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Veterans, PTSD Severity, and Health Conditions Over Time

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Veterans, PTSD Severity, and Health Conditions Over Time

by

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Each person whose signature appears below certifies that this dissertation in his/her opinion is adequate, in scope and quality, as a dissertation for the degree Doctor of Philosophy.

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ABBREVIATIONS

PTSD	Post Traumatic Stess Disorder
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OND	Opertation New Dawn
HPA	Hypothalamic-Pituitary-Adrenal
BMI	Body Mass Index
TBI	Traumatic Brain Injury
VA	Veterans Affairs
M	Mean
SD	Standard Deviation
LASC	Los Angeles Symptoms Checklist
VHA	Veterans Health Administration
CPRS	Computerized Patient Record System
VistA	Veterans Health Information Systems and Technology Architecture
VISN	Veterans Integrate Service Network
HR	Hazard Ratio
CI	Confidence Interval
SE	Standard Error

ABSTRACT OF THE DISSERTATION

Veterans, PTSD Severity, and Health Conditions Over Time

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Macey Mendez-Vigo Wolfe

Doctor of Philosophy, Graduate Program in Psychology
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Dr. Kendal Boyd, Chairperson

PTSD has been linked to the development of numerous health conditions; this study's aim is to determine if PTSD predicts the diagnosis of type II diabetes, overweight/obesity, hypertension, musculoskeletal disorders, neurological disorders, and chronic pain. Participants were 416 veterans presenting for PTSD assessment/treatment that had served in the most recent conflicts (Operation Enduring Freedom, Operation Iraqi Freedom, Operation New Dawn, and Dessert Storm) with a mean age of 35.5 (*SD* = 10.9). Participants completed a measure of PTSD symptomatology. Electronic medical records were used to obtain diagnosis of health conditions. Cox-Regression analyses were used to evaluate PTSD as a predictor of time to diagnosis for each of the health condition, after controlling for sex, education, and race/ethnicity. Asian/Pacific islanders had greater odds of a type 2 diabetes diagnosis when compared to White/Caucasian participants (*HR* = 5.99, 95% CI [.1.15-31.17]). Identifying as Asian/Pacific islander decreased the odds of participants being diagnosed with a neurological condition compared to White/Caucasian participants (*HR* =.25, 95% CI [.35-8.6]). Participants who identified as Hispanic/Latino had lower odds of being diagnosed with overweight/obesity, neurological disorders, and musculoskeletal disorders compared to White/Caucasian participants (*HR* = .37, 95% CI [.19-.70], *HR* = .55, 95% CI [.35-8.6], *HR* = .48 95% CI [.27-.87]). The odds of being

diagnosed with hypertension were higher for participants identifying as Hispanic/Latino than Caucasian/White participants (*HR* = 2.90, 95% CI [1.29-6.58]). Having a two-year degree compared to a high school degree decreased the odds of participants having overweight/obesity (*HR* = .31, 95% CI [.12-.76]). Having some college, a two-year degree, or a four-year degree increased the odds of developing a neurological disorder (*HR* = 1.67, 95% CI [1.02-2.75], *HR* = 2.08, 95% CI [1.03-4.20], *HR* = 2.35, 95% CI [3.10-40.20]). Every one-year increase in age increased the odds of participants being diagnosed with chronic pain (*HR* =1.05, 95% CI [1.01-1.10]). PTSD was a significant predictor of the development of hypertension in young veterans (*HR* = 1.42, 95% CI [1.00-2.01],). Given the findings, mental health and medical professionals are poised to deliver more timely interventions to prevent, treat, and screen for hypertension, even in young veterans.

CHAPTER ONE

INTRODUCTION

Posttraumatic stress disorder (PTSD) is a trauma related disorder characterized by re-experiencing a traumatic event (e.g., flashbacks, nightmares), persistent avoidance of stimuli associated with the event, alterations in cognitions or mood, and marked alterations in arousal (American Psychiatric Association, 2013). In the United States, the prevalence of those with PTSD is estimated to be 3.5%, but is usually found to be higher in veterans: around 5% to 31% depending on the exact group of veterans being studied (American Psychiatric Association, 2013; Holowka, Marx, Kaloupek, & Keane, 2012; Magruder et al., 2005). PTSD prevalence in veterans from the most recent conflicts (Desert Storm, Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn) are estimated to be between 7% and 23% (Fulton et al., 2015; Kang, Natelson, Mahan, Lee, & Murphy, 2003; Seal, et al., 2009).

Research in the area of health and PTSD has consistently demonstrated a link between PTSD pathology and multiple negative health outcomes. For instance, veterans with PTSD are more likely to engage in risky behavior, such as excessive alcohol intake, cigarette smoking, and sedentary lifestyle (American Psychiatric Association, 2013; Buckley, Mozley, Bedard, Dewulf, & Greif, 2004; Durai et al., 2011; Goldberg et al., 2014; Hourani et al., 2012; McDevitt- Murphy et al., 2010; Morrison, 2012). Additionally, it has been found that veterans and civilians with PTSD have poorer physical health, poorer functional health status, and more role limitations (Asnaani, Reddy, & Shea, 2014; Berger et al., 2007; Hall et al., 2014; Jakupcak, Luterek, Hunt, Coneybeare, & McFall, 2008; Lauterbach, Vora, & Rakow, 2005; A. Maia, McIntyre,

Pereira, & Ribeiro, 2011; McAndrew et al., 2013; Solomon, Helvitz, & Zerach, 2009). Moreover, veterans and others with PTSD also utilize health care and specialty health care at higher rates than controls (Eytan, Toscani, Loutan, & Bovier, 2006; D. B. Maia et al., 2007; Stein, McQuaid, Pedrelli, Lenox, & McCahill, 2000; Vedantham et al., 2001). PTSD is also associated with higher mortality rates, as well as significantly more chronic illness (Boscarino, 2006; Goldberg et al., 2014).

There are behavioral, cognitive, and biological outcomes related to PTSD that may lead to the development of health conditions. From a behavioral perspective, risk-taking behavior, nicotine use, excessive alcohol consumption, poor diet, and lack of exercise are associated with PTSD and can certainly have an effect on the physical health of individuals, especially when they occur in tandem (Goldberg et al., 2014; Hourani et al., 2012; Vaccarino et al., 2014). Biologically, PTSD is linked with abnormalities in the hypothalamic-pituitary-adrenal (HPA) axis, endorcinological abnormalities, and thyroid dysfunction (Boscarino, 2004; Friedman & Schnurr, 1995; Yahuda, 2000). Specifically, these abnormalities are related to lower than normal cortisol levels in those with PTSD, suggesting an atypical stress response and recovery. When individuals without experience prolonged or chronic stress, or a trauma, and do not go on to develop PTSD they also have elevated levels of cortisol (Meewise, Reitsma, De Vries, Gersons, Olf, 2007; Yahuda, 2000; Yahuda, 2002). Because cortisol both initially prepares the body to cope adequately with stressors and is part of a negative feedback loop in the HPA axis, which serves to reduce the stress response over time, it is hypothesized that lower than normal cortisol levels are due to an enhanced negative feedback loop in those with PTSD (Boscarino 2004; Sriram, Rodriguez-Fernandez, & Doyle III, 2012; Yahuda 2000).

Somatization, the conversion of distress, depression, and anxiety symptoms into physical symptoms also occurs in a high percentage of those experiencing trauma (Van Ommeren et al., 2002).

Diabetes

There are well-documented relationships between specific health conditions and PTSD in both veterans and non-veterans. Type 2 diabetes is one such health condition; when uncontrolled, or poorly controlled, negative health consequences include neuropathy, cardiovascular disease, kidney damage, and retinopathy, among others (Nathan et al., 2009). Rosenbaum et al. (2015) found in a recent meta-analysis that PTSD was a significant predictor of type 2 diabetes. Likewise, merely experiencing trauma has been associated with the development of type 2 diabetes in primary care populations (Norman et al., 2006). Additionally, the odds of developing type 2 diabetes were significantly increased subsequent to PTSD, as was the development of other endocrine and metabolic disorders and higher fasting blood glucose; this finding held across genders and military versus civilian samples (Babić, Maslov, Babić, & Vasilj, 2013; Farr et al., 2015; Heppner et al., 2009; Lauterbach et al., 2005; Lukaschek et al., 2013; Nazarian, Kimerling, & Frayne, 2012; Roberts et al., 2015; Rosenbaum et al., 2015).

Physiologically, the mechanisms hypothesized to be involved in those with PTSD developing type 2 diabetes include the HPA axis, central and peripheral nervous systems, and the endocrine system (McEwan, 2008; Lukaschek et al., 2013). More specifically, the stress associated with PTSD increases glucocorticoids within the body; these hormones

then impair the function of a glucose transporter (GLUT4) in muscles, adipose tissue and other areas of the body (Reagan, Grillo, & Piroli, 2008). Once this transporter is impaired, increases in glucose impairment and peripheral insulin resistance are observed (Reagan, Grillo, & Piroli, 2008). Cortisol, a glucocorticoid resulting from stress, also impairs the liver's sensitivity to insulin, which can have the effect of increasing glucose in the blood; when this happens chronically, a person is at risk for developing type 2 diabetes (McEwan, 2008). Additionally, hyperthyroidism is found in significant numbers of veterans and non-veterans with PTSD (Friedman, et al., 2005; Kozaric-Kovacic, Karlovic, & Kocijan-Hercigonja, 2002). The thyroid can produce excess hormones through HPA axis dysfunction and stress associated with PTSD, which creates glucose intolerance by both the reduction in insulin secretion as well as peripheral insulin sensitivity, increasing risk of the development of type 2 diabetes (McEwan, 2008; Roubsanthisuk, et al., 2006).

Overweight and Obesity

Overweight and obesity have also been demonstrated to be related to PTSD. Veterans with PTSD have been found to weigh more than those without (Goldberg et al., 2014). Similarly, having PTSD increased the odds for both male and female veterans to be overweight or be diagnosed with other metabolic disorders (Nazarian et al., 2012). PTSD is also associated with obesity, and veterans with PTSD are more likely to be obese and/or have abdominal obesity (Babić et al., 2013; Vieweg et al., 2007). Additionally, in non-veteran populations, women with PTSD have a higher body mass index (BMI) and men's likelihood of developing obesity, higher BMI, and increased fat

mass rises as PTSD severity also rises (Farr et al., 2015; Roberts et al., 2015). In relation to obesity and overweight, binge eating also has been associated with PTSD in veterans. (Hoerster et al., 2015).

At this time, there is very little research into the physiological mechanisms that produce significantly higher rates of overweight and obesity in populations with PTSD. However, it is hypothesized that the mechanism is likely related or similar to other metabolic and hormonal processes that are related to the increased occurrence in type 2 diabetes in those with PTSD (Suliman, e al., 2016). Behaviorally, those with PTSD are more likely to engage in negative health behaviors and/or have binge eating disorder or bulimia, including veterans with PTSD (Hoerster et al., 2015; Rheingold, Acierno, & Resnick, 2004; Rosenberger & Dorflinger, 2013). Also, those with trauma histories or PTSD seem to have more extreme eating behaviors, overeating patterns, and physical inactivity, all of which can lead to obesity. Exposure to traumatic events and the development of PTSD may be related to risky health behaviors, such as binge eating, through their ability to reduce negative affect in the short term and thus may be frequently used as means to cope with symptoms (Rheingold, Acierno, & Resnick, 2004). These behaviors can then contribute to the development of obesity.

Hypertension

PTSD is also associated with hypertension (high blood pressure), which is theorized to be linked with hyperarousal symptoms, which include hypervigilance, exaggerated startle response, and sleep disturbance (American Psychiatric Association, 2013; Paulus, Argo, & Egge, 2013). Hypertension can put one at risk for cardiovascular

disease, which is concerning as it has been found that PTSD and length of trauma exposure are associated with higher resting blood pressure and heart rate in both veteran and non-veteran samples (Buckley et al., 2004; Muraoka, Carlson, & Chemtob, 1998; Paulus et al., 2013). In community samples, those with PTSD, PTSD and depression, or trauma exposure were significantly more likely to report or be diagnosed with hypertension than controls and those without PTSD (Kibler, Joshi, & Ma, 2009; Lauterbach et al., 2005; Norman et al., 2006; Sareen et al., 2007). Similarly, in veteran samples, both males and females with PTSD were more likely to report hypertension and other circulatory disorders than those without PTSD (Muraoka et al., 1998; Nazarian et al., 2012). Additionally, younger veterans (under 55 years old) with PTSD who have been exposed to a traumatic blast seem to be at even higher risk for developing hypertension than younger veterans with PTSD and no blast exposure (Paulus et al., 2013).

Hypertension is thought to be linked to PTSD physiologically through increased sympathetic nervous system activity (HPA axis; Balint, et al., 2016; Bedi & Arora, 2007; Schlaich, et al., 2004). More specifically, this increase in sympathetic arousal has an effect on the catecholamines of the heart, increasing vasoconstriction, leading to hypertension (Bedi & Arora, 2007; Schlaich, et al., 2004). There is also evidence that chronic PTSD sufferers may have structural and functional cardio adaptation as their body adjusts to chronic stress and load, which may also increase the risk of developing hypertension (Bedi & Arora, 2007). Additionally, previously mentioned behaviorally related health factors associated with PTSD, such as obesity or smoking, can also

increase the risk of developing hypertension (Bedi & Arora, 2007; Rheinhold, Acierno, & Resnick, 2004).

Musculoskeletal Disorders

Musculoskeletal diseases and disorders encompass a wide range of health conditions including rheumatoid arthritis, osteoarthritis, Lupus, fibromyalgia, carpal tunnel syndrome and other disorders of the joints such as bursitis and temporomandibular joint pain (Van Der Windt et al., 1999). In samples of civilian and primary care populations, experiencing trauma or having PTSD significantly increased the odds that arthritis would be reported (Lauterbach et al., 2005; Norman et al., 2006). This finding holds true in veteran populations as well; PTSD is associated with a significant increase in the odds that arthritis will be reported (Weisberg et al., 2008). In a sample of bus drivers, those with PTSD were more likely to report back issues (Vedantham et al., 2001). In a sample of female survivors of sexual trauma, PTSD symptoms were significantly associated with neuromuscular symptoms (Woods, Hall, Campbell, & Angott, 2008). In veteran samples, PTSD significantly increased the likelihood that both men and women would develop a musculoskeletal disease (Andersen, Wade, Possemato, & Ouimette, 2010; Fetzner, McMillan, & Asmundson, 2012; Nazarian et al., 2012; Schnurr & Spiro III, 2000; Weisberg et al., 2008).

There are multiple mechanisms believed to contribute to the higher rate of veterans with PTSD having musculoskeletal disorders. Risk taking behavior, which is common in those with PTSD, is thought to be partially responsible as it can lead to injury and wear on the musculoskeletal system (Buckley, Mozley, Bedard, Dewulf, & Greif,

2004; Durai et al., 2011; Goldberg et al., 2014; Hourani et al., 2012; McDevitt- Murphy et al., 2010; Morrison, 2012). Additionally, it has been consistently found that those with PTSD have higher immune response and inflammatory processes than those without PTSD (Boscarino, Forsberg, & Goldberg, 2010; Pace & Heim, 2011; Wilson, et al., 1999). Having increased immune activity and inflammatory markers is hypothesized to be associated with the development of autoimmune disorders generally, and rheumatoid arthritis more specifically (Boscarino, Forsberg, & Goldberg, 2010).

Chronic Pain

Related to musculoskeletal disorders is chronic pain, which has also been demonstrated to be associated with PTSD. It is hypothesized that chronic pain may be common in those with PTSD because they share a similar response pattern through somatic hypervigilance, heightened startle reaction, avoidance, emotional numbing, and dysregulation of the stress/pain systems (Asmundson & Katz, 2009). There is also some evidence that not only does PTSD predict the development of chronic pain, but chronic pain can also predict the development of PTSD (Beck & Clapp, 2011). Patients referred to a chronic fatigue clinic who experienced pain were also more likely to report PTSD symptoms than those without pain (Roy-Byrne, Smith, Goldberg, Afari, & Buchwald, 2004). In primary care and community samples, PTSD is significantly associated with chronic pain disorders and more intense pain (Phifer et al., 2011; Sareen et al., 2007). Likewise, veterans with mental health concerns, including PTSD, were more likely to report pain in multiple sites and chronic pain (Hourani et al., 2012), and PTSD symptoms have been related to reported pain and chronic pain (Pacella, Hruska, & Delahanty, 2013;

Runnals et al., 2013; Shipherd et al., 2007). Veterans referred for PTSD assessment also report higher levels of chronic pain (Buckley et al., 2004). Veterans with both PTSD and chronic pain also utilize more healthcare services than those with PTSD or pain alone, and veterans with PTSD report more back pain than those without PTSD (Outcalt, Yu, Hoen, Pennington, & Krebs, 2014; Weisberg et al., 2008). Finally, PTSD in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) veterans specifically is associated with chronic, widespread pain (Helmer et al., 2009).

There are multiple theories related to possible pathways which link chronic pain to PTSD, including a mutual maintenance model and a shared vulnerability model through neurological pathways (Otis, et al., 2010; Sharp & Harvey, 2001). The mutual maintenance model rests on the findings that anxiety heightens one's experience of pain, which has implications for those with PTSD, a chronic anxiety condition (Sharp & Harvey, 2001; Strigo, et al. 2010). Anxiety and hypervigilance related to trauma experiences increases a person's awareness of pain, or that a person's awareness of pain may trigger intrusive memories related to trauma. This heightened awareness may amplify their perception of pain, increase their likelihood of perceiving pain as threatening stimuli, and heighten expectation of pain (McFarlane, 2010; Sharp & Harvey, 2001). In regards to neurobiological theories, sympathetic nervous system activation, which triggers the amygdala, has been found to create pain hypersensitivity when specific receptors are activated (Scioli-Salter, et al., 2015). Additionally, the interior insula and anterior cingulate, which play a part in pain perception and emotional processing, have been found to have abnormal activation in those with PTSD (Strigo, et al. 2010).

Neurological Disorders

Neurological disorders encompass many health conditions and diseases including Alzheimer's disease, Parkinson's disease, epilepsy and other seizure disorders, brain and spinal tumors, and meningitis (MacDonald, Cockerell, Sander, & Shorvon, 2000). PTSD has been associated with neurological disorders in community and civilian samples, with those with PTSD more likely to report epilepsy, stroke, migraines/headaches, or other neurological disorders (Lauterbach et al., 2005; Vedantham et al., 2001). Similarly, full and sub-syndromal PTSD has been associated with the development of neurological disorders in both male and female veterans (Andersen et al., 2010; Fetzner et al., 2012; Nazarian et al., 2012). More specifically, in veterans presenting for epilepsy assessment, PTSD was predictive of psychogenic non-epileptic seizures (Salinsky, Evrard, Storzbach, & Pugh, 2012). In OEF and OIF veterans, increased episodes of mild TBI were associated with more severe PTSD and neurological deficits (Ruff, Riechers, Wang, Piero, & Ruff, 2012). Additionally, veterans with PTSD were found to be twice as likely to develop dementia than those without PTSD in one sample of over 150,000, while veterans with combat exposure show more memory deficits than those without (Yaffe et al., 2010; Yehuda, Golier, Tischler, Stavitsky, & Harvey, 2005). Finally, in samples of women, victims of childhood sexual abuse and male Vietnam combat veterans with PTSD were significantly more likely to have neurological soft signs when compared to those with similar experiences and no PTSD (Gurvits et al., 2000).

There are several mechanisms by which it is hypothesized that PTSD is physiologically linked to neurological disorders. First, brain imaging pre and posttraumatic experience and PTSD diagnosis shows a reduction in the volume of the

hippocampus, amygdala, and cingulate cortex (Danckwerts & Leathem, 2003; Karl, et al., 2006). These areas of the brain are part of the limbic system, which plays a significant role in emotion, learning, and most importantly, memory, which is one of the hallmark domains affected by dementia (Kimble & Kaufman, 2004). While there is a clear link between PTSD and dementia, it has also been suggested that PTSD is not necessarily the causal factor of dementia, but that the association is representative of a shared risk factor, such as head trauma (Greenberg, Tanev, Marin, & pitman, 2014). The higher incidence of dementia in those with PTSD may also be partially explained by other common comorbidities, such as hypertension and diabetes, which increase the risk of one developing vascular dementia (Greenberg, et al., 2014). Similarly, the high incidence of substance abuse in those with PTSD may also be a contributor to neurological disorders and decline as substance abuse can lead to cognitive impairment (Greenberg, et al., 2014). Additionally, increased glucocorticoids released by the HPA axis, oxidative stress, and pro-inflammatory cytokines, all of which are associated with PTSD, can damage tissue and inhibit neurogenesis, impacting learning and memory (Greenberg, et al. 2014; Kimble & Kaufman, 2004).

Hypotheses

Clearly, recent research has demonstrated that there is a relationship between PTSD and negative health conditions, and it seems reasonable to hypothesize that PTSD leads to poor health. However, there is a need for longitudinal, rather than cross-sectional, studies to help elucidate this connection. This current study's aim is to examine how PTSD may be related to the course of the development of different health concerns

over time in veterans. Specifically, the objective of this study is to ascertain if PTSD diagnosis is a predictor to develop type 2 diabetes, overweight/obesity, hypertension, musculoskeletal disorders, neurological disorders, and chronic pain. The hypotheses for this study are:

1) Veterans who evidence greater severity of PTSD symptoms will be diagnosed with type 2 diabetes more rapidly than those with less severe symptomatology.
2) Veterans who evidence greater severity of PTSD symptoms will be diagnosed with overweight/obesity more rapidly than those with less severe symptomatology.
3) Veterans who evidence greater severity of PTSD symptoms will be diagnosed with hypertension more rapidly than those with less severe symptomatology.
4) Veterans who evidence greater severity of PTSD symptoms will be diagnosed with musculoskeletal disorders more rapidly than those with less severe symptomatology.
5) Veterans who evidence greater severity of PTSD symptoms will diagnosed with neurological disorders more rapidly than those with less severe symptomatology.
6) Veterans who evidence greater severity of PTSD symptoms will be diagnosed with chronic pain more rapidly than those with less severe symptomatology.

CHAPTER TWO

METHOD

Table 1. Sample Demographics

Demographics	*N*	%
Education		
No High School	5	1.1
High School Diploma	146	33.0
Some College	185	41.8
2 Year College Degree	49	11.1
4 Year College Degree	49	11.1
Graduate Degree	9	2.0
Race/Ethnicity		
Caucasian/White	186	44.6
African American/Black	80	19.2
Hispanic/Latino	124	29.7
Asian/Pacific Islander	22	5.2
Native American	6	1.4

Participants

Participants were veterans from a Southern California Veterans Affairs (VA) Healthcare System who presented for PTSD treatment in the years 2006-2010 (*N* = 1,601). Veterans who had served in the most recent conflicts (Operation Enduring

Freedom, Operation Iraqi Freedom, Operation New Dawn, and Dessert Storm), completed Los Angeles Symptoms Checklist (LASC), completed personal information sheets, and were 18 years of age and older at the time of intake were included in the analysis. Veterans who had served in these more recent conflicts were used because this reduced the likelihood of pre-existing conditions and the general effects of aging on the development of health conditions of interest. With these criteria, 415 participants were included with 1,186 not meeting previously mentioned inclusion criteria, 325 who served in OEF/OIF/OND conflicts and 126 who served in Desert Storm (36 veterans served in both conflicts). OEF/OIF/OND veterans had a mean age of 33 and Desert Storm veterans had a mean age of 45. The age of all participants ranged from 21 – 66 years (M = 35.5 years, SD = 10.9, see Table 1).

Procedures and Materials

This study was approved the VA Institutional Review Board, protocol number 1123. The data were collected during an initial treatment planning session as part of the Trauma Recovery Services Program in the General Outpatient Mental Health Clinic at a Southern California VA Healthcare System between the years 2006 and 2010. This study included only veterans who reported serving in Desert Storm or OEF/OIF/OND. The participants were informed of the purpose of the study, advised that they had no obligation to participate, and were not reimbursed for their involvement. Approximately an hour was used for intake interviews to gather informed consent, personal information, and the Los Angeles Symptom Checklist.

A chart review of veterans who reported serving in Desert Storm or OEF/OIF/OND was completed following diagnoses: type II diabetes, overweight, hypertension, musculoskeletal disorders, neurological disorders, chronic pain, and the number of days from intake to diagnosis. The Veterans Health Administration (VHA) uses a Computerized Patient Record System (CPRS), which is the graphical interface to the Veterans Health Information Systems and Technology Architecture (VistA). Data from VistA are then extracted and compiled daily across the VHA into data warehouses at the Veterans Integrate Service Network (VISN), regional, and national (i.e., Corporate Data Warehouse level). The chart review was completed by accessing this data warehouse. ICD-9 and 10 codes were used in the search function of the electronic medical record to determine diagnosis, and a body mass index of 24.9 or above was also be used for overweight/obesity. Diagnoses were included were not genetic disorders (i.e. Huntington's Disease) or an acquired injury, such as a bone fracture due to trauma.

Measures

Severity of PTSD symptomatology was measured with the Los Angeles Symptom Checklist (LASC), a self-report measure. The LASC consists of 43 items on a five-point Likert scale, with 17 items specifically pertaining to PTSD among other items associated with distress. Higher scores are associated with more severe symptoms: a "0" on the scale represents "no problem" and a "4" on the scale represents an "extreme problem" (King, King, Leskin, & Foy, 1995). This measure has been found to have a sensitivity rate of 70% and specificity rate of 80%, with an overall agreement rate of 84% when compared to the SCID-R, demonstrating convergent validity (Housekamp & Foy, 1991). The retest

reliability of .94 has been reported and Cronbach's alpha has ranged from .89 to .94, depending on the sample population (King, King, Leskin, & Foy, 1995). The Chronbach's alpha of the 43 items for the full clinical database was .94.

Based on a prior exploratory and confirmatory factor analysis, four factors and one higher order factor were discovered: Hyperarousal/Re-Experiencing, Social Difficulties, Somatic Symptoms, Occupational Functioning, and General PTSD Symptoms (higher order factor). For this analysis, the General PTSD Symptoms Factor was used. This higher order factor represents the four primary factors and symptoms of distress, such as emotional numbing, depressed mood, and irritability. Higher scores indicate more severe PTSD symptoms.

Statistical Analysis

The hypothesis of interest is that PTSD will be a predictor of veterans developing hypertension, overweight/obesity, diabetes, musculoskeletal disorders, neurological disorders, and chronic pain over an eight-year period. Covariates controlled for were age, education, and race/ethnicity. Education, a categorical variable, was broken into the achievement levels of less than a high school degree, high school degree, some college, two year college degree, four year college degree, and graduate degrees. Due to low number of participants who endorsed having a less than a high school degree or a graduate degree, these categories was not used for analysis. The reference group was high school degree for analyses. Race/Ethnicity is a categorical variable that includes Caucasian/White, African American/Black, Hispanic/Latino, Asian/Pacific Islander, and Native American. Participants self-reported their ethnic and racial identity by writing in

their race/ethnicity rather than selecting it from a set of pre-determined categories. Caucasian was used as the reference variable for comparison. To analyze the data six Cox-Regression survival analyses were used to test whether PTSD severity predicts the development of the six health conditions listed above. Each hypothesis was tested separately using two blocks, control variables in the first block and PTSD score in the second. Kaplan-Meier survival analyses were used to estimate the mean and median survival time of each health condition. SPSS version 22.0 was used to perform all analyses.

CHAPTER THREE

RESULTS

Table 2. Cox Regression Hazard Ratios for PTSD Predicting Health Conditions

Health Condition	% of Sample (N)	Predictor	HR	95% CI
Type 2 Diabetes	6.2% (30)			
		Age	1.04	.97-1.10
		Education		
		High School (reference group)		
		Some College	1.06	.33-3.34
		2 Year Degree	.45	.07-2.92
		4 Year Degree	.21	.05-1.12
		Race/Ethnicity	1.16	.78-1.71
		Caucasian/White (referent group)		
		African American/Black	.89	.30-2.64
		Hispanic/Latino	1.12	.33-3.82
		Asian/Pacific Islander	5.99*	1.15-31.17
		PTSD	.75	.47-1.18
Overweight/Obesity	14.3% (69)			
		Age	1.00	.86-1.37
		Education		
		High School (reference group)		
		Some College	.72	.34-1.33
		2 Year Degree	.31*	.123-.76
		4 Year Degree	.50	.199-1.26
		Race/Ethnicity		
		Caucasian/White (referent group)		
		African American/Black	1.05	.53-2.11
		Hispanic/Latino	.37**	.194-70
		Asian/Pacific Islander	.37	.08-1.65
		Native American	.87	.10-7.42
		PTSD	1.01	.86-1.37
Hypertension	9.5% (46)			
		Age	1.00	.98-1.04
		Education		
		High School (reference group)		

		Some College	1.02	.47-2.21
		2 Year Degree	2.01	.393-10.31
		4 Year Degree	.26	.06-1.13
		Race/Ethnicity		
		Caucasian/White (referent group)		
		African American/Black	1.37	.35-5.28
		Hispanic/Latino	2.90*	1.29-6.58
		Asian/Pacific Islander	.70	.06-8.50
		Native American	.695	.06-8.49
		PTSD	1.42*	1.00-2.01
Musculoskeletal Condition	15.4% (74)			
		Age	1.0	.98-1.02
		Education		
		High School (reference group)		
		Some College	1.03	.56-1.87
		2 Year Degree	1.00	.44-2.27
		4 Year Degree	.88	.35-2.24
		Race/Ethnicity		
		Caucasian/White (referent group)		
		African American/Black	.47	.22-1.00
		Hispanic/Latino	.48*	.27-.87
		Asian/Pacific Islander	.72	.27-1.93
		Native American	2.63	.58-12.03
		PTSD	1.14	.91-1.42
Chronic Pain	8.3% (40)			
		Age	1.05*	1.01-1.10
		Education		
		High School (reference group)		
		Some College	.69	.27-1.78
		2 Year Degree	.57	.164-2.00
		4 Year Degree	.34	.08-2.34
		Race/Ethnicity		
		Caucasian/White (referent group)		
		African American/Black	.64	.17-2.41
		Hispanic/Latino	.49	.21-1.15
		PTSD	.719	.64-1.36
Neurological Condition	22.8% (110)			
		Age	1.00	.99-1.02

	Education		
	High School (reference group)		
	Some College	1.67*	1.02-2.75
	2 Year Degree	2.08*	1.03-4.20
	4 Year Degree	2.35*	1.32-4.87
	Race/Ethnicity		
	Caucasian/White (referent group)		
	African American/Black	1.05	.600-1.84
	Hispanic/Latino	.55*	.35-.86
	Asian/Pacific Islander	.28*	.07-.86
	PTSD	1.03	.85-1.23

PTSD scale is *z*-score, odds ratios are change in probability of having the health condition for each standard deviation increase of the PTSD scale.
*$p < .05$, ** p<.01.

Table 3. Descriptive Statistics for Days Until Diagnosed

Health Condition	N	Mean	Standard Error	Median	Standard Error
Type 2 Diabetes	37	1433.73	169.72	1158.00	506.51
Overweight/Obesity	91	1429.29	105.57	1307.00	221.56
Hypertension	54	1297.72	128.73	1133.00	147.58
Musculoskeletal Disorders	93	798.97	78.62	559.00	119.66
Chronic Pain	46	1727.90	163.63	1852.00	328.94
Neurological Disorders	133	1470.29	1296.96	1454.00	191.82

Time is measured in days.

Diabetes

The first hypothesis that PTSD would be a significant predictor of the development of type 2 diabetes in veterans of the Desert Storm or OEF/OIF/OND was not supported. The odds of being diagnosed with type 2 diabetes were 499% higher for participants identifying as Asian/Pacific Islander than participants identifying as Caucasian/White (*HR* = 5.99, 95% CI [.1.15-31.17]). Mean duration until diagnosis of type 2 diabetes in this sample was 3.65 years (*M* = 1443.73 days, *SE* = 169.72).

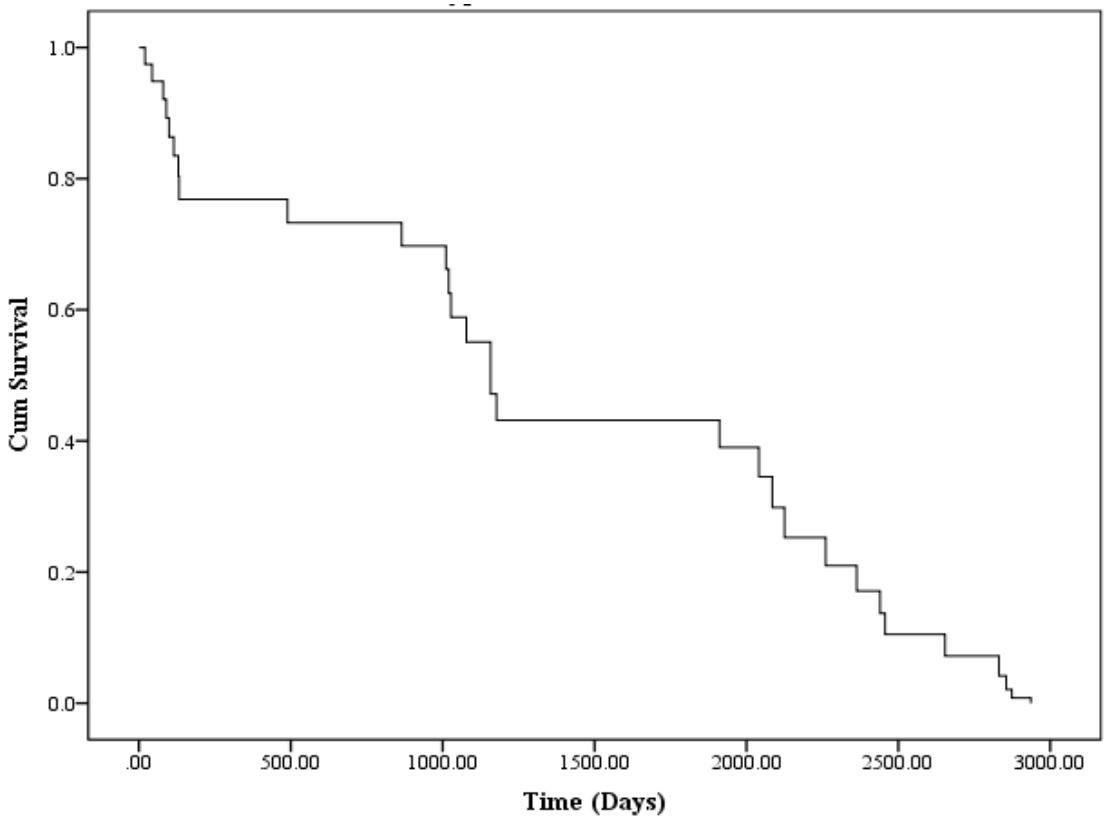

Figure 1. Survival Function of Type 2 Diabetes at Mean of Covariates. Cumulative survival of participants over time to diagnosis of type 2 diabetes.

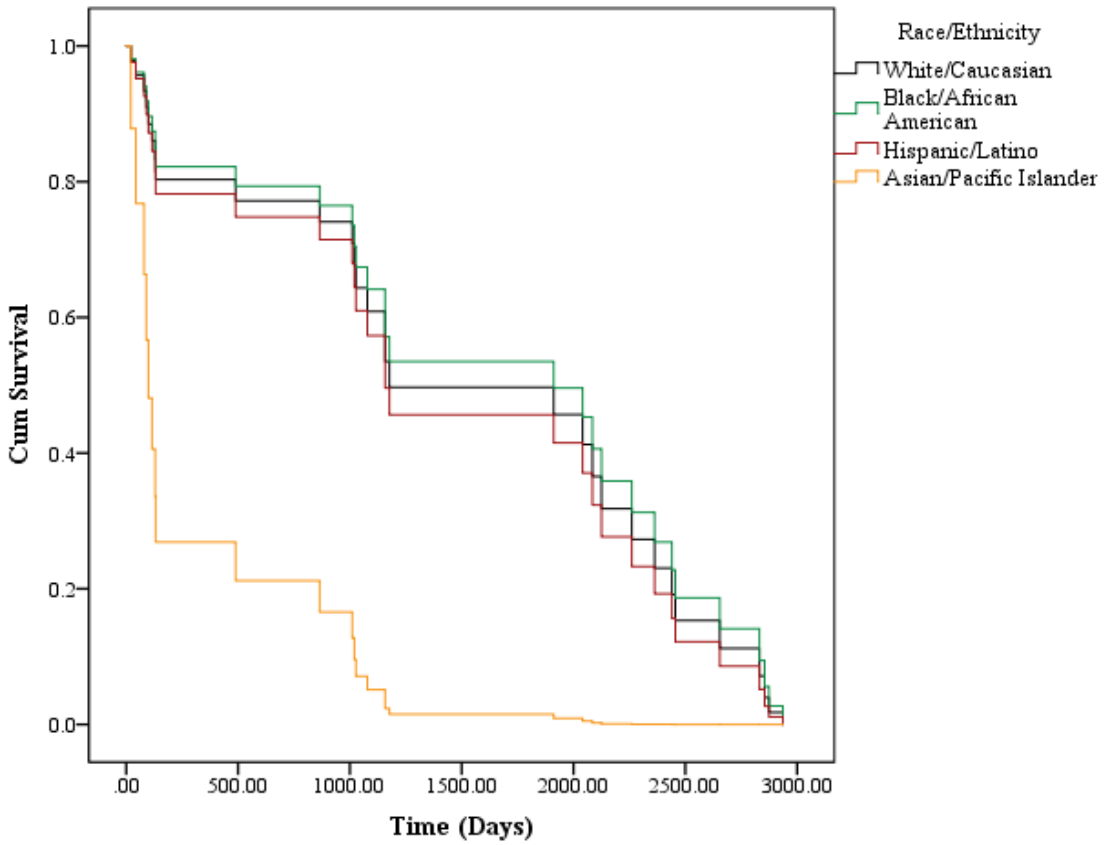

Figure 2. Survival Function for Type 2 Diabetes by Race/Ethnicity. Cumulative survival of participants by reported race/ethnicity over time to diagnosis of type 2 diabetes.

Overweight and Obesity

The hypothesis that PTSD would be a significant predictor of the development of overweight/obesity in young veterans was also not supported. The odds of being diagnosed with a overweight/obesity were 69% lower for participants with a 2 year degree compared to high school graduates (*HR* = .31, 95% CI [.12-.76]). The odds of being diagnosed with overweight/obesity were 63% lower for participants identifying as Hispanic/Latino than participants identifying as Caucasian/White (*HR* = .37, 95% CI [.19-.70]). Mean duration until diagnosis of overweight/obesity in this sample was 3.91 years (*M* = 1429.29 days, *SE* = 105.57).

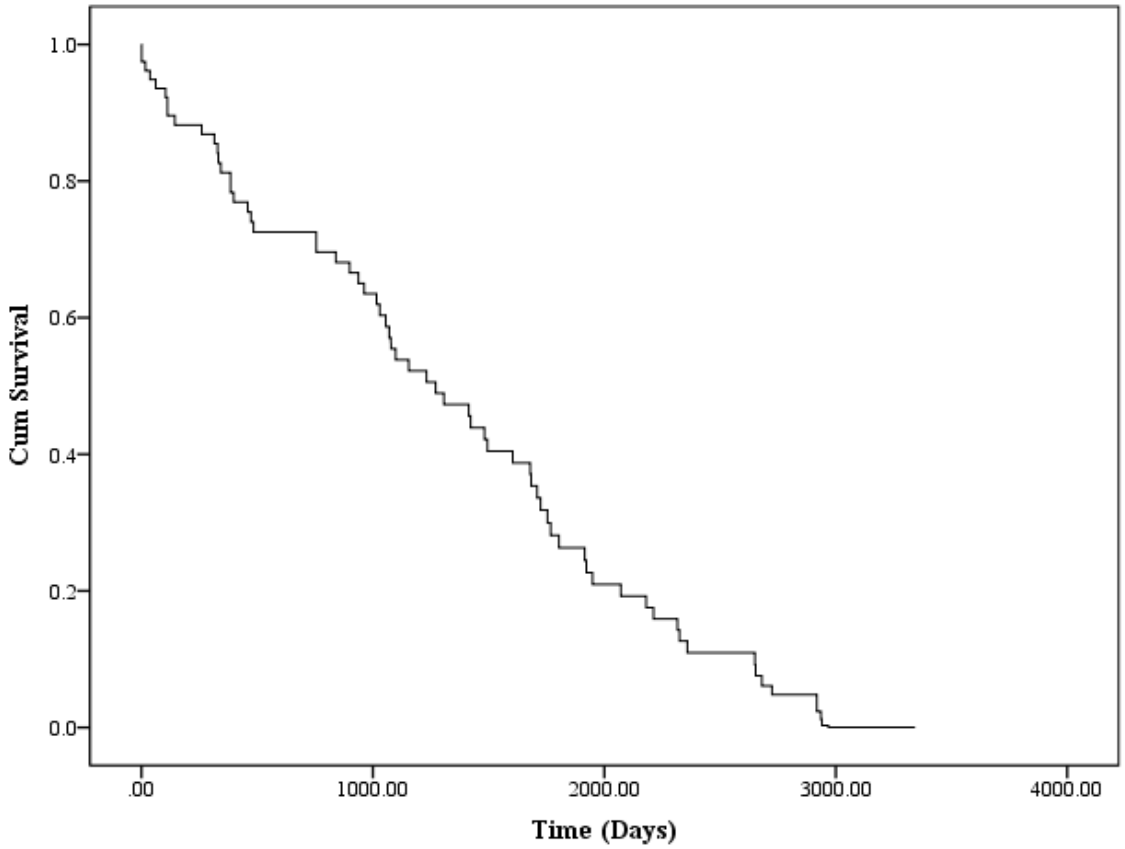

Figure 3. Survival Function of Overweight/Obesity at Mean of Covariates. Cumulative survival of participants over time to diagnosis of obesity/overweight.

Figure 4. Survival Function of Overweight/Obesity by Race/Ethnicity

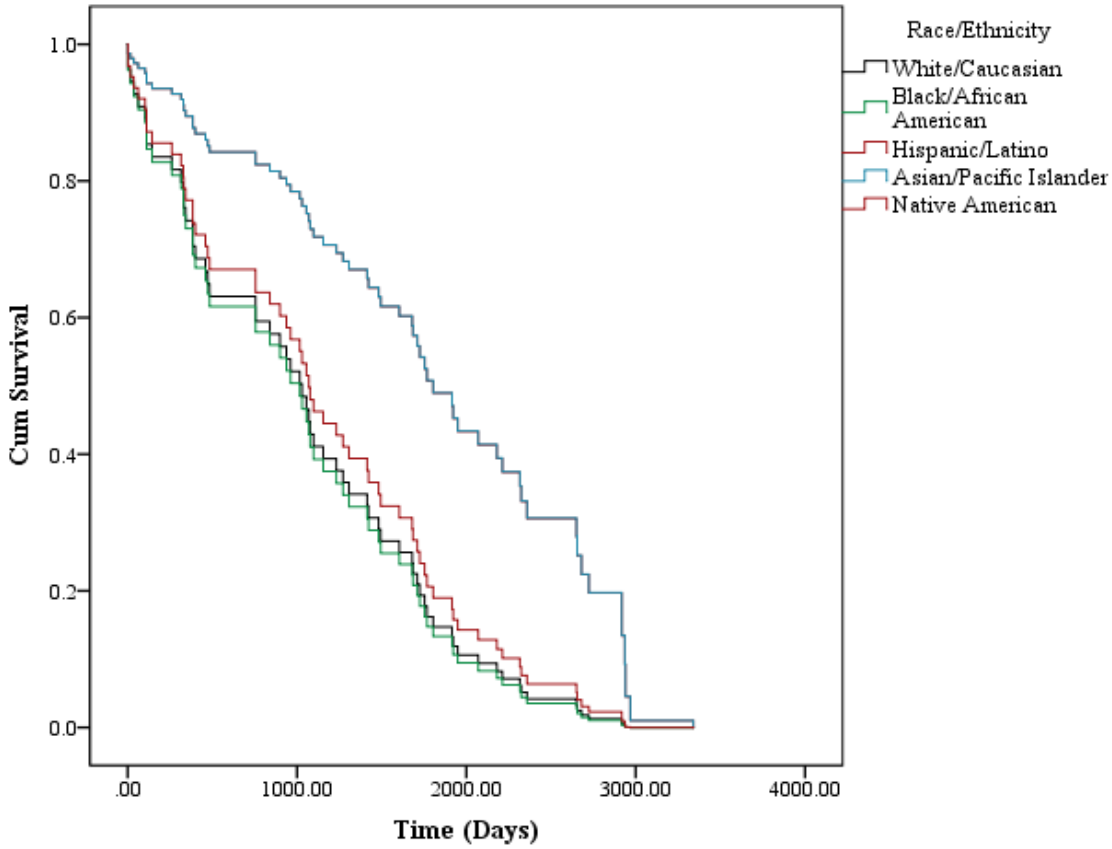

Figure 4. Survival Function of Overweight/Obesity by Race/Ethnicity. Cumulative survival of participants by reported race/ethnicity over time to diagnosis of overweight/obesity.

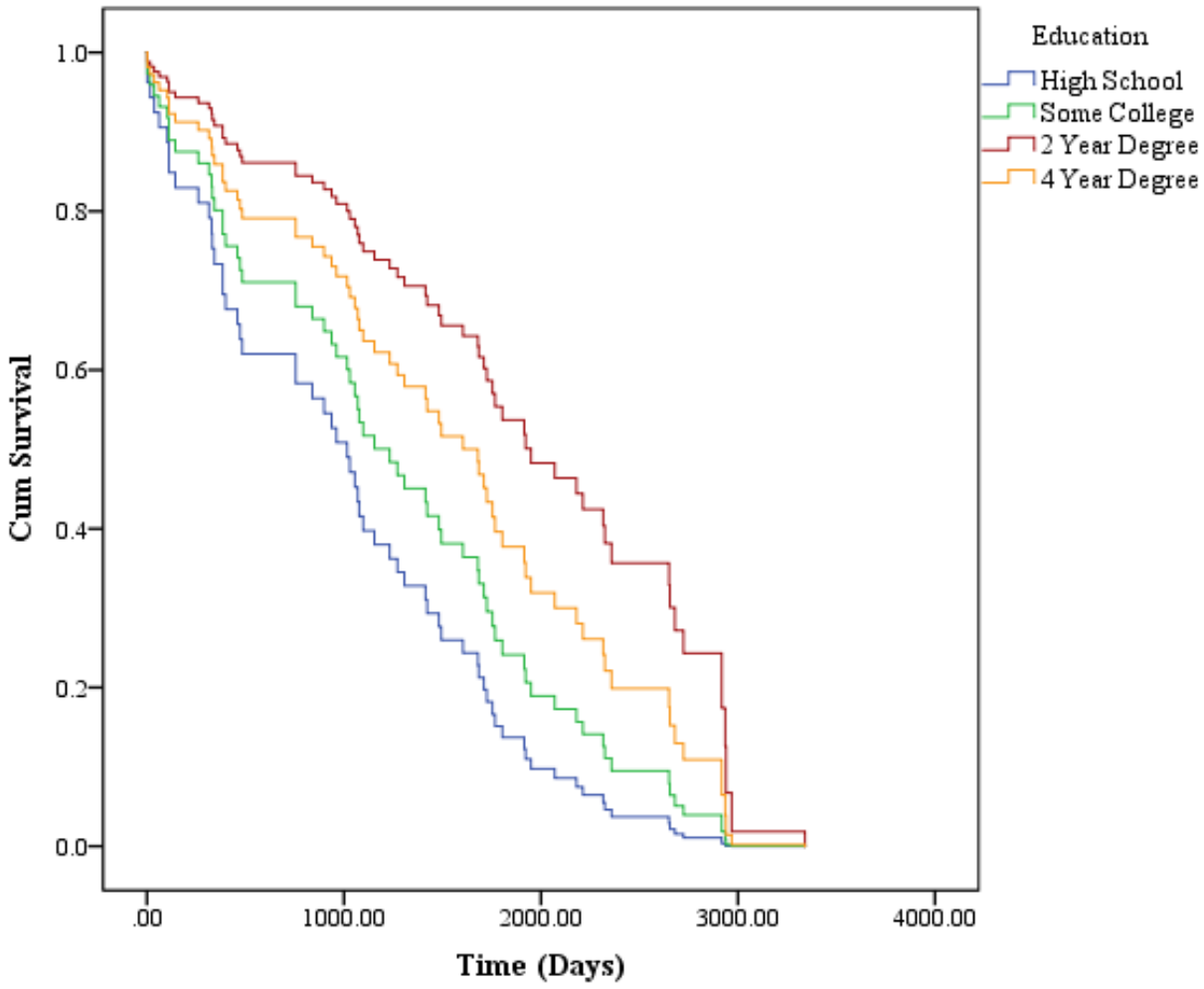

Figure 5. Survival Function for Overweight/Obesity by Education. Cumulative survival of participants by education level over time to diagnosis of overweight/obesity

Hypertension

The third hypothesis, which stated PTSD would be a significant predictor of the onset of hypertension, was supported. The odds of an OEF/OIF/OND or Desert Storm veteran developing hypertension increased by 42% for every one standard deviation increase on PTSD General Factor (*HR* = 1.42, 95% CI [1.00-2.01]). The odds of being diagnosed with a hypertension were 190% higher for participants identifying as Hispanic/Latino than participants identifying as Caucasian/White (*HR* = 2.90, 95% CI

[1.29-6.58]). Mean duration until diagnosis of hypertension in this sample was 3.55 years (*M* = 1297.72 days, *SE* = 128.73).

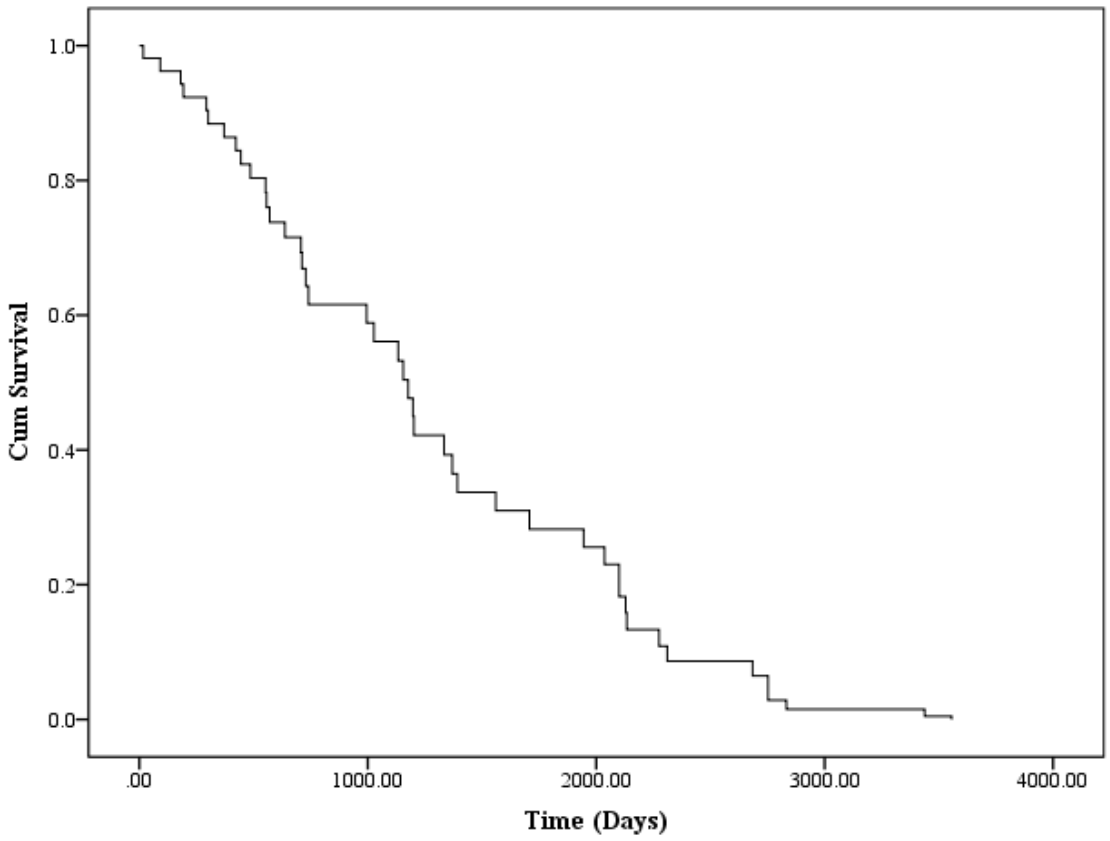

Figure 6. Survival Function of Hypertension at Mean Covariates. Cumulative survival of participants over time to diagnosis of hypertension.

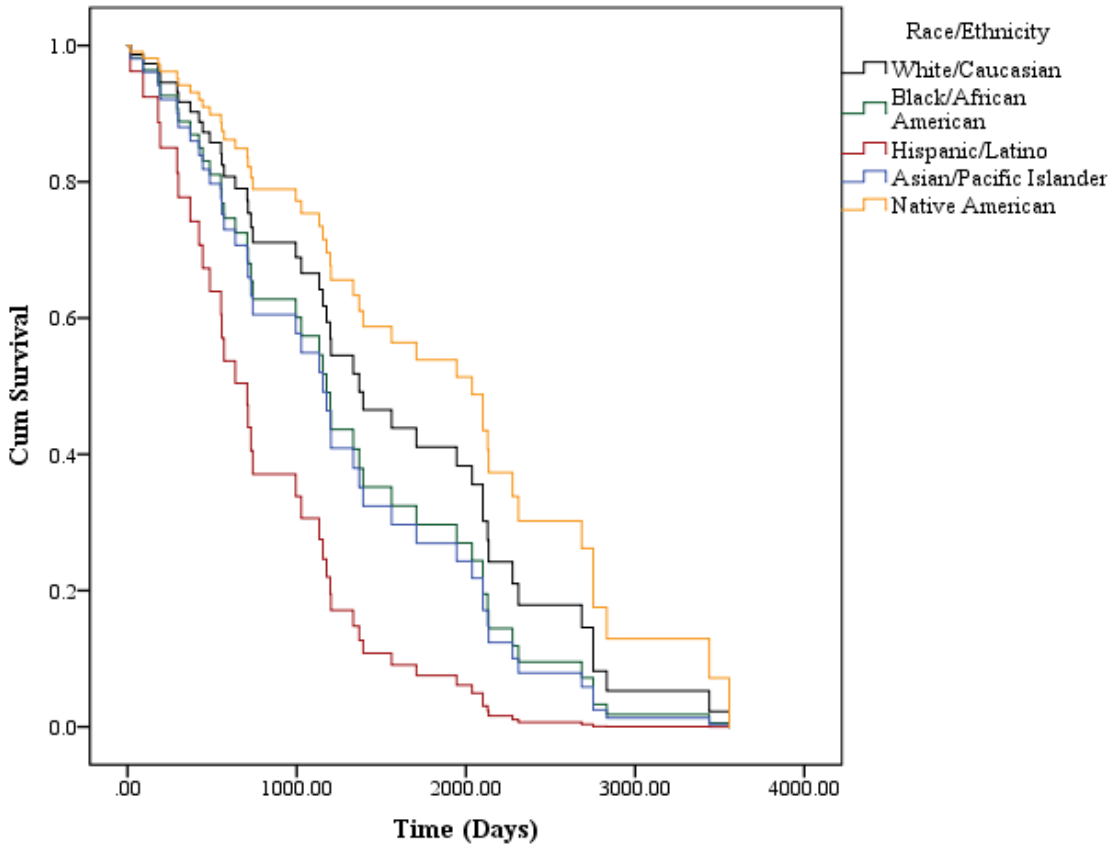

Figure 7. Survival Function for Hypertension by Race/Ethnicity. Cumulative survival of participants by reported race/ethnicity over time to diagnosis of hypertension.

Musculoskeletal Disorders

The fourth hypothesis, that PTSD would be a significant predictor of the development of musculoskeletal disorders in young veterans was not supported. The odds of being diagnosed with a musculoskeletal disorder were 52% lower for participants identifying as Hispanic/Latino than participants identifying as Caucasian/White (*HR* = .48 95% CI [.27-.87]). Mean duration until diagnosis of musculoskeletal disorders in this sample was 2.02 years (*M* = 798.97 days, *SE* = 78.62).

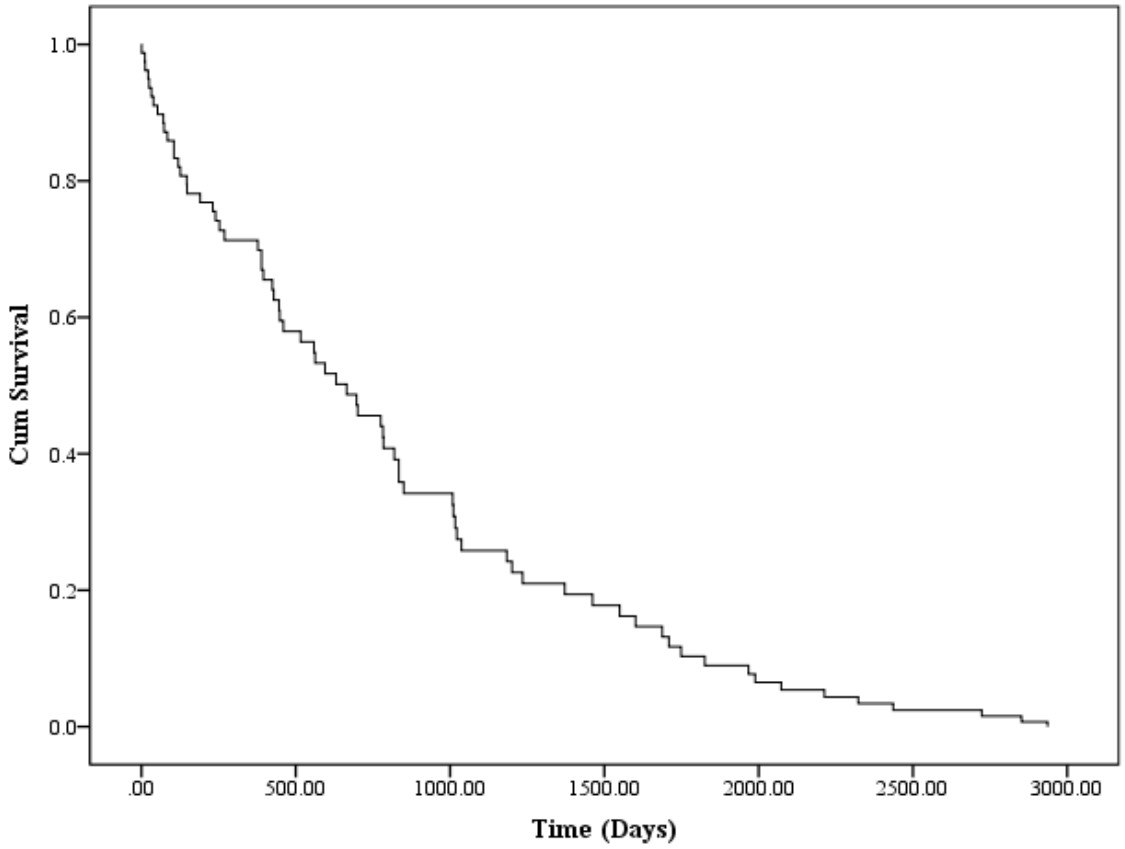

Figure 8. Survival Function of Musculoskeletal Disorders at Mean of Covariates. Cumulative survival of participants over time to diagnosis of musculoskeletal disorders.

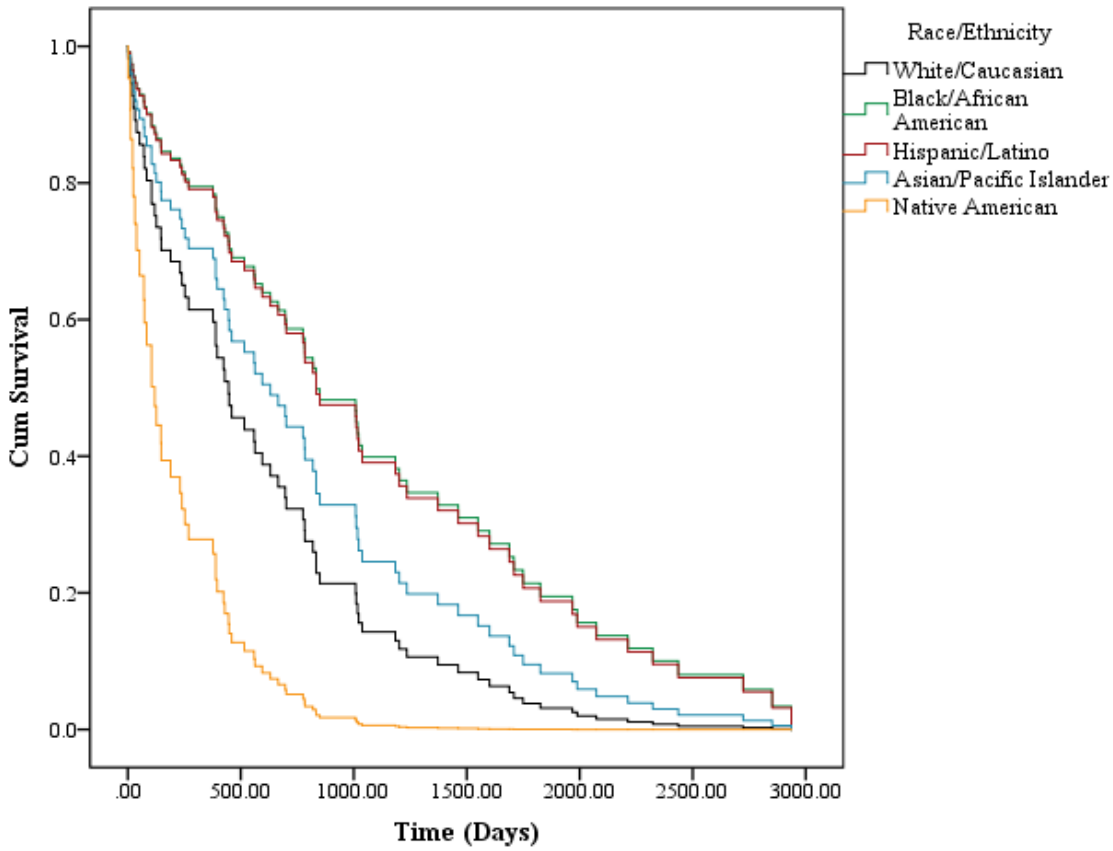

Figure 9. Survival Function for Musculoskeletal Disorders by Race/Ethnicity. Cumulative survival of participants by reported race/ethnicity over time to diagnosis of musculoskeletal disorders.

Chronic Pain

The hypothesis that PTSD would be a significant predictor of the onset of chronic pain in Desert Storm and OEF/OIF/OND veterans was not supported. However, age was a significant predictor of chronic pain onset. The odds of an OEF/OIF/OND and Desert Storm veteran developing chronic pain increased by 5% for every one-year increase in age (*HR* =1.05, 95% CI [1.01-1.10]). Race/ethnicity and education were not significant predictors of the onset of chronic pain. Mean duration until diagnosis of chronic pain in this sample was 4.73 years (*M* = 1727.90 days, *SE* = 163.63).

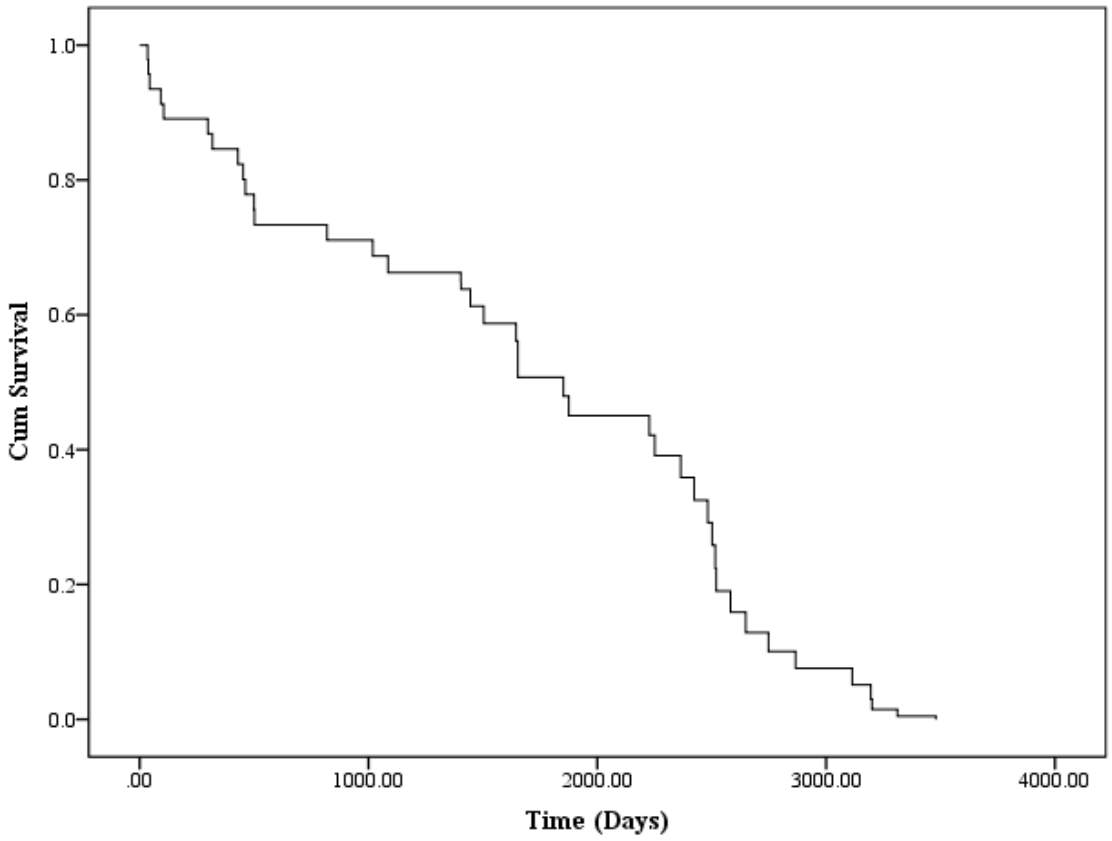

Figure 10. Survival Function of Chronic Pain at Mean of Covariates. Cumulative survival of participants over time to diagnosis of chronic pain.

Neurological Disorders

The final hypothesis that PTSD would be a significant predictor of the onset of neurological disorders in young veterans was not supported. However, education level was associated with developing a neurological condition. Having achieved an education level of some college increased the odds of developing a neurological condition by 67% when compared to having earned a high school diploma (*HR* = 1.67, 95% CI [1.02-2.75]). Having earned a two-year college degree was associated with a 108% increase in the odds of developing a neurological condition, compared to having earned a high school degree (*HR* = 2.08, 95% CI [1.03-4.20]). Finally, having earned a four year

college degree, when compared to having earned a high school degree, was associated with a 135% increase in the odds of a veteran being diagnosed with a neurological disorder (*HR* = 2.35, 95% CI [3.10-40.20]). Race/ethnicity was also found to be a significant predictor of developing a neurological disorder. The odds of being diagnosed with a neurological condition were 45% lower for Participants identifying as Hispanic/Latino than participants identifying as Caucasian/White (*HR* = .55, 95% CI [.35-8.6]). The odds of being diagnosed with a neurological condition were 75% lower for veterans who identified as Asian or Pacific Islander veterans who identified as Caucasian/White (*HR* =.25, 95% CI [.35-8.6]). Mean duration until diagnosis of neurological disorders in this sample was 4.02 years (*M* = 1470.29 days, *SE* = 1296.96).

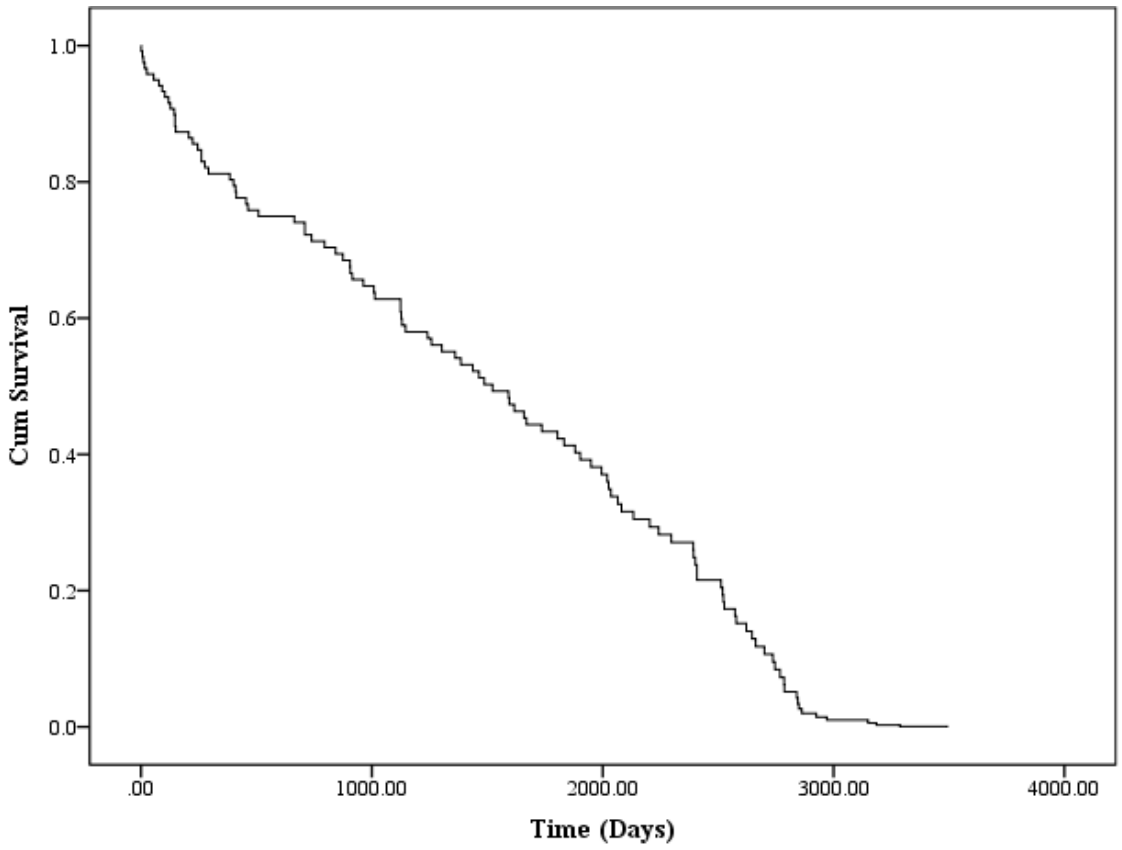

Figure 11. Survival Function of Neurological Disorders at Mean of Covariates. Cumulative survival of participants over time to diagnosis of neurological disorders.

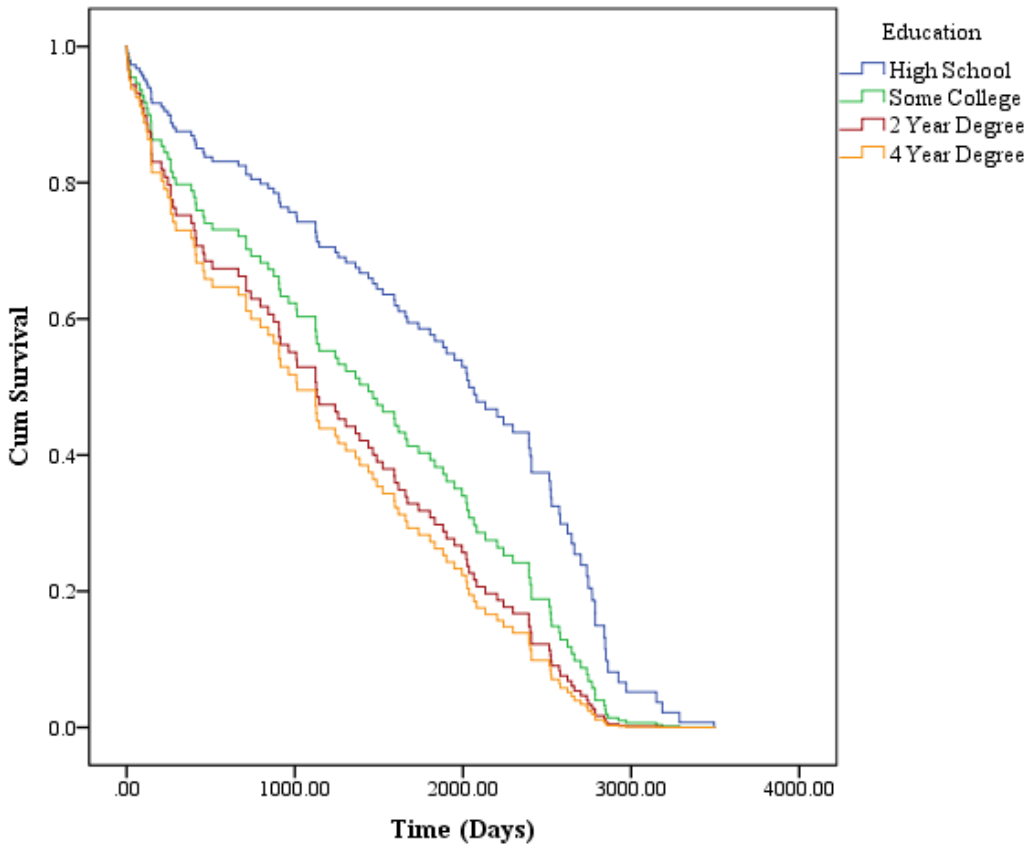

Figure 12. Survival Function for Neurological Disorders by Education. Cumulative survival of participants by education level over time to diagnosis of neurological disorders.

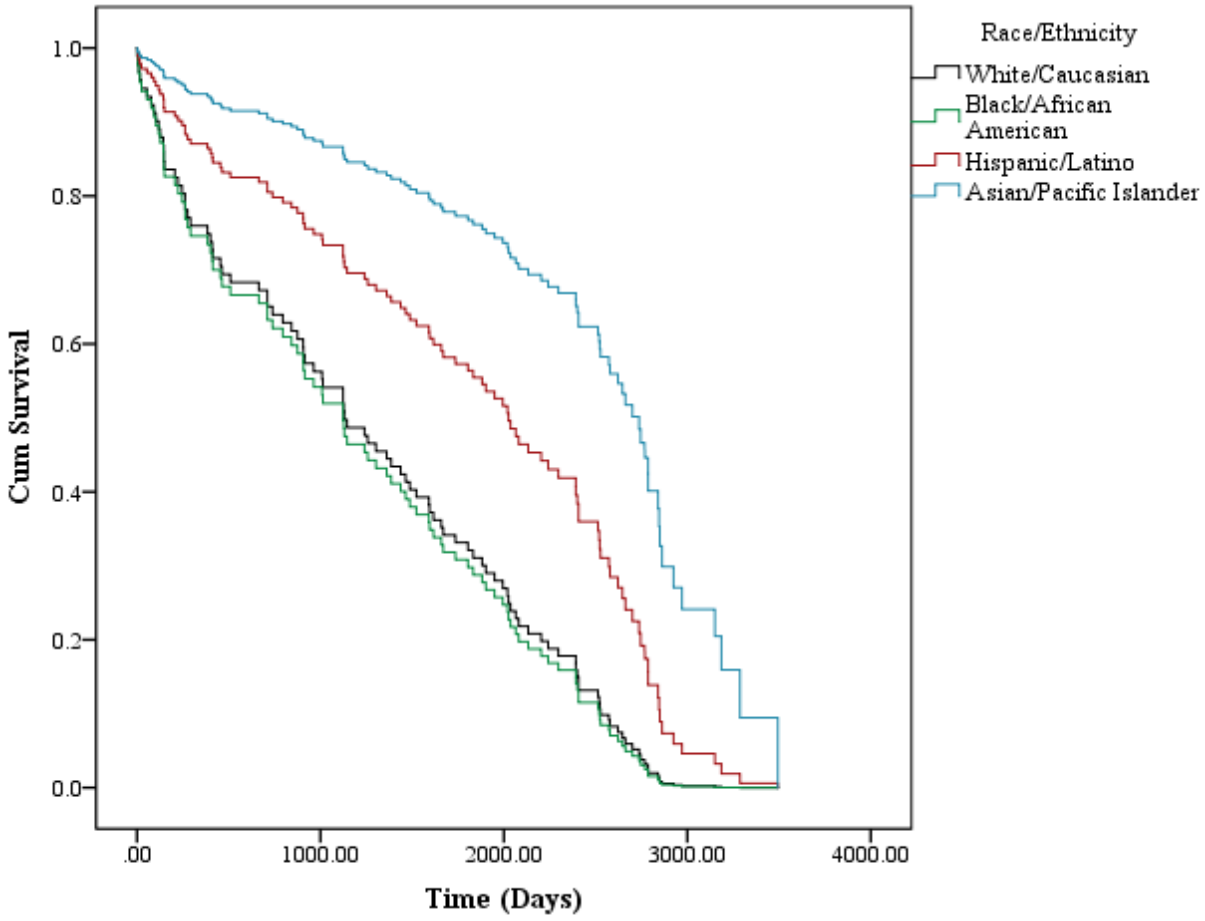

Figure 13. Survival Function for Neurological Disorders by Race/Ethnicity. Cumulative survival of participants by reported race over time to diagnosis of neurological disorders.

CHAPTER FOUR

DISCUSSION

The goal of this study was to examine the impact of PTSD on the time to diagnosis of hypertension, chronic pain, neurological conditions, musculoskeletal disorders, overweight/obesity, and type-2 diabetes over time in veterans who served in the most recent conflicts, OEF/OIF/OND and Desert Storm. Findings include that greater levels of PTSD symptomatology were associated with increases odds of a hypertension diagnosis. Participants identifying as Asian or Pacific Islander had increased odds of a type 2 diabetes diagnosis. Increased age was associated with greater odds that OEF/OIF/OND and Desert Storm veterans would develop chronic pain. Higher levels of educational achievement were associated with increased odds of developing a neurological condition when compared to achieving a high school education. Higher levels of education decreased the odds of veterans in our sample of having a diagnosis of obesity/overweight. Self-identifying as Hispanic/Latino or Asian/Pacific Islander was associated with decreased the odds of younger veterans developing a neurological condition when compared to Caucasian/White participants. Identifying as a Hispanic or Latino also decreased the odds of participants being diagnosed with overweigh/obesity and musculoskeletal disorders while endorsing this ethnic/racial category increases the odds of a hypertension diagnoses.

The main finding that PTSD is associated with young veterans having a diagnosis of hypertension is consistent with existing literature, though these findings add new longitudinal evidence. PTSD and hypertension have been linked in both community samples and veteran samples (Buckley et al., 2004; Kibler, Joshi, & Ma, 2009;

Lauterbach et al., 2005; Muraoka, Carlson, & Chemtob, 1998; Norman et al., 2006; Sareen et al., 2007; Paulus et al., 2013). The hypothesized mechanism underlying the link between these two conditions is increased sympathetic nervous system activity associated with PTSD, which appears to increase blood pressure (HPA axis; Balint, et al., 2016; Bedi & Arora, 2007; Schlaich, et al., 2004). Also, likely explanations of these findings include associated behaviors of PTSD, such smoking and obesity, which are both associated with an increased likelihood of developing hypertension (Bedi & Arora, 2007; Rheinhold, Acierno, & Resnick, 2004). Whether increased HPA activation, health risks behaviors associated with PTSD, or the combination of these factors are driving this relationship, PTSD appears to play a part in hastening the diagnosis of hypertension in younger veterans.

Secondary findings include increases in age increased the odds of veterans developing chronic pain (DePalma, Ketchum, & Saullo, 2011; Galgliese & Melzack, 1997). Although prevalence research including Asians/Pacific Islanders is scant, the result that this racial/ethnic group has lower odds of developing neurological disorders than Caucasians is consistent with current literature (Annegars, et al., 1999; Kelvin, et al., 2007; Tse, et al., 2013; Wright, Pickard, Whitfield, & Hakin, 2000). Asian American and Pacific Islander also have higher rates of type 2 diabetes, which aligns with our findings (Lee, Brachati, & Yeh, 2011). Increased levels of education as a protective factor against type 2 diabetes has also previously been demonstrated (Drewnowski & Specter, 2004).

The finding that Hispanic/Latino veterans were less likely to develop neurological disorders and musculoskeletal disorders than Caucasians has mixed support in the literature, depending on the sample and exact disorder or groups of disorders being

studied (Annegars, et al., 1999; Chong, et al., 2013; Dahodwala, et al., 2009; Luchsinger, et al., 2007; Siddharthan, Hodgson, Rosenberg, Haiduven, & Nelson, 2006; Skinner, Weinsteinm Sporer, & Wennberg, 2003). Prevalence of overweight and obesity in Hispanic/Latino veterans also tends to be higher or not significantly different than White/Caucasian veterans in most studies, though some have found lower levels of obesity in Hispanic/Latinos when compared to whites (Nelson. 2006; Sandeep, et al., 2005).

Prevalence rates of hypertension in Hispanic/Latino Whites is typically found to be not significantly different than non-Hispanic/Latino whites, while hypertension in Hispanic/Latino Blacks and non-Hispanic/Latino Blacks it tends to be higher (Borrell, 2009; Egan, Zhao, & Axon, 2010; Sudano, & Baker, 2001). Additionally, hypertension rates differ by specific Hispanic/Latino group being studied (Borrell, 2009; Lorenzo et al., 2002). Other research has also concluded that Hispanic/Latino people may have lower health literacy or be generally less aware of their hypertension status when compared to non-Hispanic Whites, which may affect their medical follow-up and control of blood pressure (Sudano, & Baker, 2001). We did not have enough data to differentiate Hispanic/Latino groups in this study which may affect this finding as well potential health literacy of our Hispanic/Latino sample.

While education was included in analyses to control for protective effects, findings suggest higher levels of achieved education increased odds of developing a neurological disorder. This is not consistent with studies of education and dementia, Parkinson's disease, mild cognitive impairment, and stroke, which show an inverse relationship between education and the development of neurological disorders (Chang,

Marmot, Farley, & Poulter, 2002; Hesdorffer, et al., 2005; Sachdev, et al., 2015; Sattler, Toro, Schonknecht, & Schroder, 2012; Sunwoo, Hong, Lee, Lee, & Sohn, 2016, Wu, et al., 2016). The protective effects of education are linked to aspects of higher socioeconomic status such as access to medical care, higher rates of infection, and diet (Sharp & Gatz, 2011). Crystalized intelligence has been found to compensate for cognitive decline and memory loss, but the actual cognitive decline of those with higher levels of education is the same rate as those with lower levels of education (Christensen, et al., 1997). The impact of education on cognitive decline and neurological disease is lessened when baseline cognitive abilities are controlled for (Christensen, et al., 1997; Sharp & Gatz, 2011). However, in neurological disorders that more frequently affect younger adults, higher education is associated with higher incidence of neurological disorders, this includes disorders such as multiple sclerosis and migraines (Ascherio & Munger, 2007; Stang & Osterhaus, 1993). Thus, given the mean age of the current same (35.5 years), this finding aligns with current knowledge about neurological diseases that affect younger adults.

Hypertension is a major risk factor for stroke, myocardial infarction, renal failure, and heart failure (Ong, Chueung, Bun Man, Pak Lau, & Lam, 2007). In 2014, it was the 13th highest cause of mortality in the United States and contributes to the development of the 1st, 5th, and 9th leading causes of death (heart disease, cerebrovascular disease, and renal failure respectively; Kochanek, Murphy, Xu, & Tejeda-Vera, 2016). Hypertension is primarily preventable and modifiable through behavior such as diet, exercise, dietary supplementation, and weight control (Whelton, et al., 2002). The results of this study have implications for both medical providers and mental health providers. First, primary

care providers, who are usually the primary medical providers treating hypertension, can screen patients, especially veterans, for PTSD as a risk factor in developing hypertension (Chobanian et al., 2003). If medical providers are aware of patients' mental health diagnoses, which is often the case in integrated settings such as the VA, they may be more vigilant in their screening for changes in blood pressure. Additionally, mental health providers can also play a role in education, prevention, and screening for hypertension in those with PTSD. Mental health providers can potentially influence the development and treatment of hypertension through encouraging and advising patients to regularly follow-up with their primary care provider. Mental health providers, especially those in integrated primary care, can provide behavioral health interventions, such as motivation interviewing for weight loss, for at risk patients and those with already diagnosed hypertension (Writing group of the PREMIER Collaborative Research Group, 2003). Though not elucidated in this study, it is possible that the reduction in PTSD symptoms through PTSD mental health treatment may also influence the development of hypertension, which may allow mental health providers to have a profound effect on the health of their patients.

Limitations of this study include weaknesses with the sample, which effected design. Because the sample came from a pre-existing clinical database and then was paired with a chart review, control over many aspects was lost. First, patients were not initially screened for pre-existing conditions; it had to be assumed participants did not have them if the diagnosis was not noted in their chart. One way to control for this limitation was the use of OEF/OIF/OND and Desert Storm veterans who presumably entered the service healthy, given eligibility requirements of the military, and therefore

did not have a great deal of time to develop the health conditions of interest. Ideally, this study would have included regular follow-up with patients to track the development of health conditions for a more accurate time of onset. It can be assumed that conditions that cause pain or other distressing symptoms are likely to bring veterans in to see a health care provider, but this of course was not known about this sample. Alternately, being overweight/obese may not cause symptoms concerning enough to see a physician and type 2 diabetes is often asymptomatic for several years after development (Lanza, Albright, Zucker, & Martin, 2007). Other disorders, such as fibromyalgia and multiple sclerosis, may go years without being diagnosed as other conditions are ruled out, despite patients seeking medical care (Choy, et al., 2010; Miller, 2004) Veterans may have also received their healthcare, and therefore diagnoses, from other locations, which may prevent diagnoses from being included in their VA medical record. Our study also used time to diagnosis as a proxy for time to onset of a condition which is a limitation on the interpretation of our results. As mentioned previously, there are multiple factors that may impact whether or not a patient has a diagnosis that may not be tied to their actual development of a health conditions. This means we are assuming that time to diagnosis closely aligns to time to onset, but this may not be truly reflect a close temporal relationship. Results should be considered with this in mind.

Other limitations include receiving PTSD treatment through the clinic the original clinical data set was gathered in may reduce the affect PTSD has on the development of health conditions. This is because if PTSD truly increases the odds of developing health conditions it stands to reason that reducing PTSD symptoms or severity may reduce this effect. We were unable to control for PTSD developed from

experiences previous to military service. This sample of veterans consisted of younger veterans due to previously mentioned reasons; this also meant that fewer veterans developed the conditions of interest during the observation time, which negatively influenced the power of the analyses and increased right censoring.

Conclusions and Future Directions

Given the results and limitations of this study, future directions should include further longitudinal investigation into the relationship between PTSD and health conditions. The six health conditions selected for this study were chosen based on ample cross sectional evidence and should continue to be researched. Addressing limitations of design and sample would increase power and internal validity. This ideally would include follow-up with participants at regular intervals as a way to control for the limitation of time to diagnosis as a proxy for time to onset of a condition. Further directions might include using non-veteran samples, or investigating specific types of trauma (e.g., childhood sexual abuse, natural disaster, motor vehicle accidents), or the effect of multiple traumas. Investigations of how PTSD treatment, regular medical care, and other factors that may mediate the relationship between PTSD and negative health outcomes would also add a great deal to existing research. While this study did not investigate the physiological etiology underlying PTSD and the development of health conditions, this is an area that is still very new with much more exploration to be done. Understanding the physiological pathways and mechanisms that drive the connection between PTSD and negative health outcomes will inform theory, treatment, and prevention. There is much more to be learned about PTSD and it's impact of the body, continued study may

improve the ability of medical and mental health professionals to provide effective interventions for those with PTSD.

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