axis-I Disorders (SCID-I) – eSCID[a]	2005, paper; 2009, eSCID	First, Spitzer, Gibbon, & Williams, 1994
	DSM-5 PTSD SCID supplement	2010; revised 2011	Developed internally, VISN 6 MIRECC workgroup (see Supporting information)
	Clinician Administered Posttraumatic Stress Disorder Scale—Global Functioning Questions (CAPS-GFQ)	2012	Blake et al., 1995
	Primary Care PTSD (PC-PTSD)	2005	Prins et al., 2003
	Davidson Trauma Scale (DTS)	2005	Davidson, 2004
Other mental health diagnoses, Symptoms & Severity	Symptom Checklist-90-Revised (SCL-90-R)	2005	Kinney, Gatchel, & Mayer, 1991
	Structured Clinical Interview for DSM-IV-TR Axis-I Disorders (SCID-I) – eSCID[a]	2005, paper; 2009, eSCID	First et al., 1994
	Beck Depression Inventory-II (BDI-II)	2005	Storch, Roberti, & Roth, 2004
Substance use	Alcohol Use Disorder Identification Test (AUDIT)	2005	Bradley, Bush, McDonell, Malone, & Fihn, 1998
	Drug Abuse Screening Test (DAST)		Skinner, 1982
	Smoking Exposure Scale (SES)	2005	Developed internally, VISN 6 MIRECC workgroup, 2005 (see Supporting information)
	Smoking: Stages of Change (short form)	2005	DiClemente et al., 1991
	Smoking Questionnaire (SQ)	2005	Developed internally, VISN 6 MIRECC workgroup (see Supporting information)
	Shiffman-Jarvik (Right Now)	2005–2012	Shiffman & Jarvik, 1976
	Smoking Consequences Questionnaire	2005–2012	Brandon & Baker, 1991
Suicidal ideation	Beck Scale for Suicide Ideation (BSS)	2005	Kumar & Steer, 1995
Physical health	National Vietnam Veterans Readjustment Study (NVVRS) medical questionnaire	2005	Kulka et al., 1990
	Brief Pain Inventory (BPI; short form)	2012	Cleeland, 1991
	Body Mass Index (height, weight, waist and hip circumference)[b]	2012	Developed internally, VISN 6 MIRECC workgroup
Trauma exposure, Symptoms & Severity	Combat Exposure Scale (CES)	2005	Lund, Foy, Sipprelle, & Strachan, 1984
	NDHS Modified Deployment Risk and Resiliency Inventory (DRRI) Combat Experiences Measure (CEM) and Other Warzone Experiences (OWE) subscales	2008	Vogt, Proctor, King, King, & Vasterling, 2008; Vasterling et al., 2006
	Traumatic Life Events Questionnaire (TLEQ) – Modified	2005	Kubany et al., 2000
Resilience	Connor Davidson Resilience Scale (CD-RISC)	2005	Connor & Davidson, 2003
	Medical Outcomes Study (MOS) Social Support Survey	2008	Sherbourne & Stewart, 1991
Traumatic brain injury (TBI)	TBI Screen	2005	Ivins et al., 2003
	McCormick Traumatic Brain Injury Interview[a]	2009	Developed internally, VISN 6 MIRECC workgroup (see Supporting information)
	Neuroimaging via Philips Ingenia 3.0 Telsa MRI scanner[b]	2013	n/a
Living status	Living Status Questionnaire (LSQ)	2008	Developed internally, VISN 6 MIRECC workgroup (see Supporting information)
Sleep	Pittsburgh Sleep Quality Index (PSQI)	2005	Buysse, Reynolds, Monk, Berman, & Kudofer, 1989
Spirituality	Modified Brief Multidimensional Measure of Religiousness/spirituality (M-BMMRS)	2012	Based on abbreviated version of the BMMRS (Fetzer-NIA-Working Group, 1999) and a screening for spiritual struggle measure, Fitchett & Risk, 2009
Cognitive functioning	Shipley Institute of Living Scale (SILS)	2005	Zachary, Paulson, & Gorsuch, 1985
Treatment experience	Treatment Questionnaire (TQ)	2008	Developed internally, VISN 6 MIRECC workgroup (see Supporting information)
Family mental health background	Family Health Questionnaire (FHQ)	2005	Developed internally, VISN 6 MIRECC workgroup (see Supporting information)

[a]Clinician-administered.

[b]Collected only at Durham VA site.

precipitation using Gentra Systems PUREGENE DNA Purification kit (Qiagen, Valencia, CA). Neurosteroid levels in sera were determined by a highly sensitive and specific gas chromatography/mass spectrometry (GC/MS) method. The limit of detection for this MS method was 1–2 pg for each neurosteroid (Marx et al., 2015). Various analyses including neurosteroid, whole-genome and other genotyping are described in further detail elsewhere (e.g. Ashley-Koch et al., 2015; Kimbrel, Garrett, et al., 2015; Kimbrel, Hauser, et al., 2015; Liu et al., 2015; Marx et al., 2015; Naylor et al., 2015; Naylor, Kilts, Szabo, Dunn, Keefe, et al., 2016).

2.6.4 | Self-administered questionnaires

Participants completed self-reported measures of various psychological and neuropsychiatric symptoms and medical conditions (see Table 1). Questionnaires were administered in a randomized order, with two exceptions. The demographic questionnaire was always administered first. The Traumatic Life Events Questionnaire (TLEQ) and Davidson Trauma Scale (DTS) were randomized as a pair, with the DTS always following the TLEQ to facilitate recall and consistency regarding index trauma-related symptoms. Certain questionnaires were modified to address cohort-specific issues. This includes the Deployment Risk and Resiliency Inventory (DRRI) Combat Experiences Measure (CEM) and Other War Zone Experiences (OWE) subscales, consistent with methods supported by Vasterling et al. (2006) in the Neurocognition Deployment Health Study. Additional modifications are identified in the following sections.

2.6.5 | Clinician-administered interviews and questionnaires

The Structured Clinical Interview for DSM-IV-TR Axis-I Disorders (SCID-I; First et al., 1994), a semi-structured interview guide, was used to determine DSM-IV Axis I diagnoses. The SCID has been found to be both clinically sensitive and reliable (Keane & Barlow, 2002), with good to excellent interrater reliability for current disorders and moderate test–retest reliability for lifetime disorders (Rogers, 2001). Both lifetime and current psychiatric diagnoses and symptom-level data were collected. All interviewers completed the recommended SCID training program (watching training tapes, observing, being observed and rated with feedback). Interviewers have demonstrated excellent mean interrater reliability for any Axis I diagnoses (Fleiss' kappa = 0.94), and specifically for current PTSD (Fleiss' kappa = 1.0). Given that this was a multi-site study, the biggest challenge faced was the potential for rater drift. This was addressed by requiring all study interviewers to attend biweekly peer consultation, supervised by a licensed psychologist. Additional annual rater observations were conducted to evaluate rater drift. In 2010, data collection transitioned to the electronic SCID (eSCID). Interview method was unchanged but used electronic data capture instead of paper and pencil to reduce data entry errors.

Several eSCID skip patterns were modified to ensure a more complete administration of the most common psychiatric disorders among this cohort. The PTSD section was reconfigured to be administered first, prior to other anxiety disorders. As the most prevalent diagnosis among this cohort, ruling out PTSD before assessing other anxiety disorders was most efficient and evidence-based. Additionally, all PTSD items were administered without skip-outs, and regardless of whether DSM-IV criterion A2 (fear, helplessness, or horror in response to trauma exposure) or symptom clusters were fully endorsed. This supported early recognition that veterans did not always endorse experiencing "fear, helplessness, or horror". The purpose of administering all symptom items would allow future evaluation of subthreshold PTSD symptoms (Brancu et al., 2016), which can also cause significant impairment and warrants further research.

2.6.6 | Neuroimaging

A Philips Ingenia scanner at the Durham VAMC site was used to acquire a T1-weighted high resolution 0.9375 mm × 0.9375 mm × 1.0 mm three-dimensional (3D) turbo field echo pulse sequence with contrast enhancement and SENSE (TR/TE/flip angle = 8.148 ms/3.728 ms/8°, FOV = 240 mm, 1-mm slice thickness, 170 slices, 256 × 256 matrix, one excitation). The DTI was obtained with a high in-plane resolution (1.75 mm × 1.75 mm × 2.0 mm) 3D turbo field echo pulse sequence with contrast enhancement and SENSE (TR/TE/flip angle = 8.148 ms/3.728 ms/90°), two averages, 34 non-collinear directions (diffusion gradients), SENSE factor = 1, non-zero b-value = 800 s/mm^2, 80 slices, 128 × 128 matrix, one excitation. A resting-state functional magnetic resonance imaging (fMRI) was acquired using a high in-plane resolution (1.8 mm × 1.8 mm × 4.0 mm) 3D turbo field echo pulse sequence with contrast enhancement and SENSE (TR/TE/flip angle = 2000 ms/35 ms/90°, axially oriented slices: 30, 128 × 128 matrix). Further detail regarding neuroimaging analyses is described elsewhere (e.g. Morey et al., 2008; Morey, Gold, et al., 2013; Morey, Haswell, et al., 2013).

2.7 | Managing challenges of a long-term multi-site study

2.7.1 | Changes to study battery over time

One of the greatest challenges was determining how to remain relevant and up-to-date over the course of an 12-year data collection period. During this time, our understanding of the mental health needs of this particular cohort expanded, and in 2013, the guidelines for how to evaluate PTSD also changed with the release of the DSM-5. To meet these challenges, in 2008 and 2012, we convened a group of subject matter experts to review the measures and evaluation methods. There was a recognition that the core battery should remain consistent over time to support reliable comparisons and that new measures needed to be few and brief in order to fit feasibly into the one-day study visit and not add burden to participants. The group solicited and reviewed recommendations, taking into consideration (a) resources available, (b) evidence base, (c) length of administration, (d) whether the data could be gathered in other ways (e.g. medical records data), (e) how the constructs fit with the current study battery, (f) projected enrollment to justify power analyses for those additional measures, (g) plans for the longitudinal concurrent cohort follow-up and any planned current subgroup follow-up studies, and (h) whether any measures could be removed or replaced. Ultimately measures evaluating moral injury and spirituality, pain, body mass index (BMI) measurements (not available in medical record data), social support, and

additional war zone experiences were added to expand knowledge in those emerging areas (see Table 1 for these measures and when they were added). The moral injury and spirituality measure, Modified Brief Multidimensional Measure of Religiousness/Spirituality (M-BMMRS; see Table 1), was developed specifically to evaluate the most critical and basic religious/spiritual demographics and topics that had previously been published as important to attend to among veterans with PTSD.

In 2010, four DSM-5-related PTSD questions were also added to supplement the DSM-IV SCID-I interview (see Supporting Information). These four questions were developed in response to proposed changes to the DSM-5 PTSD criteria and prior to the actual publication of DSM-5 in 2013. These items were based on early proposals for the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5; Weathers et al., 2013), though developed prior to the new CAPS-5 scale being released. The questions were reviewed and piloted by SCID interviewers as well as by internal and external PTSD subject matter experts. While criteria A2 ("fear, helplessness, or horror" experience) and criterion C "foreshortened future" were no longer part of the DSM-5 diagnosis, the items were nevertheless kept as part of administration for both the purpose of consistency and to allow greatest flexibility with changing scoring rubrics. The change to criterion C "avoidance cluster" was determined not to be a significant change to warrant revision to current administration. The study team also added a specifier of "self, other, both" based on the knowledge that the new negative cognitions symptoms could refer to self and/or others, which would be useful data for pre-post screening for follow-up evidence-based psychotherapy study trials. Since the data collection method required full administration of all SCID PTSD items, scoring could essentially be programmed to evaluate (a) DSM-IV PTSD, (b) a reasonable approximation to DSM-5 PTSD, and (c) various subthreshold levels of PTSD using different algorithms of cluster and symptom endorsements.

Measures of PTSD-related functioning (CAPS-Global Functioning Questions [GFQ]; Blake et al., 1995) and an internally developed clinician-administered traumatic brain injury (TBI) interview were also added, the latter to better operationalize severity of TBI according to the American Congress of Rehabilitation Medicine criteria (Menon, Schwab, Wright, & Maas, 2010) (see Table 1 and Supporting Information).

2.7.2 | Publishing during long-term ongoing data collection

A significant challenge for any long-term study is how to handle publishing during data collection. Procedures were implemented to develop a "production" database in which data were added during enrollment at planned intervals, and a "research" database where cleaned data were deposited. Data cleaning occurred immediately if a new problem was identified that would lead to analysis problems but would otherwise be slated for yearly cleaning. Upon yearly cleaning, the new dataset was considered to be "locked down" and with few exceptions, only the locked down datasets were made available for analyses. The electronic data gathering system also allowed date-stamping and tracking of changes in case there were questions about cleaning corrections.

2.7.3 | Workgroup authorship, data access, and consistency in publication

Over time, as collaborations and interest grew in this dataset, a Publication Committee was established to provide guidance for authorship credit and consistency across all published work and to track publications. The committee developed (1) a review process for all requests to analyze or use the data and (2) an authorship workgroup and guidelines based on the International Committee of Medical Journal Editors (ICMJE) guidelines.

3 | RESULTS

3.1 | Demographics and clinical characteristics

Of more than 3600 participants enrolled in the baseline study as of July 2016, 20% of the sample is comprised of women, and approximately half of the participants are African-American/Black. The average age of the sample is 37.0 (standard deviation [SD] = 10.2 years; see Table 2). Most veterans (91%) were discharged from the military honorably, served in the Army (65%), were enlisted rank (92%), and served in a war zone (79%). Approximately 8.5% of the participants were active duty military service members and nearly one-third also served in the Reserves or National Guard. Nearly half of the cohort had served in the military prior to the post-9/11 era, including some who also served during the First Persian Gulf War and other previous eras (see Table 3).

Approximately half of the cohort reported receiving outpatient mental health treatment either within and/or outside the VA system. Slightly more than half had at least one medical condition diagnosed by a physician, and more than half had a disability for which the individual was receiving VA benefits ("service connected disability") (Table 2).

Approximately 22% met criteria for current major depressive disorder (MDD; 42% met criteria for lifetime MDD), 26% met current PTSD criteria (37% lifetime), 15% of the total sample had both current PTSD and MDD, 6% met criteria for current alcohol abuse and/or dependence (37% lifetime), and 1.5% met criteria for cannabis abuse/dependence (10% lifetime). Twenty-one percent endorsed at least one deployment-related TBI (per MIRECC TBI interview) (See Table 4 for complete details about clinical presentation). Mean number of lifetime traumatic events experienced (Table 5) was 3.93 (SD = 3.48), with women reporting significantly more traumatic events throughout their lifetime, during military service, and after military service. (Note that the relative proportions, percentages, and means shown in the tables have not significantly changed since July 2016).

3.2 | Published findings

The PDMH study is an open ongoing study that is completing baseline data collection as it transitions to a longitudinal study. Thus, reported findings are still considered to be preliminary analyses of subsets of the data as we continue to collect sufficient data for certain subsamples. For a study that has been collecting data for over 10 years, the purpose of continuously publishing preliminary findings is to share important findings with the broader public, to support ongoing research, and for pre-decisional efforts to formulate future potential

TABLE 2 Demographics of the study participants

	Total cohort (*n* = 3247)		Male (*n* = 2587)		Female (*n* = 660)	
	Frequency or mean	% or SD	Frequency or mean	% or SD	Frequency or mean	% or SD
Age	37.48	10.24	37.61	10.30	37.00	10.02
18–29	870	28.59%	687	28.41%	183	29.28%
30–39	912	29.97%	710	29.36%	202	32.32%
40–49	839	27.57%	672	27.79%	167	26.72%
50–59	360	11.83%	302	12.49%	58	9.28%
60+	62	2.04%	47	1.94%	15	2.40%
Race						
White	1580	49.30%	1357	53.03%	223	34.52%
African-American	1534	47.86%	1127	44.04%	407	63.00%
Other	91	2.84%	75	2.93%	16	2.48%
Hispanic						
Non-Hispanic	3023	94.68%	2399	94.26%	624	96.30%
Hispanic	170	5.32%	146	5.74%	24	3.70%
Marital status						
Married	1726	53.24%	1528	59.13%	198	30.09%
Separated/divorced	786	24.24%	558	21.59%	228	34.65%
Never married	719	22.18%	495	19.16%	224	34.04%
Widowed	11	0.34%	3	0.12%	8	1.22%
Years of education	13.48	3.65	13.37	3.61	13.90	3.80
Education						
< high School or general educational development (GED)	115	3.55%	109	4.22%	6	0.91%
High School	1207	37.23%	1028	39.78%	179	27.20%
Assoc/tech	859	26.50%	665	25.74%	194	29.48%
Bachelor's	614	18.94%	458	17.72%	156	23.71%
Masters/PhD	253	7.80%	177	6.85%	76	11.55%
Other	194	5.98%	147	5.69%	47	7.14%
Working status						
Working – Full time	1261	38.96%	1002	38.85%	259	39.36%
Working – Part time	355	10.97%	258	10.00%	97	14.74%
Not working[a]	1621	50.08%	1319	51.14%	302	45.90%
Living status: Where						
Rent/own	2199	88.92%	1747	88.50%	452	90.58%
Family/friends	223	9.02%	182	9.22%	41	8.22%
Group home/shelter	35	1.42%	31	1.57%	4	0.80%
Other	16	0.65%	14	0.71%	2	0.40%
Living status: With whom						
Alone	369	14.92%	258	13.07%	111	22.24%
Spouse/partner/children	1537	62.15%	1272	64.44%	265	53.11%
Family	370	14.96%	282	14.29%	88	17.64%
Friends/roommate	172	6.96%	142	7.19%	30	6.01%
Other	25	1.01%	20	1.01%	5	1.00%

[a]Non-working may include retirees, students, and 100% disabled.

policy recommendations. Once sufficient data are collected, information will be shared with the VA that may help with developing or formulating policies to improve post-deployment mental health care. More than 35 manuscripts of preliminary analyses of subsets of data have been published from data acquired by the PDMH study (Appendix Table A2) and 20 manuscripts published from PDMH follow-up and longitudinal cohort studies (Appendix Table A1).

3.3 | Retention efforts

3.3.1 | Additional sub-studies of the PDMH study cohort

As a result of the infrastructure developed to maintain a data repository, more than 25 IRB-approved studies have recruited or are currently recruiting participants from the re-contact database of the repository for genetic, epigenetic, gene expression, metabolomic,

TABLE 3 Military background

	Total cohort (*n* = 3247)		Male (*n* = 2587)		Female (*n* = 660)	
	Frequency or mean	% or SD	Frequency or mean	% or SD	Frequency or mean	% or SD
Current military status						
Active	171	8.55%	132	8.23%	39	9.80%
Discharged	1830	91.45%	1471	91.77%	359	90.20%
Discharge type						
Honorable	1193	87.14%	942	86.11%	251	91.27%
General (honorable)	144	10.52%	123	11.24%	21	7.64%
Other	32	2.34%	29	2.65%	3	1.09%
Branch						
Army	2046	65.03%	1598	63.87%	448	69.57%
Navy	520	16.53%	401	16.03%	119	18.48%
Air force	245	7.79%	188	7.51%	57	8.85%
Marines	320	10.17%	303	12.11%	17	2.64%
Coast Guard	15	0.48%	12	0.48%	3	0.47%
Reserves/National Guard						
National Guard	636	19.81%	538	16.75%	98	3.05%
Reserves	473	14.73%	340	10.59%	133	4.14%
Rank						
Enlisted	2970	92.01%	2363	91.87%	607	92.53%
E1–E6	2406	74.57%	1896	73.72%	510	77.74%
E7–E9	564	17.47%	467	18.16%	97	14.79%
Warrant officer	42	1.30%	38	1.48%	4	0.61%
W1–W3	26	0.81%	25	0.97%	1	0.15%
W4–W5	16	0.50%	13	0.11%	3	0.46%
Officer	216	6.69%	171	6.65%	45	6.86%
O1–O5	187	5.79%	144	0.56%	43	6.55%
O6–O7	29	0.90%	27	1.05%	2	0.30%
Era (not mutually exclusive)[a]						
World War II (1939–1945)	2	.06%	2	.06%	0	0.00%
Korean (1950–1953)	3	.09%	2	.06%	1	.03%
Between Korean & Vietnam (1954–1959)	7	.22%	7	.22%	0	0.00%
Vietnam (1960–1975)	135	4.16%	127	3.91%	8	.25%
Post-Vietnam (1976–1989)	519	15.99%	440	13.56%	79	2.43%
First Persian Gulf (1990–1991)	957	29.48	788	24.28%	169	5.21%
Post-Gulf (1991–2001)	1334	41.10%	1066	32.84%	268	8.26%
OEF (Afghanistan)	1784	54.96%	1401	43.16%	383	11.80%
OIF (Iraq)	2694	82.99%	2146	66.11%	548	16.88%
OND (post Iraq)	255	7.75%	198	6.10%	57	1.76%
Tours (mean)	1.53	1.35	1.60	1.38	1.22	1.14
Tours served						
0 (never deployed)	369	11.58%	235	9.24%	134	20.84%
1	1644	51.58%	1301	51.14%	343	53.34%
2	734	23.03%	627	24.65%	107	16.64%
3	261	8.19%	228	8.96%	33	5.13%
4+	179	5.62%	153	6.01%	26	4.04%
Warzone exposure						
Did not serve in warzone	672	21.00%	430	16.86%	242	37.237%
Served in a warzone	2528	79.00%	2120	83.14%	408	62.77%
Warzone assignment						
Services support	491	19.42%	348	16.42%	143	35.05%
Combat support	1015	40.15%	812	38.30%	203	49.75%

(*Continues*)

TABLE 3 (Continued)

	Total cohort (*n* = 3247)		Male (*n* = 2587)		Female (*n* = 660)	
	Frequency or mean	% or SD	Frequency or mean	% or SD	Frequency or mean	% or SD
Services & combat support	103	4.07%	78	3.68%	25	6.13%
Combat	712	28.16%	689	32.50%	23	5.64%
Combat & services support	11	0.44%	11	0.52%	0	0.00%
Combat & combat support	164	6.49%	152	7.17%	12	2.941%
All	32	1.27%	30	1.42%	2	0.49%
Theater exposure						
Under fire	690	21.39%	547	21.28%	143	21.83%
Under fire & wounded	184	5.70%	146	5.68%	38	5.80%
Under fire & fired weapon	702	21.76%	651	25.32%	51	7.79%
Under fire, fired weapon, wounded	377	11.69%	354	13.77%	23	3.51%
None	1273	39.46%	873	33.96%	400	61.07%

[a]Note: Eras are not mutually exclusive. This table includes all eras that veterans may have served as part of their military career, in addition to their service during the Operation Enduring Freedom (OEF)/Operation Iraqi Freedom (OIF)/Operation New Dawn (OND) era.

neuroimaging, neurocognitive, and psychosocial evaluations on subgroups of interest (e.g. veterans with PTSD, veterans with TBI). Preliminary information gathered from a number of these studies suggests success in recruiting this cohort for longitudinal follow-ups, as follows: (1) large numbers of participants have been recruited into additional sub-studies (e.g. neuroimaging study $n > 485$; neurocognitive study $n > 425$); (2) 73% of eligible participants in an imaging genetics sub-study and 89% of a magnetoencephalography (MEG) sub-study were able to be recruited using telephone contact information only, with no further contact attempts (e.g. mailed letters); and (3) a neurocognitive sub-study has thus far been able to meet over 85% of its recruitment goal (out of a planned 500) recruiting from the repository.

3.3.2 | Pilot study to test feasibility of longitudinal follow-up

At Year 10, a pilot study of a small randomized subsample of the full cohort was conducted to examine the feasibility of conducting a longitudinal follow-up of this cohort. The Dillman Total Design Method (Hoddinott & Bass, 1986) was used as the model for re-contacting 100 baseline PDMH study participants who had consented to re-contact for future studies. The 100 participants were randomized and broken down to an equal number across three approximately 3-year cohorts (first 3-4 years, next 3 years, and most recent 3 years of recruitment), and also balanced to reflect 50% male and 50% female. The purpose of this stratification was to determine whether recruitment of certain years or by female gender would pose any differential challenges. Four attempts were made to contact each participant, followed by four attempts to contact the participant's friend/kin if direct contact failed. Initial contacts were by mail and included the option of opting out of future contact if desired. Participants and/or kin were also contacted by telephone two weeks after the second mailing was sent.

Overall, 91% of the sample was located (25% by mail only, the remaining by telephone calls and medical record review). After 7% attrition (due to death, incarceration, desire to no longer be contacted, or multiple failed missed connections), 83% of the 100 participants provided updated contact information and expressed interest in ongoing contact for a future follow-up study.

3.3.3 | Full mail-out

At Year 9 of the study, a retention check was conducted by sending out a letter, using the Dillman Method, to all prior study participants to evaluate the accuracy of contact records. Of the 3037 letters mailed, 674 (22%) were sent back due to an incorrect or outdated address, highlighting the need to use telephone and other methods to reach participants.

4 | DISCUSSION

The PDMH study was one of the earliest to comprehensively assess Iraq/Afghanistan-era veterans, with data collection beginning in 2005. The study is complementary to other similar studies and repositories of this cohort, including the National Health Study for a New Generation of US Veterans (2016; Eber et al., 2013); Translation Research Center for TBI and Stress Disorders (TRACTS; McGlinchey, Milberg, Fonda, & Fortier, 2017; see also Lippa et al., 2015, for example related study); South Texas Research Organizational Network Guiding Studies on Trauma and Resilience (STRONG STAR 2016) and STRONG STAR Consortium to Alleviate PTSD (STRONG STAR-CAP; Peterson, 2017; Peterson & Keane, 2017; see also McLean et al., 2017, Resick et al., 2017, and https://tango.uthscsa.edu/strongstar/affiliated.asp for example related studies); Injury and Traumatic Stress (INTRuST; Stein & Lang, 2017; see also McAllister et al., 2016, for example related study), among others. It is also one of the few studies that includes a SCID assessment, blood draw, and original consent to re-contact participants for future studies. With data collected on over 3600 Iraq/Afghanistan-era veterans, over 94% of whom originally agreed to be re-contacted, and a randomized feasibility pilot demonstrating 83% interest in participating in a longitudinal follow-up study, perhaps the most unique contribution is the robust research infrastructure to support future longitudinal follow-ups of the total cohort. It also demonstrates our ability to support large-scale worldwide

TABLE 4 Clinical presentation at time of study

	Total cohort (*n* = 3247)		Male (*n* = 2587)		Female (*n* = 660)	
	Frequency or mean	% or SD	Frequency or mean	% or SD	Frequency or mean	% or SD
NVVRS: Physician diagnosis						
0	1251	41.97%	1001	42.17%	250	41.19%
1	916	30.73%	719	30.29%	197	32.45%
2	491	16.47%	394	16.60%	97	15.98%
3	198	6.64%	153	6.44%	45	7.41%
4+	125	4.19%	107	4.51%	18	2.97%
Service-connected disability						
No	1361	41.92%	1105	42.96%	256	39.20%
Yes	1864	57.41%	1467	57.04%	397	60.80%
Average disability % rating	50.19	28.80	49.88	28.95	51.35	28.99
Lifetime hospitalization for mental health						
No	2755	84.85%	2161	83.63%	594	90.27%
Yes: VA	219	6.74%	197	7.62%	22	3.34%
Yes: Non-VA	189	5.82%	157	6.08%	32	4.86%
Yes: VA & non-VA	79	2.43%	69	2.67%	10	1.52%
Outpatient treatment for mental health (past three years)						
No	1520	47.99%	1236	49.05%	284	43.89%
Yes: VA	876	27.66%	696	27.62%	180	27.82%
Yes: Non-VA	437	13.80%	337	13.37%	100	15.46%
Yes: VA & non-VA	334	10.55%	251	9.96%	83	12.83%
Current smoker						
No	2410	74.64%	1885	73.26%	525	80.03%
Yes	819	25.36%	688	26.74%	131	19.97%
Trouble controlling violent behavior in past 30 days						
No	2944	90.86%	2340	90.59%	604	91.93%
Yes	296	9.14%	243	9.41%	53	8.07%
Jail time						
0	2506	77.37%	1918	74.28%	588	89.50%
< 2 weeks	570	17.60%	509	19.71%	61	9.28%
> 2 weeks	163	5.03%	155	6.00%	8	1.22%
Self-report scales						
SCL-90: General stress	0.91	0.84	0.90	0.83	0.93	0.87
SILS: Full scale IQ	96.98	11.20	96.81	11.38	97.68	10.46
DTS Total score	40.82	39.98	41.05	39.91	39.92	40.29
MOS social support Total score	73.54	26.15	74.01	25.92	71.7	26.98
CD-RISC (resilience) Total score	72.58	18.46	72.67	18.18	72.24	19.52
BDI Total score	14.47	12.75	14.21	12.58	15.49	13.37
0–13 (minimum)	1785	54.99%	1435	55.49%	350	53.03%
14–19 (mild)	445	13.71%	363	14.04%	82	12.42%
20–28 (moderate)	503	15.50%	399	15.43%	104	15.76%
29–63 (severe)	513	15.80%	389	15.04%	124	18.79%
BSS Total score	0.97	3.19	1.01	3.28	0.84	2.81
0–5	3010	92.84%	2389	92.53%	621	94.09%
6+	232	7.16%	193	7.47%	39	5.91%
AUDIT Total score	4.95	5.94	5.47	6.17	2.92	4.36
0–6 (minimum)	2521	77.76%	1934	74.85%	587	89.21%
7–19 (abuse)	595	18.35%	534	20.67%	61	9.27%
20+ (dependency)	126	3.89%	116	4.49%	10	1.52%
DAST Total score	1.00	2.64	1.11	2.78	0.60	1.91

(*Continues*)

TABLE 4 (Continued)

	Total cohort (*n* = 3247)		Male (*n* = 2587)		Female (*n* = 660)	
	Frequency or mean	% or SD	Frequency or mean	% or SD	Frequency or mean	% or SD
0 (none)	2449	75.47%	1900	73.50%	549	83.18%
1–5 (low)	599	18.46%	512	19.81%	87	13.18%
6–10 (intermediate likely meets DSM criteria)	129	3.98%	110	4.26%	19	2.88%
11–15 (substantial)	43	1.33%	41	1.59%	2	0.30%
16–20 (severe)	25	0.77%	22	0.85%	3	0.45%
SCID diagnoses						
Bipolar						
Current	51	1.57%	36	1.39%	15	2.27%
Lifetime	85	2.62%	58	2.24%	27	4.09%
MDD						
Current	714	21.99%	550	21.26%	164	24.85%
Lifetime	1363	41.98%	1037	40.09%	326	49.39%
Psychotic disorder						
Current	23	0.71%	20	0.77%	3	0.45%
Lifetime	27	0.83%	23	0.89%	4	0.61%
Anxiety (no PTSD)						
Current	383	11.80%	269	10.40%	114	17.27%
Lifetime	401	12.35%	280	10.82%	121	18.33%
PTSD						
Current	929	28.61%	755	29.18%	174	26.36%
Lifetime	1200	36.96%	940	36.34%	260	39.39%
Somatization						
Current	29	0.89%	18	0.70%	11	1.67%
Lifetime	n/a	n/a	n/a	n/a	n/a	n/a
Eating disorder (any)						
Current	16	0.49%	12	0.46%	4	0.61%
Lifetime	32	0.99%	19	0.73%	13	1.97%
Adjustment disorder						
Current	69	2.13%	56	2.16%	13	1.97%
Lifetime	n/a	n/a	n/a	n/a	n/a	n/a
Comorbid depressive disorders +PTSD						
Current	477	14.69%	382	14.77%	95	14.39%
Lifetime	850	26.18%	653	25.24%	197	29.85%
Substance use (abuse or dependence)						
Alcohol						
Current	190	5.9%	166	6.4%	24	3.6%
Lifetime	1203	37.1%	1059	40.9%	144	21.8%
Sedative/hypnotic						
Current	1	0.0%	1	0.0%	0	0.0%
Lifetime	21	0.7%	20	0.8%	1	0.2%
Cannabis						
Current	48	1.5%	40	1.6%	8	1.2%
Lifetime	323	9.6%	284	11.0%	39	5.9%
Stimulants						
Current	1	0.0%	1	0.0%	0	0.0%
Lifetime	24	0.7%	21	0.8%	3	0.5%
Opioid						
Current	1	0.3%	1	0.0%	0	0.0%
Lifetime	54	1.7%	50	1.9%	4	0.6%

(*Continues*)

TABLE 4 (Continued)

	Total cohort (*n* = 3247)		Male (*n* = 2587)		Female (*n* = 660)	
	Frequency or mean	% or SD	Frequency or mean	% or SD	Frequency or mean	% or SD
Cocaine						
Current	13	0.4%	12	0.5%	1	0.2%
Lifetime	94	2.9%	86	3.3%	8	1.2%
Hallucinogen						
Current	0	0.0%	0	0.0%	0	0.0%
Lifetime	27	0.8%	24	0.9%	3	0.5%
Polysubstance						
Current	2	0.1%	2	0.1%	0	0.0%
Lifetime	25	0.8%	24	0.9%	1	0.2%
Other						
Current	1	0.0%	1	0.0%	0	0.0%
Lifetime	14	0.4%	13	0.5%	1	0.2%

TBI occurrence & severity	**Total (*n* = 1598)**		**Men (*n* = 1266)**		**Women (*n* = 332)**	
	N	**%**	***N***	**%**	***N***	**%**
Prior to military	389	24.34%	342	27.01%	47	14.16%
Mild	351	21.96%	313	24.72%	38	11.45%
Moderate or severe	38	2.38%	29	2.29%	9	2.71%
Military, non-deployed	294	18.40%	253	19.98%	41	12.35%
Mild	240	15.02%	209	16.51%	31	9.34%
Moderate or severe	54	3.38%	44	3.48%	10	3.01%
Deployment	333	20.84%	304	24.01%	29	8.73%
Mild	274	17.15%	251	19.83%	23	6.93%
Moderate or severe	59	3.69%	53	4.19%	6	1.81%
After military	93	5.82%	83	6.56%	10	3.01%
Mild	79	4.94%	72	5.69%	7	2.11%
Moderate or severe	14	0.88%	11	0.87%	3	0.90%

Note: n/a, not assessed.

[a]Categories not mutually exclusive; TBI interview data only available for 1649 participants.

collaborative genomic study efforts of similar studies to better understand the genomic architecture of conditions such as PTSD (Ripke et al., 2014; Logue et al., 2015).

Several methodological strengths include: (1) capturing a wide range of information including genome-wide association studies (GWAS) and methylation on all of the samples allowing for genetic and epigenetic effects, metabolomic, proteomic, transcriptomic, neuroimaging, clinical, and behavioral data to evaluate cutting edge biological mechanisms and therapeutic candidates, (2) plans to connect this information with health care utilization data to better understand risk and protective factors affecting health care outcomes, (3) long-term efforts to prevent rater drift and ensure reliability of diagnostic assessments, and (4) development and implementation of an electronic system to reduce data-entry errors. The use of semi-structured clinical interviews for psychiatric diagnosis is also a significant strength, as most large studies that have examined mental health diagnoses have relied on medical chart diagnoses or screens that may introduce significant biases, false-positive rates, and other errors. Additionally, the repository has successfully supported recruitment for over 25 additional follow-up studies, with data from those studies planned for integration into the current database to further expand all possible future analyses. Recently, the GWAS, neuroimaging, and neurosteroid and small molecule data have also begun to be combined into several biomarker analyses. While some of these efforts have been undertaken with other cohorts, this is the only study we are aware of for which all of these methods have been pursued in concert with this particular cohort of veterans to create such a comprehensive data repository. This comprehensive repository has already led to a number of important advancements in clinical practice and will continue to do so as it expands. This includes clinical trials testing pharmacological interventions to treat TBI (Marx et al., 2015), subthreshold PTSD (Naylor et al., 2013), and PTSD resistant to antidepressants (Naylor et al., 2015); development of violence risk assessment measures (Elbogen et al., 2013; Elbogen et al., 2014); identification of white matter alterations that occur after blast exposure without acute TBI symptoms (Taber et al., 2015); performance of screening tools for hazardous alcohol use (Calhoun et al., 2010; Crawford et al., 2013), posttraumatic stress (McDonald et al., 2008; McDonald et al., 2009; McDonald et al., 2014), and resilience (Green et al., 2014); and the context in which performance-validity tests may be affected (McCormick et al., 2013).

TABLE 5 Trauma exposure background at time of study

	Total cohort (*n* = 3247)		Male (*n* = 2587)		Female (*n* = 660)	
	Frequency or mean	% or SD	Frequency or mean	% or SD	Frequency or mean	% or SD
Criterion A endorsed	3.93	3.48	3.58	3.23	5.32	4.02
Number of traumas *Prior* to military						
0	1236	38.07%	1068	41.28%	168	25.45%
1	683	21.03%	564	21.80%	119	18.03%
2	456	14.04%	359	13.88%	97	14.70%
3	299	9.21%	210	8.12%	89	13.48%
4+	573	17.65%	386	14.92%	187	28.33%
Number of traumas *During* military						
0	944	29.07%	798	30.85%	146	22.12%
1	648	19.96%	514	19.87%	134	20.30%
2	527	16.23%	419	16.20%	108	16.36%
3	377	11.61%	300	11.60%	77	11.67%
4+	751	23.13%	556	21.49%	195	29.55%
Number of traumas *After* military						
0	2091	64.40%	1730	66.87%	361	54.70%
1	598	18.42%	452	17.47%	146	22.12%
2	293	9.02%	222	8.58%	71	10.76%
3	113	3.48%	84	3.25%	29	4.39%
4+	152	4.68%	99	3.83%	53	8.03%
Number of childhood sexual abuse exposures						
0	2840	87.47%	2402	92.85%	438	66.36%
1	229	7.05%	115	4.45%	114	17.27%
2	134	4.13%	62	2.40%	72	10.91%
3	44	1.36%	8	0.31%	36	5.45%
Number of childhood violence exposures						
0	2204	67.88%	1802	69.66%	402	60.91%
1	676	20.82%	523	20.22%	153	23.18%
2	367	11.30%	262	10.13%	105	15.91%
Self-report scale scores						
CES	11.34	10.65	12.64	10.85	6.22	7.99
DTS	40.82	39.98	41.05	39.91	39.92	40.29

Demographic strengths include successful recruitment of a sample containing a high percentage of women (20%) and African Americans (nearly 50%), those receiving VA benefits through a service-connected disability (57%), war zone exposure (79%), service in past eras (nearly 50%), mental health conditions (approximately 50%), and TBI (21%). These large subgroups will support follow-up studies evaluating between-group comparisons of post-deployment mental health trajectories.

4.1 | Limitations of the study design

A limitation is that the study participants comprise a large convenience sample of post-9/11 service members who live in the Mid-Atlantic region of the country, many of whom are receiving health care services through the VA, rather than a representative sample of the US veteran population. This is not necessarily a limitation for the current study, however, as the purpose of this effort was not to determine prevalence rates via an epidemiological approach but rather to (a) screen conditions for follow-up recruitment studies and (b) characterize specific risk and protective factors within certain subgroups. Additionally, despite it being a convenience sample, the PDMH study demographics still closely match the demographic make-up of the US post-9/11 veteran population in age and educational attainment for both men and women. While the PDMH study cohort includes a higher percentage of non-white and unmarried veterans than the national veteran population, it nonetheless reflects the general finding that post-9/11 US veterans are more likely to be non-white and unmarried (National Center for Veterans Analysis and Statistics [NCVAS], 2015). The PDMH study sample also matches the general finding that post-9/11 women veterans are more racially diverse, more likely to be unmarried, and more likely to hold a higher educational degree than their male colleagues (NCVAS, 2015).

Compared with US Iraq/Afghanistan veterans receiving VA health care services nationally, the PDMH study cohort has a higher percentage of female veterans (20% compared with 12.2%, even prior to oversampling efforts; Epidemiology Program et al., 2015); however, it closely matches the regional population receiving VA health care (18.6% women; Hoffman, 2016). Military branch, rank, and status

(former active duty versus Reserve/National Guard) breakdowns are similar to the national VA Iraq/Afghanistan veteran health care population. Mental health diagnostic rates are similar for PTSD, depression, and alcohol abuse/dependence; however, rates are lower for other drug abuse/dependence (Epidemiology Program et al., 2015).

While self-report validity could be a concern for certain individuals or a smaller study, we believe having a larger cohort diminishes the concerns regarding potential self-report problems by a small subgroup. Additionally, when validity has been identified as a concern for an individual participant (e.g. inconsistencies between SCID and self-reports) those few cases were removed from future analyses. As participants may not all have the ability to provide certain medical data accurately (e.g. medications, diagnosed physical disorders), these will be checked via the medical chart data extraction. Unfortunately, a limitation to this method is lack of access to non-VA medical records.

Given our interest in examining PTSD symptom severity longitudinally, we chose to continue administering the same DSM-IV-based measure of PTSD, even after the in PTSD diagnostic criteria from DSM-IV to DSM-5. While we considered adding an entirely separate interview to measure DSM-5 criteria, we were concerned about participant burden. Given the substantial overlap between DSM-IV and DSM-5 criteria, we chose to simply add four additional items that tap non-overlapping or significantly changed PTSD symptom criteria to the DSM-IV based interview. A potential limitation of this approach is that the interview used in this study may not be directly comparable to other standardized interviews currently being developed to assess DSM-5 PTSD. This approach could also potentially increase the correlation between DSM-IV based and DSM-5 based diagnostic assessment.

While an electronic data-entry system is a strength when it comes to reducing data-entry errors, it may also introduce unintended modifications to standard paper-and-pencil measures. A controlled comparison was not conducted to examine the effect of using a computer versus paper forms for this study. However research findings across multiple studies with different populations suggest that Web-based administration produces findings nearly identical to paper-and-pencil administration (e.g. Carlbring et al., 2007; Van de Looij-Jansen & de Wilde, 2008; Weigold, Weigold, & Russell, 2013).

4.2 | Implications and next steps

The course and treatment of mental health issues cannot be determined in a single snapshot, but evolves over time. In developing this large PDMH cohort study, we intend to track participants longitudinally across the lifespan. In particular, we seek to (1) determine what behavioral, biological, medical, and other mental health-related factors predict the development of post-deployment mental illness, (2) determine which interventions are effective in forestalling the development or decreasing the severity of post-deployment mental illness, (3) identify risk and resiliency factors that affect illness trajectories, and (4) evaluate the functional outcomes (e.g. disability, treatment-seeking, quality of life) associated with various longitudinal trajectories.

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DECLARATION OF INTEREST STATEMENT

The authors have no competing interests.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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APPENDIX

TABLE A1 PDMH repository-based publications: Purpose and topic

Topic	Reference	Brief findings	Purpose of repository usage
Suicide	Youssef, Green, Beckham, & Elbogen, 2013b	This study evaluated the role of resilience factors in predicting suicidal ideation and attempts at 3-year follow-up in 176 veterans.	Part of a 3-year longitudinal follow-up study
Anger, aggression, and violence	Elbogen et al., 2013	Evaluated 150 dyads of Iraq and Afghanistan war veterans and family/friends. Purpose was to identify whether self-reported problems with violence were empirically associated with future violent behavior among Iraq and Afghanistan War veterans and whether and how collateral informant interviews enhanced the risk-assessment process.	Part of a 3-year longitudinal follow-up study
	Elbogen et al., 2014	Evaluated the predictive validity of a brief decision-support tool (violence screening and assessment of needs [VIO-SCAN]) to screen veterans for problems with violence and identify potential candidates for a comprehensive risk assessment. Included 197 dyads of veterans and collateral informants as part of sampling.	Part of a 3-year longitudinal follow-up study; data was one of two sampling frames.
Neuroimaging biomarkers	Morey, Petty, Cooper, LaBar, & McCarthy, 2008	Thirty-nine veterans recently returning from Iraq and Afghanistan deployments underwent a functional magnatic resonance imaging (fMRI) scan while exposed to emotional combat-related and neutral civilian scenes interleaved with an executive processing task. Purpose was to investigate the relationship of executive and emotion-processing regions with severity of posttraumatic stress disorder (PTSD) symptoms.	To recruit a target population
	Hayes et al., 2011	Compared responses by 15 combat veterans diagnosed with PTSD and 14 trauma-exposed control participants to trauma-related and neutral pictures while undergoing event-related fMRI. Purpose was to examine the neural correlates of successful memory encoding.	
	Morey, Gold, et al., 2013	Compared 99 subjects with current PTSD and 101 trauma-exposed controls without PTSD using structural MRI and clinical diagnostic assessments. Purpose was to assess the effect of PTSD on volumetric changes in the amygdala and	

(*Continues*)

TABLE A1 (Continued)

Topic	Reference	Brief findings	Purpose of repository usage
		hippocampus, as well as the contribution of illness duration, trauma load, and depressive symptoms.	
	Morey, Haswell, et al., 2013	Compared high angular resolution diffusion imaging (HARDI) of 30 subjects with mild traumatic brain injury (TBI) and comorbid PTSD and depression with non-TBI participants from primary (n = 42) and confirmatory (n = 28) control groups. Purpose was to investigate the effect of PTSD and comorbid TBI on white matter integrity.	
	Brown, LaBar, et al., 2014	Compared resting-state fMRI scans between 20 military veterans with PTSD and 22 matched trauma-exposed controls to measure task-free synchronous blood oxygen level dependent activity. Whole-brain voxel-wise functional connectivity of basolateral and centromedial amygdala seeds was compared between groups. Purpose was to better understand PTSD differences in amygdala-complex function and functional connectivity with cortical and subcortical structures.	
	Taber et al., 2015	Compared 23 veterans exposed to primary blast without TBI symptoms, six exposed to primary blast with mild TBI, and 16 unexposed to blast. Purpose was to use diffusion tensor imaging to investigate white matter alterations associated with blast exposure with or without acute symptoms of TBI.	Partial recruitment of target population, supplemented by additional approaches
Neuroimaging and genetics	Morey et al., 2011	Compared 22 veterans with PTSD and 20 trauma-exposed controls without PTSD using available fMRI and genotype data. Purpose was to investigate whether SLC6A4 promoter polymorphisms (5-HTTLPR, rs25531) and several downstream single nucleotide polymorphisms (SNPs) modulated activity of brain regions involved in the cognitive control of emotion in post-9/11 veterans with PTSD.	To recruit a target population
Neurocognition	McCormick, Yoash-Gantz, McDonald, Campbell, & Tupler, 2013	Sample consisted of 170 subjects from the repository and additional subjects recruited from other sources. Depression, PTSD, and TBI subgroups were also compared. Purpose was to investigate prior reports of high neuropsychological performance-validity-test failure rates and their relationship to research and clinical contexts.	Partial recruitment, supplemented by additional approaches
	Shura, Rowland, & Yoash-Gantz, 2014	Evaluated psychometric properties of the Behavioral Dyscontrol Scale (BDS) and BDS-II scoring systems. The BDS-II showed improved psychometric properties and was significantly more reliable than the BDS.	
	Shura, Rowland, & Yoash-Gantz, 2015	Sample evaluated 164 subjects. Purpose was to evaluate the factor structure and construct validity of the BDS-II.	To recruit a target population
	Shura, Miskey, Rowland, Yoash-Gantz, & Denning, 2016	Compared 44 "failed-validity" and 168 "passed-validity" groups. Purpose was to evaluate the accuracy of individual embedded validity measures and to reduce them to the most efficient combination to improve comprehensive assessment of performance validity.	To recruit a target population
Neurosteroids and other therapeutics	Marx et al., 2009	Proof-of-concept randomized controlled trial of adjunctive pregnenolone for cognitive and negative symptoms in patients with schizophrenia or schizoaffective disorder. Randomized 21 participants.	Augment recruitment of target population
	Naylor et al., 2013	Proof-of-concept randomized controlled trial of paroxetine in subthreshold PTSD. Purpose was to conduct a small pilot randomized controlled trial of paroxetine for subthreshold PTSD. Randomized 13 participants.	To recruit a target population
	Marx et al., 2015	Proof-of-concept randomized controlled trial of a neurosteroid intervention in mild TBI and biomarker candidate study in blast-related TBI. Purpose was to examine the potential utility of neurosteroids as therapeutic interventions in TBI via a pilot proof-of-concept randomized controlled trial with adjunctive pregnenolone. Randomized 30 participants. Also see Table A2 for baseline analyses informing this trial.	To recruit a target population for intervention study
	Naylor et al., 2015	Proof-of-concept randomized controlled trial of adjunctive aripiprazole in Operation Enduring Freedom (OEF)/ Operation Iraqi Freedom (OIF) era veterans with PTSD resistant to antidepressant treatment. Randomized 16 participants.	To recruit a target population for intervention study
Other	Brown, Strauss, et al., 2014	Compared 68 subjects with PTSD and 60 trauma-exposed non-PTSD controls. Purpose was to evaluate effects of	Part of recruitment study evaluating target population

(*Continues*)

TABLE A1 (Continued)

Topic	Reference	Brief findings	Purpose of repository usage
		study procedures involving exposure to aversive stimuli on participation distress.	
	Dedert et al., 2012	Compared 76 veterans with PTSD and 70 without PTSD. Purpose was to evaluate attitudes toward genetic research in PTSD.	Part of a 3-year longitudinal follow-up study

TABLE A2 PDMH baseline study publications and findings by topic

Topic	Reference	Brief findings
Trauma exposure assessment	Dedert et al., 2009	Particular categories of trauma (childhood, combat, adult, medical) were differentially associated with the risk of different psychiatric diagnosis, comorbidity, and current symptom severity.
	Schry et al., 2015	Among male OEF/OIF veterans, military sexual assault (MSA) was associated with greater symptom severity and treatment support than for those without MSA, above and beyond the effects of known vulnerability factors.
Resilience and trauma	Brancu et al., 2014;	Social support does not serve as a buffer as well for those with PTSD compared with those without the disorder; however, comorbid conditions do not necessarily make this dampened buffering effect any worse.
	Van Voorhees et al., 2012	Childhood trauma-based PTSD, especially avoidance and numbing symptoms, were found to be related to compromised social support in adulthood.
	Green et al., 2010; Youssef et al., 2013a	In terms of overall resilience, (a) higher levels of resilience are especially protective for those with high combat exposure (Green et al., 2010); (b) resilience plays a uniquely protective role in PTSD and functional correlates such as suicidality, alcohol problems, and depression (Green et al., 2010; Youssef et al., 2013a); and (c) childhood trauma exposures were significantly associated with depressive symptoms and suicidal ideation (Youssef et al., 2013a).
Suicide	Symptomotology: Guerra, MIRECC Registry Workgroup & Calhoun, 2011; Kimbrel et al., 2014	PTSD emotional numbing symptoms (e.g. feelings of detachment from others, restricted range of affect) were most strongly uniquely associated with suicide ideation (Guerra et al., 2010). For those with comorbid PTSD and major depressive disorder (MDD), the numbing plus the cognitive-affective cluster of depressive symptoms (e.g. persistent depressed mood; excessive/inappropriate guilt) were related to suicidality. Further support for this finding was later presented using a 3-factor measurement model of *externalizing* (substance use disorders), *fear* (panic disorder, social phobia, specific phobia, and obsessive–compulsive disorder), and *distress* (PTSD and depression) factors (Kimbrel et al., 2014). The *distress* factor in particular was significant for suicidality and suicide attempts.
	Vulnerability: Youssef et al., 2013a	Childhood trauma exposures were found to be associated with depressive symptoms and suicidal ideation.
Violence	Elbogen et al., 2010	Aggressive impulses or urges, difficulty managing anger, and perceived problems controlling violent behavior were each significantly associated with PTSD hyperarousal symptoms.
Substance use	Smoking: Calhoun et al., 2011; McClernon et al., 2013	PTSD symptoms affected the expectancies veterans had regarding the benefits of smoking, including beliefs that smoking could reduce negative affect and boredom or increase social facilitation (Calhoun et al., 2011). The risk of smoking increased as a function of the number of comorbid psychiatric illnesses with similar reported expectancies (McClernon et al., 2013) suggesting that both PTSD as well as co-occurring psychiatric conditions affect smoking habits.
	Alcohol and other drug use: Kelley et al., 2013; Kelley et al., 2015	Depressive symptoms significantly mediated the effects of combat and non-combat exposure on both alcohol and drug use. Similarly, PTSD symptoms served as a similar mediator between trauma exposure and alcohol, but only for men and not for other drug use. PTSD symptoms did not serve as a mediator between trauma exposure and alcohol use nor drug use for women.
Pain	Runnals et al., 2013	Veterans with PTSD endorsed pain-related complaints at greater rates than veterans without PTSD, and even higher rates were observed among those with comorbid PTSD/MDD. The highest rates of pain complaints were reported among those with comorbid PTSD/MDD. Women were also more likely to endorse back pain and headaches in general.
	Kilts et al., 2010; Naylor, Kilts, Szabo, Dunn, Keefe, et al., 2016; Naylor, Kilts, Szabo, Dunn, Tupler, et al., 2016	In a small proof-of-concept study (n = 90 males), allopregnanolone levels were found to be inversely associated with low-back pain and chest pain. DHEA levels were also inversely associated with muscle soreness and positively associated with chest pain. In a larger replication study of 485 males (Naylor, Kilts, Szabo, Dunn, Keefe, et al., 2016), allopregnanolone levels were inversely associated with muscle soreness and chest pain. After correcting for the family-wise error rate, only muscle soreness remained significant. Allopregnanolone levels were also found to be

(*Continues*)

TABLE A2 (Continued)

Topic	Reference	Brief findings
		inversely associated with aggregate total pain scores. In a second exploratory replication study evaluating 403 females (Naylor, Kilts, Szabo, Dunn, Tupler, et al., 2016) serum DHEA sulfate levels were inversely correlated with low back pain in female veterans. Female veterans reporting moderate/extreme low back pain demonstrated significantly lower DHEA sulfate levels than those reporting no/little low back pain (Naylor, Kilts, Szabo, Dunn, Tupler, et al., 2016).
Biomarkers: Genetics	Liu et al., 2013; Kimbrel, Garrett, et al., 2015; Liu et al., 2015; Ashley-Koch et al., 2015	For Caucasian veterans, an association was found between variant rs4790904 in the protein kinase C alpha (PRKCA) gene and each of the PTSD symptom clusters. An association was also observed between rs12898919 in the cholinergic receptor nicotinic alpha-5 (CHRNA5) gene and PTSD (Kimbrel, Garrett, et al., 2015). For African American veterans, a similar significant association was found between this variant gene and a current full diagnosis of PTSD (but not for symptoms clusters separately; Liu et al., 2013). A significant additive effect was also observed among African American veterans for 5-HTTLPR such that the odds of having a current diagnosis of PTSD increased by 1.502 for each additional S′ allele. No evidence for an association between 5-HTTLPR and PTSD was observed in the Caucasian sample for this gene variant (Liu et al., 2015). In a genome-wide association study, among African American veterans, the UNC13C and DSCAM genes were found to be associated with an increased risk of PTSD. Within the Caucasian subset, the most significant genes were TBC1D2, SDC2, and PCDH7. PRKG1 and DDX60L were also identified when evaluated by meta-analysis of both subsets (Ashley-Koch et al., 2015). For African Americans, when combat exposure was high, the APOE ε4 allele was associated with higher rate of PTSD and worse symptom severity (Kimbrel, Hauser, et al., 2015).
	Guffanti et al., 2014	Despite high power, results did not support past research presenting an association between variations in the RORA gene and PTSD and suggested no evidence that RORA polymorphisms modified the relation of trauma exposure with PTSD (Guffanti et al., 2014).
Biomarkers: Neurosteroids, other small molecules, and proteins	Szabo et al., 2014	Using mass spectrometry to evaluate amino acid neurotransmitter systems as biomarker candidates for suicidality, glycine, an excitatory amino acid and NMDA receptor modulator, was found to be significantly elevated in veterans reporting suicidal ideation.
	Naylor, Kilts, Szabo, Dunn, Keefe, et al., 2016	Allopregnanolone levels were inversely associated with certain kinds of reported pain (see earlier) (Naylor, Kilts, Szabo, Dunn, Keefe, et al., 2016). Serum DHEA sulfate levels were inversely correlated with low-back pain in female veterans (see earlier) (Naylor, Kilts, Szabo, Dunn, Tupler, et al., 2016).
	Marx et al., 2015	When neurosteroid levels (pregnanolone, androsterone, pregnenolone, allopregnanolone) were examined in 55 male veterans with blast-related traumatic brain injury (TBI) compared with 55 male control veterans who had been deployed to Iraq or Afghanistan but had not sustained a blast-related TBI, findings suggested that specific neurosteroids (pregnanolone, androsterone, pregnenolone) may be dysregulated following blast-related TBI, and that supplementation with neurosteroids could be a promising pharmacological intervention strategy to ameliorate deficits in these molecules. Neurosteroid levels in veterans with a history of blast-related TBI and co-occurring PTSD were not significantly different compared with neurosteroid levels in veterans with a history of blast-related TBI and no concurrent PTSD.
Gender	Curry et al., 2013	Lifetime MDD was more common in women (46.5%) than in men (36.3%), with gender differences in comorbid conditions (i.e. higher anxiety and eating disorders in women and higher alcohol and nicotine use disorders in men). However, primary-onset MDD was no more common among women than among men. Furthermore, MDD usually followed the onset of other comorbid disorders among women veterans, indicating the need to assess for earlier lifetime disorders in veterans with MDD.
	Runnals et al., 2013	Women were more likely to endorse back pain and headaches than men. See pain section earlier.
	Kelley et al., 2013; Kelley et al., 2015	PTSD symptoms were found to mediate the effects of trauma exposure on alcohol differently for men and women. See substance use section earlier.
	Schry et al., 2015	Male veterans who reported MSA (the most egregious form of military sexual trauma experiences, involving force or penetration) endorsed higher levels of Department of Veterans Affairs (VA) service-connected disability, recent outpatient mental-health treatment utilization, PTSD symptoms, depression symptoms, and suicidality than the general OEF/OIF sample without MSA. When comparing to a cohort matched on demographic and trauma-exposure factors, PTSD symptoms, depressive symptoms, and suicidal ideation remained higher for males with MSA.
	Schry et al., 2016	Previous sexual abuse/assault was associated with later sexual assault in both male and female veterans. Adolescent sexual assault was a significant predictor of MSA among males but not among females.
Sleep	Swinkels et al., 2013	Sleep durations of less than 5 hours and greater than 9 hours were each associated with increased odds of current PTSD, MDD, and smoking. Poor sleep quality was also associated with PTSD, panic disorder, MDD, suicidal ideation, and risky drinking.

(*Continues*)

TABLE A2 (Continued)

Topic	Reference	Brief findings
	Ulmer et al., 2015	The combination of sleep-onset and sleep-maintenance difficulties were associated with risk factors for hypertension and cardiovascular disease, including greater odds of current smoking and psychiatric symptomotology, as well as elevated systolic blood pressure in certain age-by-race interactions.
Psychometric properties of measures	McDonald et al., 2008; McDonald, Beckham, Morey, & Calhoun, 2009; McDonald et al., 2014	Prior to the emergence of the new DSM-5 PTSD criteria, a four-factor structure of PTSD had emerged in our sample cohort as providing the best fit using the Davidson Trauma Scale (DTS) (McDonald et al., 2008). Early investigations suggested that although a cut score of 40 was originally recommended by the developers of the DTS, in this cohort different cut points may be optimal for different purposes (McDonald et al., 2009; McDonald et al., 2014). Combining this cut score criterion with symptom cluster criteria further may improve specificity and predictive power (McDonald et al., 2014).
	Calhoun, McDonald, Eggleston, Beckham, & Straits-Troster, 2010	Although the PC-PTSD screener (used in VA primary care settings) performed well at the cut score of 3, it was outperformed by the DTS for both sensitivity and specificity due to false positives from the PC-PTSD.
	Crawford et al., 2013	Both the Alcohol Use Disorders Identification Test (AUDIT) and AUDIT-C appeared to be valid instruments for identifying alcohol abuse or dependence among our cohort. The AUDIT performed slightly better than the AUDIT-C in identifying diagnoses of past-year alcohol abuse or dependence.
	Green et al., 2014	An exploratory factor analysis of the CD-RISC did not support the original five-factor analytic structure, but rather supported a two-factor model of resilience, composed of adaptability (8 items) and self-efficacy-themed (6 items) items. It was recommended that the adaptability-themed factor was the most useful factor of resilience for post-9/11 US military veterans.
	Gentes et al., 2014	A confirmatory factor analysis of the Structured Clinical Interview for DSM-IV-TR Axis-I (SCID-I) PTSD subscale demonstrated that a 5-factor cluster model (re-experiencing, active avoidance, emotional numbing, dysphoric arousal, anxious arousal) provided the best overall fit to the data.