



Posttraumatic stress disorder diagnosis and gender are associated with accelerated weight gain trajectories in veterans during the post-deployment period



Eugenia Buta^{a,b,*}, Robin Masheb^{a,c}, Ralitz Gueorguieva^{b,c}, Harini Bathulapalli^a,
Cynthia A. Brandt^{a,d}, Joseph L. Goulet^{a,c}

^a Pain Research, Informatics, Multimorbidities and Education (PRIME) Center, VA Connecticut Healthcare System, West Haven, CT, United States

^b Yale School of Public Health, Department of Biostatistics, New Haven, CT, United States

^c Yale School of Medicine, Department of Psychiatry, New Haven, CT, United States

^d Yale School of Medicine, Department of Emergency Medicine, New Haven, CT, United States

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ABSTRACT

Background: Veterans are disproportionately affected by overweight/obesity and growing evidence suggests that post-deployment is a critical period of accelerated weight gain.

Objective: We explored the relationship between posttraumatic stress disorder (PTSD) diagnosis, gender, and post-deployment weight trajectories among U.S. Operations Iraqi Freedom, Enduring Freedom, and New Dawn veterans.

Design: We used Veterans Affairs electronic health record data from 248,089 veterans (87% men) who, after their last deployment, had at least one medical visit between October 2001 and January 2009 and more than one BMI recorded through September 2010. We analyzed repeated BMI measurements using linear mixed models, with demographics, PTSD and other relevant psychiatric diagnoses as predictors.

Results: At the first recorded BMI, veterans' median age was 29, and 59% of women and 77% of men were overweight/obese. They had a median of 6 BMI measurements during a median follow-up of 2.4 years. Controlling for potential confounders, women with a PTSD diagnosis had a yearly BMI growth rate of 0.11 kg/m² (95% CI 0.09 to 0.13, $p < 0.001$) higher than women without PTSD. For men, the corresponding PTSD effect was also significant, but slightly lower: 0.07 kg/m² (95% CI 0.05 to 0.09, $p < 0.001$); women-men difference: 0.03 (95% CI 0.01 to 0.06) kg/m², $p = 0.006$.

Conclusions: The post-deployment period is critical for weight gain, particularly for veterans diagnosed with PTSD and women veterans with PTSD. Efforts are needed to engage post-deployment veterans in weight management services, and to determine whether tailored recruitment/treatment interventions will reduce disparities for veterans with PTSD.

1. Introduction

Obesity is prevalent among military veterans with a higher obesity rate reported among Veterans Affairs (VA) health care users (28%) compared to veteran non-users of VA (24%) and non-veterans (23%); in addition, 45% of veteran VA users and 48% of veteran VA non-users were reported to be overweight, compared to 35% of non-veterans. In a sample of Operations Iraqi Freedom and Enduring Freedom (OEF/OIF) veterans using VA healthcare services, the majority of men (66%) and almost half of women (47%) were reported to be overweight or obese at their first VA visit (Rosenberger, Ning, Brandt, Allore, & Haskell, 2011).

These rates of overweight and obesity are of serious concern because patients with obesity have been shown to have a higher risk of developing conditions such as type 2 diabetes, hypertension, cardiovascular disease, stroke, and osteoarthritis (Bray, 2004; Khaodhiar, McCowen, & Blackburn, 1999). The post-deployment period in particular appears to be a vulnerable time of accelerated weight gain in veterans (Rosenberger et al., 2011).

A number of cross-sectional (Dobie et al., 2004; Vieweg et al., 2007) and longitudinal (LeardMann et al., 2015; Maguen et al., 2013) studies have reported an association between obesity and Posttraumatic Stress Disorder (PTSD) in veterans, and a recent systematic review and meta-

* Corresponding author at: 300 George Street, Suite 511, New Haven, CT 06520, United States.
E-mail address: eugenia.but@yale.edu (E. Buta).

analysis suggests this association is present in non-veterans as well (Bartoli et al., 2015). Interestingly, the post-deployment period appears to be a time of increased incidence or identification of PTSD as well as obesity. PTSD is the most common psychiatric disorder among American military veterans, particularly among veterans returning from OEF/OIF of whom it is estimated that 14% meet probable criteria for the diagnosis (Tanielian & Jaycox, 2008). PTSD has considerable public health and quality of life implications with impairment and suicide risk similar to other mental disorders such as major depression and panic disorder (Kessler, 2000; Nepon, Belik, Bolton, & Sareen, 2010; Wilcox, Storr, & Breslau, 2009). Among US service members and veterans in the Millennium Cohort Study, PTSD was independently associated with a higher risk of weight gain (LeardMann et al., 2015). In a longitudinal study of latent BMI trajectories from Operation Enduring Freedom, Iraqi Freedom and New Dawn (OEF/OIF/OND) veterans post-deployment, veterans with PTSD had increased odds of being in the highest risk (heaviest) BMI classes (Maguen et al., 2013).

Few studies have specifically looked at gender differences in the association between PTSD and obesity, and those that have report mixed results. LeardMann et al. (2015) found no evidence of gender modifying the association between PTSD and weight gain in the Millennium Cohort Study. Similarly, a US cross-sectional survey did not find differences in past year PTSD and associations with obesity by gender (Pagoto et al., 2012). Maguen et al. (2013) found that the association between PTSD and latent BMI classes in veterans was similar across genders. However, these differences were not adjusted for some factors that may be important confounders of this association (e.g. there is growing evidence of depression being positively associated with odds of developing obesity (Luppino et al., 2010) and PTSD (Campbell et al., 2007)). On the other hand, in a longitudinal study of German adolescents and young adults, obesity was associated with PTSD in women but not men (Perkonig, Owashi, Stein, Kirschbaum, & Wittchen, 2009).

Collectively, these findings suggest that more attention is needed to understand whether the differences in weight trajectories post-deployment between those with and without a PTSD diagnosis vary by gender. The goal of this study is to replicate and extend the previous longitudinal veteran studies by examining whether PTSD status is associated with the rate of change in BMI in a cohort of OEF/OIF/OND veterans using VA health care services, and to examine the extent to which the association between PTSD and BMI trajectory differs by gender.

2. Methods

2.1. Study population

We considered OEF/OIF/OND military veterans listed in the VA Roster file (provided by Defense Manpower Data Center—Contingency Tracking System Deployment File) who, after the end of their last military deployment, used the VA healthcare system for at least one medical visit between October 1, 2001 and January 1, 2009 (total of 395,698 participants). Military deployment involves the performance of

military duties in support of the operation either in the theater of operation (overseas) or within the United States. For each participant, we used VA electronic health record (EHR) data to obtain all International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnoses and BMI measurements available from the date of their first medical visit through September 30, 2010. Because we were interested in BMI change over time, we excluded participants who had no or only one BMI measurement available (260,193 participants left). Further exclusion of 4.7% participants with unknown race/ethnicity led to a final sample size of 248,089 veterans. Overall, those included in the analytic sample were slightly more likely to be Black (18% vs. 14%) given their race was known, less likely to have more than a high school education (20% vs. 26%) and slightly younger at last deployment (median 26.9 vs. 28.1 years) than those excluded.

2.2. Study variables

The *outcome* of interest was BMI, which was assessed repeatedly over time. BMI was computed based on height and weight data routinely collected and recorded in EHR records during VA clinical visits. We removed from analyses a small percentage (0.03%) of biologically implausible BMI values (BMI < 11 or BMI > 70).

Our main *predictor* variables were PTSD and gender. PTSD diagnoses were identified from VA electronic records using the ICD-9-CM diagnosis code 309.81. PTSD was considered present if a participant's records contained at least one inpatient or two outpatient PTSD codes (Mattocks et al., 2010) and the date of the first code was taken to be the diagnosis date. We required at least two outpatient diagnosis codes or one inpatient code to classify a participant as having PTSD based on evidence in the literature that this algorithm performs better for identifying psychiatric disorders and HIV in administrative data than an algorithm based on at least 1 outpatient and 1 inpatient code (Fultz et al., 2006; Lurie, Popkin, Dysken, Moscovice, & Finch, 1992; Walkup, Wei, Sambamoorthi, & Crystal, 2004). Gender was obtained from the VA roster.

2.2.1. Covariates

The VA roster also provided information on other socio-demographic variables, including date of birth (from which we derived age at first BMI measurement (baseline)), race/ethnicity (Black, Hispanic, Other, White), education (binary indicator of having more than a high school education vs. high school or less) and time in years since the end date of last deployment to baseline. The psychiatric comorbidities major depression and substance use disorder (SUD) [defined as alcohol/drug abuse or dependence] were identified in a similar manner to PTSD (ICD-9-CM codes used available in Table 1). Smoking data came from the VA Health Factors data (that is, data collected when providers are periodically prompted via computerized clinical reminders to ask patients about their tobacco use) (McGinnis et al., 2011).

Table 1
International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes.

Condition	Corresponding ICD-9-CM codes
Posttraumatic stress disorder (PTSD)	309.81
Major depression	296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.3x
Substance use disorder	291, 291.0, 291.1, 291.2x, 291.3, 291.4, 291.5, 291.8, 291.81, 291.89, 291.9, 303, 303.0, 303.00, 303.01, 303.02, 303.03, 303.9, 303.90, 303.91, 303.92, 303.93, 305.0, 305.00, 305.01, 305.02, 305.03, 790.3, 980, 980.8, 980.9, E860.0, E860.1, E860.8, E860.9, 357.5, 425.5, 535.3, 571.0, 571.1, 571.2, 571.3, V11.3
	292, 292.0, 292.1, 292.11, 292.12, 292.2, 304, 304.00, 304.01, 304.02, 304.03, 304.09, 304.1, 304.11, 304.12, 304.13, 304.20, 304.21, 304.22, 304.23, 304.30, 304.31, 304.32, 304.33, 304.40, 304.41, 304.42, 304.43, 304.50, 304.51, 304.52, 304.53, 304.6, 304.60, 304.61, 304.62, 304.63, 304.7, 304.70, 304.71, 304.72, 304.73, 304.8, 304.80, 304.81, 304.82, 304.83, 304.9, 304.90, 304.91, 304.92, 304.93, 305.20, 305.21, 305.22, 305.23, 305.29, 305.30, 305.31, 305.32, 305.33, 305.40, 305.41, 305.42, 305.43, 305.50, 305.51, 305.52, 305.53, 305.60, 305.61, 305.62, 305.63, 305.70, 305.71, 305.72, 305.73, 305.80, 305.81, 305.82, 305.83, 305.90, 305.9, 305.91, 305.92, 305.93
	291, 291.0, 291.1, 291.2x, 291.3, 291.4, 291.5, 291.8, 291.81, 291.89, 291.9, 303, 303.0, 303.00, 303.01, 303.02, 303.03, 303.9, 303.90, 303.91, 303.92, 303.93, 305.0, 305.00, 305.01, 305.02, 305.03, 790.3, 980, 980.8, 980.9, E860.0, E860.1, E860.8, E860.9, 357.5, 425.5, 535.3, 571.0, 571.1, 571.2, 571.3, V11.3
	292, 292.0, 292.1, 292.11, 292.12, 292.2, 304, 304.00, 304.01, 304.02, 304.03, 304.09, 304.1, 304.11, 304.12, 304.13, 304.20, 304.21, 304.22, 304.23, 304.30, 304.31, 304.32, 304.33, 304.40, 304.41, 304.42, 304.43, 304.50, 304.51, 304.52, 304.53, 304.6, 304.60, 304.61, 304.62, 304.63, 304.7, 304.70, 304.71, 304.72, 304.73, 304.8, 304.80, 304.81, 304.82, 304.83, 304.9, 304.90, 304.91, 304.92, 304.93, 305.20, 305.21, 305.22, 305.23, 305.29, 305.30, 305.31, 305.32, 305.33, 305.40, 305.41, 305.42, 305.43, 305.50, 305.51, 305.52, 305.53, 305.60, 305.61, 305.62, 305.63, 305.70, 305.71, 305.72, 305.73, 305.80, 305.81, 305.82, 305.83, 305.90, 305.9, 305.91, 305.92, 305.93

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