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Psychological Contributors to Respiratory Distress in Post-Deployment Veterans

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ABSTRACT

Since September 11, 2001 over 2.7 million service members have deployed in support of Operations Enduring and Iraqi Freedom and have served combat tours in the Middle East and Southwest Asia. These Veterans commonly experienced complex environmental exposures including, but not limited to, exposure to burn pits. Burn pits are solid-waste disposal sites that have been employed by the military to eliminate refuse from military bases in the Iraq and Afghanistan theaters of operations. Over 200,000 of these Veterans have registered with the Veterans Affairs Administrations' (VA) Airborne Hazards and Open Burn Pit Registry (AHOBPR) as part of an ongoing effort to examine, document, and understand the incidence of post-deployment illness in this population. Of note, nearly 50% of these Veterans have experienced respiratory distress or illness following deployment, which represents a substantial readiness, public health, and treatment challenge for the VA and Department of Defense. Previous studies have examined the role of environmental hazards in the etiology of these illnesses; however, few have examined the differential impact of psychological trauma and stress in exacerbating these respiratory symptoms. The present study examined the relative impact of environmental and psychological exposures on respiratory distress in post-deployment Veterans of conflicts in the Middle East and Southwest Asia. Data were obtained from the AHOBPR program and survey database ($N = 207{,}311$) and include information about the Veterans' deployment-related environmental exposures, combat exposure, emotional difficulties, and respiratory diagnoses. Multiple regressions and a likelihood ratio test were conducted to compare the predictive value of environmental factors and psychological factors on respiratory distress. The total effects of emotional difficulties on respiratory distress outperformed the total effects of all other individual variables. Additionally, the cumulative effect of the psychological aspects of

our model was a better predictor of post-deployment respiratory distress than the respiratory diagnoses. It is likely that emotional distress and hyperventilation may account for some of the diagnostic and treatment complexities in this condition. Future interventions for post-deployment Veterans with respiratory illness should address the potential role of psychological distress and hyperventilation in exacerbating and maintaining respiratory distress.

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CHAPTER 1: INTRODUCTION

Since September 11th, 2001, over 2.7 million United States Military Personnel have deployed in support of Operations Enduring Freedom, Iraqi Freedom and follow-on operations (Institute of Medicine, 2010). Of these individuals, almost 200,000 have registered for the Veterans Affairs Administrations Airborne Hazard and Open Burn Pit Registry (AHOBPR) and reported, through this program, diseases, symptoms, and negative health effects that they believe are tied to their deployment experiences (Veterans Affairs Administration [VA], 2019). The AHOBPR was created in the wake of number of case and small sample studies that highlighted the negative health outcomes observed in Veterans of modern conflicts, especially in the Middle East and Southwest Asia. While originally focused on Veterans of the OEF/OIF conflicts, the AHOBPR was expanded to include Veterans of previous conflicts, most notably the Gulf War (VA, 2019).

Early studies suggested that post-deployment respiratory illness might be etiologically related to environmental and airborne hazards more common to, or unique to, the Middle East and Southwest Asia (SWA) regions (Sharkey et al., n.d). Researchers posited that these locations might have shared environmental factors, or shared deployment conditions, that could feasibly damage the health of Service Members (Blasch et al., 2016; Sharkey et al., n.d.; Weese & Abraham, 2009). This myriad of environmental exposures will be discussed in greater detail later in this introduction; however, at this point it is important to recognize that many environmentally related etiologies for post-deployment respiratory illness have been explored in the literature, with no single factor accounting for more than a small portion of the variance in these conditions. Many of the existing studies specifically focused on the effects of airborne hazards on Veteran pulmonary illness, especially given the large number of post-deployment Veterans who complained of dyspnea, or shortness of breath, and other respiratory impairments (Blasch et al., 2016; Weese & Abraham, 2009). Of the AHOBPR Veterans, over 33% reported that they have pulmonary symptoms that began during their deployment and which they attribute to environmental hazards and exposures (VA, 2019). Almost 26% reported that they have difficulty engaging in daily activities, such as running and walking, due to a pulmonary condition (VA, 2019). These observations and Figures rightly continue to cause concern over the possible effects of deployment environmental exposures on Veteran holistic, and specifically, respiratory health.

Adding complexity to our understanding of this issue, researchers have suggested that underdiagnosed and underrecognized psychological disorders and factors may co-exist with, and exacerbate, pulmonary organic illnesses (Abdel-Hamid, 2018; Slatore et al., 2018; Wauters et al., 2019). This conversation about the role of psychological factors on post-deployment organic respiratory illness dates back to recognition of Gulf-War Syndrome and heightened emphasis on biopsychological overlap in post- deployment illness (Abraham et al., 2012; King et al, 2011; Szema et al, 2017; Wauters et al., 2019). Modern models suggest that psychological factors and illnesses can impact medical diagnosis of post-deployment respiratory illness and Veterans' health outcomes in three main ways: 1) they can mimic organic pulmonary illness, 2) they can exacerbate organic pulmonary illness, and 3) they can impact how Veterans' seek, utilize, and adhere to appropriate medical care (Abdel-Hamid, 2018; Leventhal et al., 2016; Slatore et al., 2018; Wauters et al., 2019)

Previous literature has linked medically unexplained or underexplained shortness of breath, or dyspnea, to the effects of emotional distress and psychological illness on respiration itself, sensitivity to sensations of suffocation, and other physiological processes relating to distress and anxiety (Aluis et al., 2013; Bailey, 2004; Burkhardt et al., 2010; Chenivesse et al., 2014;; Hauzer et al., 2015; Livermore et al., 2012; Slatore et al., 2018; Wilhelm et al., 2001). This research is particularly compelling because Veterans of modern wars tend to have high rates of mental illness. A meta-analysis of PTSD prevalence studies focused on OEF/OIF Veterans estimated the prevalence at 23%, which would translate to around 530,000 Veterans (Fulton et al., 2015). Similarly, 23% of veterans registered with the AHOBPR reported experiencing psychological distress that frequently interfered with their ability to complete activities of daily living (VA, 2019).

The VA has recognized that combat exposure and combat stress, alone and in combination with other deployment stressors, can cause emotional distress and psychological disorders in combat Veterans (VA, 2019). These psychological exposures are very common among Veterans registered with the AHOBPR, with at least 70% reporting events consistent with combat exposure and traumatic combat experiences (VA, 2019).

The following sections lay out the existing literature regarding the interactions between environmental, organic, and psychological factors in post-deployment dyspnea, and form the basis for a new, psychologically informed, model of post-deployment dyspnea, discussed later in this paper.

Environmental Exposures, Deployment, and Respiratory Illness

Of the 2.7 million Veterans who were deployed in support of OEF and OIF, around 1,200,000 have sought care in the Veterans Affairs Administration (VA) health system, and over 200,000 self-selected into the VA's Airborne Hazards and Open Burn Pit Registry (AHOBPR) (VA, 2019). Historically, the AHOBPR has focused on Veterans of campaigns in Iraq (Operation Iraqi Freedom) and Afghanistan (Operation Enduring Freedom). The registry has expanded its sample of Veterans of other conflicts; however these individuals still represent less than 10% of the total number of enrollees (VA, 2019). The focus on OEF/OIF is primarily due to two reasons: first, Iraq and Afghanistan are the most common post-9/11 combat deployment locations (Institute of Medicine, 2010). Second, Iraq and Afghanistan are most highly associated with burn-pits.

Burn-pits are solid-waste disposal sites that have been employed by the military to eliminate refuse from military bases in the Iraq and Afghanistan theaters of operations. These pits typically use JP-8, or jet fuel, to incinerate trash and other discarded items, including plastics, tires, and medical waste (Blasch et al., 2016; Weese & Abraham, 2009). Early Veteran concern and research into the health effects of deployments focused strongly on burn-pits, in part due to their visibility. They were often large, open-air fixtures on military bases and located a few hundred meters from living and work locations. They also gave off huge quantities of smoke and debris when in service (Blasch et al., 2016; Weese & Abraham, 2009).

The AHOBPR was originally focused on burn-pit exposure and was named the Open Burn Pit Registry (Sharkey et al., n.d.). The Burn Pit Registry was initiated in 2012, when Congress mandated research into burn-pit exposures incurred by Veterans over the course of their service in OEF/OIF. This was spurred by early research suggesting a relationship between burn-pit exposure and later disease, especially respiratory illness (Abraham & Weese, 2016). These diseases ranged from mild reactions, such as coughing, to serious and even fatal illness such as constrictive bronchiolitis and asthma (Abraham et al, 2012; King et al, 2011). The VA and Congress eventually expanded the scope of the original Open Burn Pit Registry to include other environmental hazards and renamed it to reflect this wider interest (Sharkey et al., n.d.).

Of the individuals registered with the VA's AHOBPR, 94% reported a burn-pit exposure during deployment, with many reporting multiple concomitant environmental exposures, and

60% reported direct duties involving burn-pits during their deployment (VA, 2019). Additionally, 26% percent reported that they had a lung disease that interfered with them completing their daily activities, 14.4% reported asthma, 12.8% reported chronic bronchitis, and 18.6% reported chronic multi-symptom illness (VA, 2019).

Occupational health researchers have identified causal mechanisms that provide some explanation for the relationship between environmental exposures and physical complaints and conditions following deployment. Many have noted that burn-pits specifically, and Iraq and Afghanistan military bases more generally, are associated with much higher than average concentrations of airborne particulate matter (PM) (Abraham & Weese, 2009). PM is a heterogeneous mixture of toxic and non-toxic particles that are suspended in the air, and which have been linked to lower respiratory problems, COPD, reductions in lung function, and reductions in life expectancy (Abraham & Weese, 2009). In fact, long term PM2.5 exposure, the smallest and most dangerous type of particulate matter, has been linked to a 6% increase in mortality risk (Abraham & Weese, 2009).

A subset of military members deployed to these regions, especially those co-located with burn pit sites, are exposed to levels of PM that exceed the Military Exposure Guidelines and the Environmental Protection Agency's (EPA) 24-hour criteria for PM (Abraham et al, 2012; Blasch et al., 2016; Weese & Abraham, 2009). For example, occupational medicine surveys of major military bases in Afghanistan with burn pit sites noted that PM2.5 levels exceeded 35 ug/m3, which is almost three times healthy levels, in 75% of air samples. Levels of PM10 also routinely exceeded 150 ug/m3, which is also three times the recommended limit (Weese & Abraham, 2009).

PM exposure is only one of many potential hazards associated with burn-pits and environmental factors in the Iraq and Afghanistan area (Blasch et al., 2016). Other researchers have suggested that dust storms, dust disturbed by convoy movements, fumes from fuel and other chemicals, weapons smoke, or exposures to toxic substances such as asbestos, chlorine, or sulfur dioxide could play a role in the widespread respiratory reactions observed in Veterans (King et al., 2011; VA, 2019).

Respiratory Health and Environmental Exposures

A wide range of studies have examined the link between Veteran respiratory health and environmental exposures during deployment (Abraham et al., 2012; Roop et al., 2007; Sanders et al., 2005; Sersa et al., 2017). For example, Sanders et al. (2005), noted approximately 69% of OEF/OIF Veterans in a large sample reported experiencing respiratory illness following their deployment, and 17% required medical care. A study of Swedish soldiers returning from military deployments in Afghanistan found that time deployed was positively correlated with wheeze and wheeze with breathlessness in Soldiers (Sersa et al., 2017). Abraham and Weese (2016) linked deployments in the Persian Gulf in excess of one year to a higher incidence of asthma when compared with non-deployers. Roop et al. (2007) found, in one sample of OEF/OIF Veterans, that almost 5% reported a diagnosis of asthma following their deployment. The Veterans also reported a significantly higher incidence of wheezing, sputum, cough, and chest pain/tightness when compared to non-deployers. Additionally, Szema et al. (2017) observed that 58% of Veterans reporting burn pit exposure reported general respiratory illness, with 45% reporting shortness of breath after minimal activity, 68% reporting chronic cough, and 26% reporting asthma related symptoms. Finally, in a broad analysis of military medical records examining the effects of deployment to Iraq and Afghanistan on respiratory health, Abraham et al. (2012) found that medical encounters in the military health system for obstructive pulmonary disease, including asthma and COPD, increased significantly post-deployment to Iraq and Afghanistan.

It is clear in the literature that there are numerous environmental hazards that are common to many post-deployment Veterans that could cause pulmonary illness (Blasch et al., 2016; King et al., 2011; VA, 2019). These pulmonary conditions can be incredibly impairing and can severely limit Veterans' abilities to perform their daily activities and stay active (VA, 2019). Many studies have examined the role of environmental factors on pulmonary disease, but few have considered non-pulmonary alternative or contributory diagnostic explanations for dyspnea and perceived respiratory distress (Abdel-Hamid, 2018; Slatore et al., 2018; Wauters et al., 2019). Almost none have examined the impact of psychological exposures and psychological distress on respiratory processes, despite the ubiquity of these psychological experiences in this population (Abdel-Hamid, 2018; Slatore et al., 2018; Wauters et al., 2019).

Combat Exposure and Emotional Distress

Deployments, especially to combat zones, can be profoundly distressing and traumatic, and are associated with high rates of general psychopathology and distress (Seal, 2007; Ferrier-Auerbach et al., 2010; Sheerin et al., 2018). For example, in a study conducted by Seal (2007), the researcher reviewed records from over 100,000 OEF and OIF Veterans presenting for treatment at VA facilities, and found that almost 25% had received a mental health diagnosis, and 31% had received either mental health or psychosocial diagnoses.

Beyond mere deployment, direct combat exposure and participation in combat are among the most stressful events that Soldiers can experience, especially when it involves injury, death, or handling human remains (Armstrong et al., 2014; Ferrier- Auerbach et al., 2010; Sheerin et al., 2018; Xue et al., 2015). While combat exposure tends to occur in concert with other stressors, it predicts trauma symptoms, negative affect, and arousal symptoms above and beyond other deployment related stressors (Ferrier-Auerbach et al., 2010; VA, 2019). Combat is also associated with higher levels of post-traumatic stress disorder, mental health symptom severity, and psychopathology (Armstrong et al., 2014; Seal, 2007; Sheerin et al., 2018). For example, in a sample of OEF and OIF veterans who had experienced combat, Sheerin et al. (2018) found that 69% were diagnosable with a DSM-IV-TR Axis I disorder, based on structured diagnostic interviews. The researchers noted that, in combat veterans, resilience to the consequences of combat seemed to be the exception instead of the norm.

Much of the literature regarding combat exposure focuses on PTSD and treats PTSD as a qualitatively discrete entity; however, researchers have emphasized that PTSD tends to cooccur with, and be indicative of, high levels of general emotional distress (Marshal et al., 2010; Zoellner et al., 2013). Zoellner et al. (2013) noted that PTSD shares experiences of fear, dysphoria, distress, and attention biases towards threats with anxiety disorders and depression. They also noted that dysphoria and distress seem to be a general response to frequent traumatization and hopelessness, rather than a factor that is unique to PTSD. Marshall et al. (2010) found that 8 of the 17 DSM-IV symptoms of PTSD reflect general dysphoria and psychological distress, which are trans-diagnostically related to many other mental health conditions. This is consistent with Sheerin et al.'s (2018) finding that Veterans exposed to combat had broadly elevated psychopathology profiles, across diagnoses. In this sense, combat exposure is generally related to high levels of emotional distress, with PTSD representing only one manifestation of that stress (Marshall et al., 2010; Zoellner et al., 2013).

Data from the AHOBPR shows that many, but not all, Veterans registered with the VA for environmental exposure surveillance have concomitant combat exposures (VA, 2019). As of

2019, almost 70 percent of the registered Veterans reported that they had been close enough to feel the blast of an improvised explosive device (IED) (VA, 2019). Notably, Ferrier-Auerbach et al. (2010) found that blast exposure in a combat zone predicted PTSD beyond what would be expected by combat exposure alone. They hypothesized that this could be due to IED blast exposure being associated with more severe combat exposure and traumatization, or physiological changes due to the blast. Regardless of the mechanism of action, the population of Veterans registered with the AHOBPR appear at risk for PTSD, mental health disorders, and emotional distress in addition to their pulmonary complaints. This is reflected in AHOBPR data that shows that 23% of registered Veterans experienced depression, anxiety, or emotional problems severe enough to interfere with basic activities of daily living, such as running or walking, and 82% reported insomnia (VA, 2019).

Emotional Distress and Dyspnea

The relationship between emotional distress and dyspnea is well established in the literature on specific anxiety disorders; however, dyspnea has also been shown to be more broadly related to emotional distress, anxiety, and fear (Burkhardta et al., 2010; Giardinoa et al., 2010; Hauzer et al., 2012; Slatore et al., 2018; Voogda et al., 2011; Wauters et al., 2019; Wilhelm et al., 2001). For example, emotional distress can act as an exacerbating factor when individuals have underlying physical vulnerabilities or illnesses (Aluis et al.'s, 2013; Bailey, 2004; Slatore et al., 2018; Wauters et al., 2019). Alternatively, in the absence of underlying organic respiratory pathology, severe emotional distress can lead to hyperventilation and can cause bronchoconstriction and dyspnea, which can be either acute or enduring (Chenivesse et al., 2014; Wilhelm et al., 2001). Emotional distress and anxiety also tend to be commonly recognized differential diagnoses in cases of medically unexplained dyspnea, even when that dyspnea is related to observable dysfunction and impairment (Chenivesse et al. 2014; Hauzer et al., 2012). When occurring in conjunction with organic illness, emotional distress can exacerbate dyspnea and increase patient's subjective sensations of difficulty breathing, independent of actual respiratory load (Aluis et al., 2013; Bailey et al. 2004).

The association between dyspnea and anxiety is best established in the literature on panic disorder (Burkhardta et al., 2010; Feire & Nardi, 2012; Hauzer et al., 2012; Whilhelm et al., 2001). Though panic disorder represents anxiety that is quantitatively (and likely qualitatively and etiologically) separate from more general forms of anxiety and emotional distress, research by Burkhardta et al. (2010) found an independent link between general anxiety levels and dyspnea in patients with panic disorder. This reinforces the transdiagnostic general distress concept of psychological dyspnea discussed above.

Within the panic disorder literature, one study found that during increased respiratory load, panic disorder and social anxiety patients both experienced more dyspnea and respiratory distress than controls and had a slower symptomatic and physiological recovery (Wilhelm et al., 2001). Persons with panic disorder and social anxiety also exhibited more awareness of breathing, more sigh breaths, and more breathing patterns suggestive of hyperventilation. This suggests that heightened anxiety sensitivity in both disorders may be related to psychogenic dyspnea associated with maladaptive breathing patterns and sensitivity to suffocation (Wilhelm et al., 2001).

Feire & Nardi (2012) found evidence of subclinical changes in respiration in panic disorder patients at a resting state, which contributed to dyspnea and could be triggered by environmental respiratory stimulants such as carbon dioxide. Hauzer et al. (2012) found that medically unexplained dyspnea is often accompanied by high anxiety and, specifically, panic disorder. Three factors tended to differentiate between organic and psychogenic dyspnea: verbal descriptors of air hunger, feeling depressed, and concentrating on breathing.

Other research, outside of the panic disorder field, has noted that diagnoses of depression and PTSD were associated with higher odds of receiving a diagnosis of any respiratory disease and bronchitis, specifically, but not pulmonary diseases that are more reliant on objective testing (such as Pulmonary Function Tests) (Slatore et al., 2018). Similarly, World Trade Center responders with PTSD have an increased risk of developing respiratory symptoms, and that PTSD was a better predictor of those symptoms that objective pulmonary function (Slatore et al., 2018). This suggests that emotional distress across psychiatric diagnoses, including reactions to trauma, may lead to respiratory distress, and can pose a considerable diagnostic and treatment challenge (Slatore et al., 2018).

Anxiety as an Exacerbator of Pulmonary Disease

Research has also demonstrated a moderating effect of emotional distress and anxiety on severity in organic lung disease (Bailey, 2004; Giardinoa et al., 2010; Vogelea & Leupoldt, 2008). For example, Giardinoa et al. (2010), found that anxiety was related to more severe perceptions of respiratory distress and higher emotional responses to dyspneic sensations, which increased perceptions of severity (Giardinoa et al., 2010; Vogelea & Leupoldt, 2008). These findings were echoed in Aluis et al.'s (2013) findings that high trait anxiety individuals tended to rate respiratory load tasks as more unpleasant, and reported higher levels of dyspnea than individuals with low trait anxiety. They also noted that high suffocation-fear individuals exhibited signature respiratory changes, such as increased minute ventilation, which can increase subjective distress during organic dyspnea by inducing hyperventilation (Aluis et al., 2013).

In another study, Bailey (2004) observed that dyspnea and anxiety have a cyclical relationship, with anxiety impacting perceptions of dyspnea, and being associated with more severe dyspnea as both a result and causative factor. They noted that anxiety also contributed to COPD patients' perceptions of increased shortness of breath even in non-symptomatic periods, and that the patient's anxiety-induced dyspnea and organic dyspnea interacted to increase total perceived dyspnea.

Dyspnea and Disability in Veterans

Dyspnea can be a profoundly disabling respiratory symptom, and it has been consistently demonstrated to negatively impact individuals' abilities to maintain employment and complete activities of daily living (Gruenberger et al., 2017; Ozsoy et al., 2018; Rai et al., 2017). This high level of impairment exists even when the dyspnea is identified as psychogenic or without an organic cause (Chenivesse, 2013; Gruenberger et al., 2017; Ozsoy et al., 2018; Rai et al., 2017). The disabling effects of dyspnea, in general, have been consistently demonstrated and highlighted in medical literature (Gruenberger et al., 2017; Ozsoy et al., 2018; Rai et al. 2017). For example, Ozsoy et al. (2018), found that- in a sample of patients with COPD- dyspnea, cough, and sputum, had the second highest impact on activities of daily living (ADLs) after exercise capacity. They also noted that, of dyspnea, cough, and sputum, dyspnea was most strongly related to ADLs. Specifically, within the AHOBPR, 26% of registered Veterans reported respiratory distress that caused difficulties in completing activities of daily living, including running or walking (VA, 2019).

In a cross-sectional study of individuals with COPD, Rai et al. (2017) examined factors that influenced those individuals' likelihood of holding paid employment. They found that more severe breathlessness and a higher symptom score were negatively correlated with paid employment. Additionally, they found that dyspnea was the only factor among BMI, airflow obstruction, and exercise capacity that significantly predicted unemployment. Finally, they found that individuals with a high dyspnea score were 64% less likely to hold employment than those with low scores. Subjective dyspnea predicted unemployment, while objective measures of lung functioning did not. Finally, Gruenberger et al. (2017) found that higher dyspnea ratings were associated with higher absenteeism, more reported work impairment, higher activity impairment, and more health care use.

There is more research focused on the contributory effects of psychological dyspnea on organic illness than its standalone impairment; however, hyperventilation syndrome provides a relevant example of the independent effect of psychological dyspnea on functioning. Hyperventilation syndrome (HVS) is a psychologically moderated, dysfunctional breathing disorder that causes mild to severe chronic dyspnea that has no definitive organic cause (Chenivesse et al., 2014). Importantly, a study of HVS patients found that they had lower quality of life scores, measured by the SF-36, than patients with COPD, cystic fibrosis, or asthma (Chenivesse et al., 2014). This included lower functioning scores on physical functioning, social functioning, physical roles, emotional roles, mental health, vitality, body pain, and general health (Chenivesse et al., 2014). The authors concluded that HVS, despite not having a physical origin, can be profoundly incapacitating and significantly impact quality of life, even when compared to organic lung diseases.

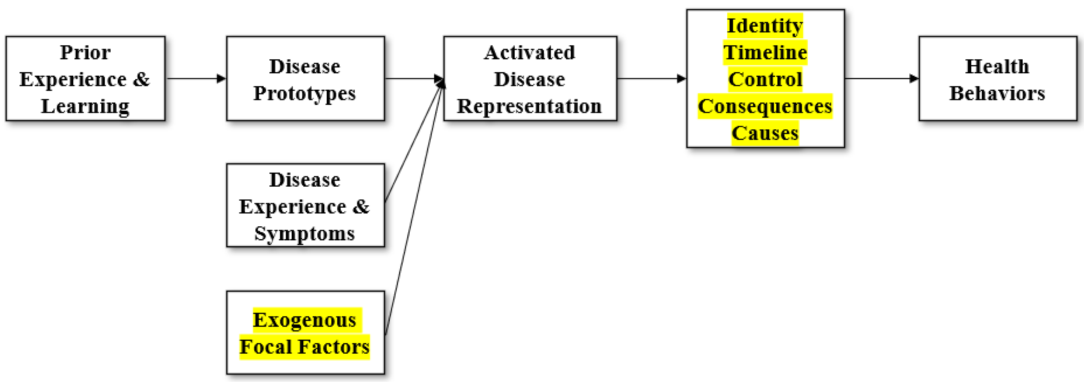
Illness Attribution

Illness attribution refers to the complex process by which individuals come to understand and represent themselves, their health, perceived symptoms, and disease (Leventhal et al., 2016). The approach to, and definition of, attribution that we employ in this paper is derived from

Leventhal and colleagues' (2016) Common Sense Model (CSM) and reflects a slight modification of the Common-Sense Model that better fits with our research question. This modified version of the CSM model is depicted in Figure 1, and an applied example of the modified model is depicted in Figure 2.

Figure 1

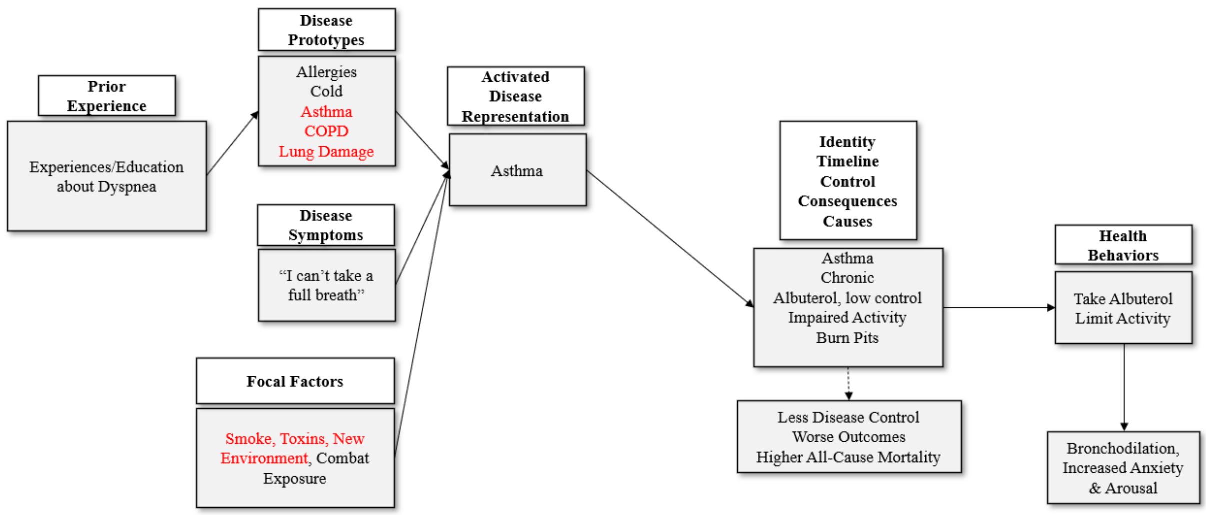
Modified CSM



Modified Common-Sense Model (CSM) : Derived from Leventhal (2016)

Figure 2

Applied Example of the Modified CSM



Modified Common-Sense Model (CSM) : Derived from Leventhal (2016)

Within Figure 1, our variable of attribution is essentially a combination of Leventhal's (2016) exogenous influencers on disease representation construction (focal factors) and five subcomponents of illness representation (identity, causes, timeline, control, and consequences).

In Leventhal's model, when an individual experiences a symptom, or a deviation from the normal self-prototype, they compare that new experience against a bank of prior experiences with illness, and form a representation, or context- specific mental model, of the new disease symptoms and experience (Leventhal et al., 2016). Disease symptoms and exogenous factors may interact with multiple illness prototypes (such as chest pain being associated with both heartburn and heart attacks) to determine illness representation, and representations are never constructed without context clues that allow the individual to determine which prototype should be activated into a representation (Leventhal et al., 2016). Depending on these interactions, representations can be clear or ambiguous, accurate and inaccurate, and appropriate or inappropriate (Leventhal et al., 2016). Figures 1 and 2 illustrate this process. When an individual experiences physical symptoms, they compare those symptoms against a storehouse of experiences and knowledge about disease, to determine which disease prototypes best explain those symptoms (Leventhal et al., 2016). This process interacts with the environment and with salient environmental cues that prime the individual to interpret symptoms as being more likely to be related to certain prototypes over others (Leventhal et al., 2016). For example, an individual who starts coughing might be more likely to activate their prototype for a cold, as opposed to allergies or pneumonia, if they were recently coughed on by someone with a cold. Once this process is complete, the individual activates the perceived highest likelihood prototype, which becomes an illness representation. Representations determine health behavior, or how the individual treats or copes with their illness, through five main dimensions: identity, causes, timeline, control, and consequences (Leventhal et al., 2016). Identity refers to the label, often a disease name, the individual uses to describe their symptoms. Causes refer to what the individual believe caused, or led to, their disease state or symptoms. Timeline refers to the expected duration and progression of the disease. Consequences refers to the expected functional and biological effects of the disease process. Finally, control refers to the amount of control over the symptoms and disease that the individual feels they have, including the expected efficacy of medications and interventions (Leventhal et al., 2016).

The flow and results of these processes are depicted in Figure 2.

Our concept of attribution, as used in this study, is a combination of exogenous focal factors and the five dimensions of illness representations. When this paper refers to attribution, it is referring to the process by which individuals select between potential disease prototypes by looking for salient cues in their environment (e.g. a friend coughing), and determine whether those cues might explain their symptoms. The cues that the individual focuses on then influence the activated disease representation, which in turn decides how the individual understands the label, causes, level of impact, and potential treatments for their illness. Importantly for the current study, if an individual develops an erroneous or incomplete attribution for their illness or symptoms, then they will conceptualize the disease's label, causes, level of impact, and potential treatments incorrectly.

Studies have noted the danger of patients having and reacting to erroneous attributions for disease (Darr et al., 2008; Nijrolder et al., 2015; Roesch et al., 2010). For example, Darr et al. (2008) found that when patients attributed coronary heart disease to genetic, rather than lifestyle or personal, factors, they tended to be less likely to seek appropriate treatment and take steps to control their illness through lifestyle modifications (Darr et al., 2008). Attribution can affect how, and how effectively, and individual responds to symptoms, such as with the paradoxical exacerbating effects of maladaptive compensatory over-breathing in chronic hyperventilation (Abdel-Hamid, 2018). These responses can be very hard to inhibit without compelling alternative explanations because internal somatic sensations can partially reinforce the maladaptive behavior (Abdel-Hamid, 2018).

Nijrolder et al. (2015) tied erroneous causal representations to worse patient outcomes, regardless of treatment seeking and adherence, noting that patients with fatigue who reported a physical, as opposed to a psychosocial, causal representation tended to have longer duration fatigue and fewer feelings of personal control. Concerningly, they also found that patient causal representations after an initial consultation with a health care professional tended to differ from the healthcare professional's causal representations of their condition in 34% of cases (Nijrolder et al., 2015). This suggests that patients may hold develop and hold strong erroneous causal representations even when providers do not provide a cause or differ in their causal representations (Nijrolder et al., 2015). Finally, there is evidence that individuals who believe their health functioning is impaired, regardless of the actual level of impairment, are at a higher risk of mortality (Zvolensky, Schmidt & Stewart, 2003).

Proposed Model

Although some studies have examined the potential that psychological comorbidities could impact the rates and severity with which Veterans report post-deployment dyspnea (see Wauters et al., 2019), to date there has not been a systematic study examining the relative and combined impact of psychological exposures and environmental exposures on post-deployment dyspnea and related life outcomes- such as activity level and maladaptive coping. Additionally, there have not been any models developed to help describe and explain the mechanisms of medically unexplained and underexplained dyspnea in post-deployment Veteran populations. Finally, there have not been models examining the effects of Veteran attribution on symptoms, treatment seeking, and outcomes. Figure 3 is an attempt to address many of these difficulties. It combines a psychological model of dyspnea (Figure 3, psychological wing), a general pulmonary disease model (Figure 3, organic wing), and a model of the potential role of attribution. Taken together, it helps to provide a general structure to examine and pull apart the causal links between physiological and psychological exposures and their effects on respiration and dyspnea.

Figure 3

Combined Model of Post-Deployment Dyspnea

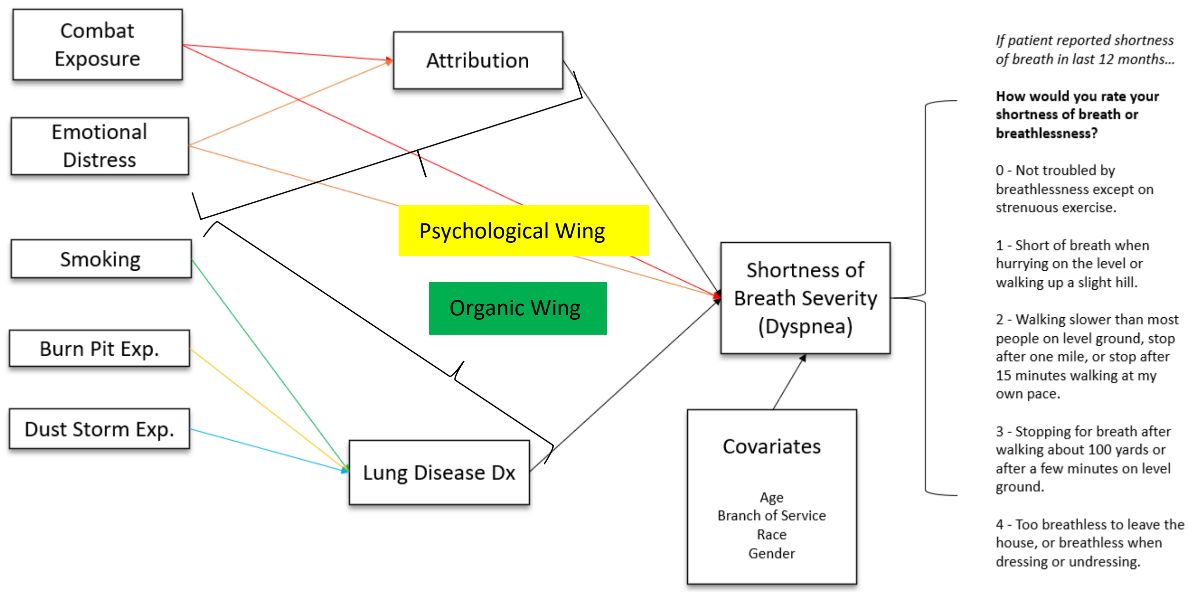


Figure 3 visually depicts how combat exposure and environmental exposures during modern deployments could potentially work, independently and in tandem, to cause or exacerbate dyspnea in Veterans. The two paths to dyspnea, psychological and organic, interact additively to determine overall perceived dyspnea (Bailey, 2004; Livermore et al., 2015; Vogele and Leupoldt, 2008; Voogd et al., 2011). This total perceived dyspnea, as a coherent experience, impacts various outcomes such as limitations in daily activities and quality of life (Bailey, 2004; Livermore et al., 2015; Vogele and Leupoldt, 2008; Voogd et al., 2011). The association between dyspnea and ADL limitations is well established in the literature, and these are partially captured within the shortness of breath outcome variable (Bailey, 2004; Livermore et al., 2015; Vogele and Leupoldt, 2008; Voogd et al., 2011).

Attribution plays a crucial role in influencing the relationship between emotional distress, combat exposure, and dyspnea (Gil-Lacruz and Gil-Lacruz, 2010; Leventhal, Phillips, and Burns, 2016; Livermore et al., 2015; Livermore et al., 2012; Nickel and Spink, 2010). Attribution, in this model, refers to how much Veterans conceptualize their symptoms as enduring, organic disease processes (e.g. COPD or asthma) as opposed to modifiable, psychological factors, like post-traumatic stress or anxiety. The model specifies that, if their attention is focused on respiratory dangers and exposures, Veterans may be more likely to experience ambiguous, overlapping biopsychological symptoms of both processes- such as chest tightness, tight throat, choking, or hyperventilation -as respiratory symptoms. Additionally, if Veterans misattribute a part or the whole of their symptoms to enduring organic causes and ignore psychological factors, they may seek out inappropriate care, inappropriate levels of care, and have worse outcomes (Leventhal et al., 2016; Livermore et al., 2015; Nickel & Spink, 2010). Of note, this process could also occur in the reverse direction, with respiratory symptoms being interpreted as anxiety and being medically treated as such (Bailey, 2004). The current literature would suggest that this inverse faulty attribution would be less likely due to the prevalence of objective tests for lung disease, and the mental availability of medical (organic) heuristics for medical professionals (Chenivesse et al., 2014; Slatore et al., 2018). As such, it is important to note that the relationship between anxiety and dyspnea is bidirectional, but individuals' attributions are more likely to error towards underweighting psychological contributors.

Attributions can lead to a negative feedback loop in which symptoms are exacerbated through both internal and external attempts at symptom reduction. For example, compensatory breathing can lead to hyperventilation, and anxiogenic medications such as albuterol can paradoxically worsen psychogenic respiratory distress (Bailey, 2004; Chenivesse et al., 2014; Hauzer et al., 2015; Leventhal et al., 2016). On the other hand, if Veterans and their providers can separate out and appropriately treat the relative impact of psychological and physical contributors to dyspnea, Veterans may have more positive outcomes (Leventhal et al., 2016; Livermore et al., 2015; Zvolensky, Schmidt, and Stewart, 2003).

Historically, we have struggled to effectively care for Veterans with complex illnesses. It has become far too common for providers to simply accept high levels of chronic impairment and distress in Veteran populations without seriously examining the complicated and overlapping contributors to that dysfunction (Abraham et al., 2012; King et al., 2011; Sharkey et al., 2017; Slatore et al, 2019; Szema et al., 2017).

Aims & Hypotheses

The broad goal of the present study was to provide a more refined understanding of the influences of various potential mechanisms on post-deployment respiratory illness. Specifically, this study examined the differential predictive utility of psychological and organic predictors of dyspnea to determine whether psychological predictors play an important role in determining post-deployment shortness of breath severity (aim 1). Based on the literature regarding psychological influences on dyspnea, we hypothesized (hypothesis 1.a.) that individual psychological variables (e.g. emotional distress) would explain as much variance in shortness of breath as organic variables (e.g. burn pit exposure).

Moving up one level, we also predicted (hypothesis 1.b.) that theoretically driven groupings of psychological variables, or sub-models, (see Table 2) will be better predictors of shortness of breath than groupings of organic variables, or sub-models (see Table 2).

Finally, we examined whether a statistical grouping of all of the psychological factors (Figure 3, labeled “psychological wing”) would explain more variance in post-deployment shortness of breath than the grouped environmental and organic factors (Figure 3, labeled “organic wing”). We predicted (hypothesis 1.c.) that the model’s psychological wing would explain an equivalent amount of variance in post-deployment shortness of breath as the model's organic wing.

We worked up from the lowest level of prediction, with each variable predicting shortness of breath as a singular predictor variable, to more complex combination effects, and finally to comparisons of the "wings" as entire constructs. This progression of hypotheses are depicted in Table 1, below.

Table 1

Aims & Hypotheses for Current Study

Hypothesis	Description	Predictor Type	Predictors	Outcome
Hypothesis 1a:	Combat exposure and emotional distress will be comparable to lung disease dx and environmental exposures as predictors of shortness of breath.	Psych	Emotional Distress	Dyspnea Severity
		Psych	Combat Exposure	Dyspnea Severity
		Organic	Lung Disease	Dyspnea Severity
		Organic	Burn Pit Exposure	Dyspnea Severity
		Organic	Dust Storm Exposure	Dyspnea Severity
		Organic	Smoke Years	Dyspnea Severity
		Control	Covariates (*Age, Race, Gender, Branch*)	Dyspnea Severity
Hypothesis 1b:	Groupings of psychological variables, or sub-models, (*see Table 2*) will be better predictors of shortness of breath than groupings of organic variables, or sub-models (*see Table 2*).	Psych	Sub-model P.1.a	Dyspnea Severity
		Psych	Sub-model P.1.b	Dyspnea Severity
		Psych	Sub-model P.2	Dyspnea Severity
		Organic	Sub-model O.1.a	Dyspnea Severity
		Organic	Sub-model O.1.b	Dyspnea Severity
		Organic	Sub-model O.1.c	Dyspnea Severity
		Organic	Sub-model O.2	Dyspnea Severity
Hypothesis 1c:	The psychological wing of the model will be a better overall predictor of shortness of breath than the organic wing.	Psych	Psychological Wing (*from Figure 3*)	Dyspnea Severity
		Organic	Organic Wing (*from Figure 3*)	Dyspnea Severity

Table 2

Hypothesis 1.b.: Sub-Models Tested

Sub-Model	Type	Included Predictors (#)	Outcome
P.1.a	Psychological	Emotional Distress, Attribution (2)	Dyspnea Severity
P.1.b	Psychological	Combat Exposure, Attribution (2)	Dyspnea Severity
P.2	Psychological	Emotional Distress, Combat Exposure, Attribution (3)	Dyspnea Severity
O.1.a	Organic	Burn Pit Exposure, Lung Disease Dx (2)	Dyspnea Severity
O.1.b	Organic	Dust Storm Exposure, Lung Disease Dx (2)	Dyspnea Severity
O.1.c	Organic	Smoke Years, Lung Disease Dx (2)	Dyspnea Severity
O.2	Organic	Burn Pit Exposure, Dust Storm Exposure, Smoke Years, Lung Disease (4)	Dyspnea Severity

CHAPTER 2: METHODS

Design

The current study is a retrospective correlational examination of previously collected data. The data was collected between 2014-2020 as part of the ongoing AHOBPR program. The VA Post-Deployment Health Services provided the data to the research team as part of a data-sharing agreement between the VA and the Uniformed Services University.

Participants

The study drew participants' data from the VA's AHOBPR registry, through a data sharing agreement with the VA Post-Deployment Health Services. Participants were recruited by the VA for the AHOBPR through encounters with the VA medical system, through outreach programs to Veterans, and through information campaigns via the internet, among other methods. In total, the AHOBPR included the responses of 211, 217 Veterans. Of the data available in the AHOBPR, we requested and received deidentified participant responses to 60 unique variables. To focus our analysis on Veterans of conflicts in the Middle East and Southwest Asia regions, we removed data from participants who were aged 60 and older. This cutoff was determined by adding the difference between the last year the United States had a substantial presence in Vietnam (1972) and the AHOBPR creation date (2014) to the minimum draft age during the Vietnam War (18). This effectively removed any participants whose primary service could have occurred in conflicts including and prior to the Vietnam War. This dropped 3,916 records, or 1.5% of the total data, leaving 207, 301 participants who were included in our analyses. Of these participants, 8% self-identified as Veterans of the Gulf War (1990-1991).

Selection Procedures

Participants self-selected into the burn-pit registry data by completing an online form provided by the VA on their public health website (VA, 2019). Veterans first had to have participated in a deployment to a location that was associated with active burn-pits or other airborne and environmental hazards. Of included Veteran records, 88% had been deployed to a location where they had been exposed to burn pits. The remainder may have deployed during the Gulf War or other operations recognized by the VA as being associated with airborne hazards. The majority of deployment locations were bases in the Iraq and Afghanistan theaters of operations. After returning from these deployments, the Veterans had the opportunity to register any symptoms and complaints with the registry by signing up with the Veterans Affairs Administration. After registering, they were given the opportunity to provide data for the registry through voluntary online data entry.

Inclusion criteria for the AHOBPR included a deployment to one of the countries or theaters recognized by the VA as being associated with burn pits and/or environmental hazards (e.g. dust storms) (VA, 2019). There were no exclusion criteria for providing data to the registry. For our analyses, we excluded participants who were aged 60 or older to focus our analyses of Veterans who served in the period including and following the Gulf War and would have primarily been exposed to hazards common to the Middle East and Southwest Asia.

Sample Size

To determine the required number of participants for the study, a power analysis was conducted. G*Power 3.1.9.4 was used for all power calculations with the following assumptions: the analysis assumed fifteen multiple linear regressions, f^2 effect size= .02, adjusted α=.0033, and power =.80. The α value was computed using a Bonferroni Correction to adjust for pairwise α

inflation across multiple comparisons. The power analysis revealed a required sample size of 1,309 participants per analysis for our baseline covariate model, 1,349 participants for regressions with one predictor variable, 1,388 participants for regressions with two predictor variable (5/15 total analyses), 1,495 participants for regressions with five predictor variables (1/15 total analyses), 1,528 participants for regressions with six predictor variables (1/15 analyses), and 1,560 participants for regressions with seven predictor variables (1/15 analyses). Across analyses, this meant our required sample was 20,926 participants. We also conducted a power analysis for our Akaike Information Criteria goodness of fit comparison, which assumed four goodness of fit analyses with w effect size= .10, between 3 and 14 degrees of freedom, and power =.80. The analysis revealed a required sample size of 5,904. In total, this meant our required sample size was 26,830. Our sample included 207,301 participants for an actual power that was statistically approximate to one.

Measures

Registrants with the AHOBPR complete a series of questions related to their service, deployment, and exposure history. This questionnaire is available to registering Veterans digitally on the VA's website. The questions requested for our analyses are listed in Appendix A.

Predictor Variables

For the current study, we focused on five main variable groups, which directly corresponded to the questions and constructs from the original survey.

Combat Exposure

For combat exposure, we utilized the combat smoke question as a proxy (q. 1.2.A), "In a typical month, how many days were you near heavy smoke from weapons, signal smoke, markers, or other combat items?" The relative frequencies of responses to this question lent support to this question as a reasonable proxy for combat exposure, with 39% of participants reporting no exposure, 61% reporting some exposure, and 30% of those reporting some exposure reporting daily, or heavy, exposure.

Emotional Distress

For emotional distress, we took the veteran's binary response to a question asking whether they had experienced a mood/anxiety/or other psychological problem that impacted their ability to conduct their activities of daily living (see appendix 1 for question text).

Attribution

In terms of attribution, we operationalized this as self-reported concern that something the Veteran *breathed* affected their health with the following response options: *0- not at all concerned, 1- a little concerned, 2- very concerned* (see appendix 1 for question text). This operationalization reflected our understanding and usage of the concept as discussed in the introduction & Leventhal et al (2016).

Organic/Enviornmental Exposures

For the organic wing of the model, we utilized the exposures that had the strongest literature support: burn pit exposure, dust storm exposure, and year spent smoking (Abraham et al, 2012; Blasch et al., 2016; King et al., 2011; Weese & Abraham, 2009). In terms of burn pit exposure, we took the average number of hours per day that the Veteran was exposed to burn pit smoke during their highest exposure deployment. Dust storms were measured as average number of days per month that the Veterans were exposed to dust storms. Finally, we included the number of years each Veteran reported having smoked as the final environmental variable due to its well-established relationship with shortness of breath and lung disease (see appendix 1 for question text).

Lung Disease

To capture the influence of respiratory illness in our model, we utilized the presence or absence of a self-reported, diagnosed disabling lung disease after deployment.

Covariates

For covariates, we controlled for participant age, sex, branch, and race across analyses. This data was self-reported by AHOBPR registrants.

Outcome Variable

Shortness of Breath (Dyspnea) Severity

Finally, for the outcome variables, we used the Veterans' shortness of breath severity over the last year, which was a self-reported average score rated from 0-4. A score of *0* indicated that the veteran was not troubled by breathlessness outside of normative situations; *1* indicated that they were short of breath hurrying on the level or walking up a slight hill; *2* indicated that they were walking slower than most people on level group, or had to stop at 1 mile or 15 minutes at their own pace; *3* indicated that they were stopping for breath after walking about 100 yards; and *4* indicated that they were too breathless to leave the house, or breathless while dressing or undressing. This operationalization of shortness of breath severity included a subsumed estimate of difficulty in activities of daily living.

Procedures

The current study utilized pre-existing data collected by the VA as part of the AHOBPR program between 2014 and 2020.

Participants were recruited for the study through the VA's public health website (VA, 2019). Veterans completed a demographics questionnaire, and then were asked to complete a series of questions regarding their exposures, medical history, functional limitations, and attributions. These data were compiled by the Veterans Affairs Administration's Post-Deployment Health Services office.

We requested the study data directly from the VA Post-Deployment Health Services office and were granted permission to receive a de-identified data subset from the AHOBPR database. The data was transferred to the researcher via a secured file transfer system. All analyses were conducted using STATA statistical software.

Data Analyses

For hypothesis 1a we conducted six multiple regressions with one predictor variable and four control variables. All regressions controlled for potential demographic confounders. These analyses are depicted in Table 3.

For hypothesis 1b we conducted seven multiple regressions, compared the adjusted R-squared values for each sub-model, and measured the eta-squared effect size of each individual variable to determine which of our groupings of variables had the greatest impact on shortness of breath. Lastly, we examined our full, combined model as a predictor of shortness of breath. All analyses controlled for potential demographic confounders. These analyses are depicted in Table 3.

For hypothesis 1c, we utilized a series of Akaike Information Criteria analyses to examine differences in relative goodness of fit between the regression model for our psychological wing (see Figure 3), our organic wing, and our psychological & organic wings with demographic covariates added. The AIC comparison avoids model fit inflation due to model overfit by statistically penalizing models for increasing number of variables. Smaller AIC values indicate a better fitting model, and all values are corrected against the number of parameters estimated in the model. This prevents overfit models from having artificially preferential AIC values. AIC values were calculated using the *fitstat* module in STATA 16.1. This analysis is depicted in Table 3. For a review of the AIC criteria see Field's (2018) discussion of measures of goodness of fit and model comparison.

Table 3

Data Analysis Plan

Hypothesis	Analyses	Predictor Type	Predictors	Outcome
Hypothesis 1a:	Multiple Regression controlling for covariates	Control	*Covariates (Age, Race, Gender, Branch)*	Dyspnea Severity
		Psych	Emotional Distress	Dyspnea Severity
		Psych	Combat Exposure	Dyspnea Severity
		Organic	Lung Disease	Dyspnea Severity
		Organic	Burn Pit Exposure	Dyspnea Severity
		Organic	Dust Storm Exposure	Dyspnea Severity
		Organic	Smoke Years	Dyspnea Severity
Hypothesis 1b:	Multiple Regressions of Sub-Models controlling for covariates	Psych	Sub-model P.1.a	Dyspnea Severity
		Psych	Sub-model P.1.b	Dyspnea Severity
		Psych	Sub-model P.2	Dyspnea Severity
		Organic	Sub-model O.1.a	Dyspnea Severity
		Organic	Sub-model O.1.b	Dyspnea Severity
		Organic	Sub-model O.1.c	Dyspnea Severity
		Organic	Sub-model O.2	Dyspnea Severity
		All	*Full Model*	Dyspnea Severity
Hypothesis 1c:	The psychological wing of the model will be a better overall predictor of shortness of breath than the organic wing.	Psych	Psychological Wing (*from Figure 3*)	Dyspnea Severity
		Organic	Organic Wing (*from Figure 3*)	Dyspnea Severity

CHAPTER 3: RESULTS

Demographics

The sample demographics are depicted in Table 4, below. In total, 86% of our sample was male, 11% was female, and 4% did not provide information regarding their sex. The majority of our participants, 56%, were white, 11% were Black or African American, 9% were Hispanic, and all other races accounted for around 1-2% of the sample, each. Notably, 21% of participants declined to provide information regarding their race.

The majority of our sample had served with the US Army during their term of service. Around 60% reported having served in the Army, with the next largest reported branches being the Air Force and Marines with 21% and 11% respectively. Finally, the majority of our participants were between the ages of 31 and 59, with a mean age of 39 years old at time of registration with the AHOBPR.

Table 4

Sample Demographics

Characteristic	Characteristic Categories	Sample # (Percent)
Sex	Female	21,688 (10.5%)
	Male	177,770 (85.8%)
	Declined to Answer	7,843 (3.8%)
Race	White	114,966 (55.5%)
	Black	21,999 (10.6%)
	Asian	3,606 (1.7%)
	Pacific Islander or Native American	3,262 (1.6%)
	Hispanic	17,611 (8.5%)
	Multiple Races	2,469 (1.2%)
	Declined to Answer	43,388 (20.9%)
Branch (at Time of Service)	Army	123,439 (59.5%)
	Navy	15,427 (7.4%)
	Air Force	44,280 (21.4%)
	Marines	23,416 (11.3%)
	Other	739 (0.3%)
Age	18-25	4,170 (2.0%)
	26-30	20,266 (9.8%)
	31-40	73,991 (35.7%)
	41-59	81,033 (39.1%)
	Unknown	27,841 (13.4%)

In terms of self-reported environmental exposures and psychological factors, most Veterans reported multiple deployment related environmental exposures. A smaller number reported psychological distress and combat exposure. These results, as well as other characteristics of the sample, are depicted in Table 5.

Table 5

Other Participant Characteristics

Characteristic	Characteristic Categories	# (Percent) of Sample
Combat Exposure	Heavy	62, 550 (30%)
	Some	64,598 (31%)
	None	80,153 (39%)
Disabling Psychological Distress/Condition	Yes	44,066 (22%)
	No	163,235 (78%)
Smoking Status	Never Smoker	151, 486 (73%)
	Smoker	55,815 (27%)
Reported Environmental Exposures	Burn Pit Smoke Exposure (any)	158,888 (77%)
	Dust Storm Exposure (any)	172,017 (83%)
Reported Respiratory Symptoms/Concerns	Shortness of Breath	95,193 (46%)
	Respiratory Diagnosis following Deployment	45,042 (22%)
	Current Health Concerns Due to Deployment	191,913 (93%)
	Difficulty with Short Walk (past year)	95,217 (46%)
	Difficulty Climbing Stairs (past year)	138,529 (67%)
	Difficulty Jogging or Running (past year)	175,549 (85%)

In terms of tobacco, 73% identified as never-smokers and 27% identified as having smoked during their lifetime. Among smokers, the average number of years spent smoking was 14.

For combat exposure, combat smoke exposure was used as a proxy due to the AHOBPR's emphasis on environmental and occupational variables over psychological variables. Among the AHOBPR veterans, 39% reported having no exposure to heavy smoke from weapons, signal smoke, markers, or other combat items in a typical month, while 31% reported some exposure, and 30% reported being exposed daily during their deployment. The mean exposure was 11 days in a typical 31-day month.

In terms of psychological conditions, 22% of respondents endorsed having a depressive, anxiety, or emotional condition that affected their ability to do basic tasks of living.

Hypothesis 1a: Single Predictor Regressions

The results of the regression analyses and relationships for individual predictor variables to shortness of breath severity are depicted in Table 6. We also examined the relationships of our covariates, age, race, gender, and branch, to shortness of breath severity. The covariates were formally controlled for in our multiple regression analysis (hypothesis 1.b.). Our covariates were significantly related to shortness of breath severity in our analyses for hypothesis 1.a., but only had a negligible effect on shortness of breath severity when combined with the additional model variables in our analyses for hypothesis 1.b.

Table 6

Relationship between individual Predictors and Shortness of Breath

Type	Predictor Variable	Outcome Variable	R^2	A. R^2	F-value	Std. Beta
Control	Covariates	Dyspnea Severity	0.044	0.043	941.85*	(2)
Psych	Emotional Distress	Dyspnea Severity	0.099	0.099	2079.27	0.242*
Psych	Combat Exposure	Dyspnea Severity	0.073	0.073	1493.67	0.179*
Organic	Burn Pit Exposure	Dyspnea Severity	0.062	0.062	1255.39	0.138*
Organic	Dust Exposure	Dyspnea Severity	0.066	0.066	1321.10	0.150*
Organic	Smoke Years	Dyspnea Severity	0.047	0.047	925.07	0.059*
Organic	Lung Disease	Dyspnea Severity	0.111	0.111	2353.51	0.263*

*Note: (1) * denotes $p<.0031$, corrected (Bonferroni) significance value, (2) Beta not provided for covariates, (3) Effect sizes only reported for hypothesis 1.b. due to conflation of Adj R^2 and partial η^2 for single predictor models.*

The baseline covariate model accounted for about 4.4% of the overall variance in shortness of breath across age, sex, branch, and race (see Table 6 note 3) (Adj R^2= 0.044). Six multiple regressions were calculated to examine the relationships between the predictor variables depicted in Table 6 and dyspnea severity. All equations were controlled for demographic variables. All tested predictor variables had a $p < .0033$ for their beta values, suggesting a significant relationship with the outcome variable and improvement on the control regression. Emotional distress predicted about 5.5% of unique variance in shortness of breath severity with an R^2 of 0.099. Combat exposure predicted 2.9% of unique variance in shortness of breath with an R^2 of 0.073. Post-deployment lung disease predicted 6.8% of unique variance in shortness of breath with an R^2 of 0.111. Of note, emotional distress and post-deployment lung disease only differed by about 1% of total variance explained, with lung disease being a slightly better predictor of shortness of breath. To test what portion of this variance was unique to emotional distress and not shared with lung disease, we conducted a follow-on hierarchal multiple regression. The addition of emotional distress significantly improved the model fit, ($p= 0.000$) and resulted in a 4.5% increase in unique shortness of breath variance predicted over lung disease alone. This suggests that emotional distress and lung disease only predict about 1% shared variance in shortness of breath severity, and emotional distress predicted about 4.5% unique variance in shortness of breath severity.

Burn pit exposure ($R^2 = 0.062$), dust storm exposure ($R^2 = 0.066$), and smoke years ($R^2 = 0.047$) predicted between 0.3% and 2.2% of variance in shortness of breath. Years spent smoking only predicted about 0.3% of the variance in post-deployment shortness of breath severity, when controlling for demographic factors.

Hypothesis 1b: Multiple Regression Analyses

We conducted eight multiple regressions to determine the effects of emotional distress, combat exposure, and environmental exposures on shortness of breath when attribution and lung disease were added to the psychological and organic portions of the model (Figure 3), respectively. Environmental exposure was broken into burn pit exposure, dust storm exposure, and years smoking. Attribution was added to emotional distress and combat exposure as a predictor of shortness of breath. Lung disease was included between environmental exposures and shortness of breath. Rank, age, race, and gender were included as covariates in all regressions to control for potential demographic confounders. The results are depicted in Table 7.

Table 7

Relationship Between Grouped Model Components and Shortness of Breath

Var. Examined	Predictors	Outcome	Adj. R^2	Std. Beta (Full Model)	η^2 Effect Sizes (Full Model)
Sub-Model P.1.a.	Combat Exposure, Attribution	Dyspnea Severity	0.158*	n/a	n/a
Sub-Model P.1.b	Emotional Distress, Attribution	Dyspnea Severity	0.178*	n/a	n/a
Sub-Model P.2	Emotional Distress (ED), Combat Exposure (CE), Attribution (AT)	Dyspnea Severity	0.186*	*b* (ED)= 0.161 *b* (CE)= 0.067 *b* (AT)= 0.228	η^2 (ED)= 0.030 η^2 (CE)= 0.005 η^2 (AT)= 0.051
Sub-Model O.1.a.	Burn Pit Exposure, Lung Disease	Dyspnea Severity	0.126*	n/a	n/a
Sub-Model O.1.b.	Dust Storm Exposure, Lung Disease	Dyspnea Severity	0.128*	n/a	n/a
Sub-Model O.1.c.	Smoke Years, Lung Disease	Dyspnea Severity	0.113*	n/a	n/a
Sub-Model O.2.	Burn Pit (BP), Dust Storm (DS), Smoke Years (SY), Lung Disease (LD)	Dyspnea Severity	0.139*	*b* (BP)= 0.033 *b* (DS)= 0.052 *b* (SY)= 0.038 *b* (LD)= 0.187	η^2 (BP)= 0.001 η^2 (DS)= 0.004 η^2 (SY)= 0.002 η^2 (LD)= 0.042
Full Model Equation	All Predictors	Dyspnea Severity	0.225*	n/a	n/a

*Note: (1) * denotes $p<.0033$, (2) Partial η^2 effect sizes small:0.01, medium: 0.06, large: 0.14 (3) all analyses controlled for demographic covariates*

To summarize Table 7, we broke each aspect of the model depicted in Figure 3 into sub-models that consisted of groupings of like variables and examined the predictive value of those sub-models for our outcome variable, shortness of breath (dyspnea) severity. We compared the adjusted R^2 values of these sub-models with various configurations to determine which groupings of variables explained the most variance in shortness of breath, compared to the other groupings. Finally, we conducted a multiple regression with all of the components included, and we computed beta and η^2 values for each individual component within the full model. We expected that more influential sub-models would explain more variance in shortness of breath, and their component Predictors would retain a higher effect size even when controlling for all other Predictors in the final multiple regression.

When considered together, emotional distress and attribution explained about 13% of unique (over demographics) variance in shortness of breath severity, (Adj R^2= 0.178). Combat exposure and attribution explained about 16% of unique variance in shortness of breath severity (Adj R^2=0.158). Dust storm exposure levels and lung disease together explained about 8% of unique variance in shortness of breath severity (Adj R^2=0.129). Years spent smoking and lung disease explained about 4% of unique variance in shortness of breath severity (Adj R^2=0.113). Burn Pit exposure levels and lung disease explained about 8% of unique variance in shortness of breath severity (Adj R^2=0.126).

If we move one step up in the model, emotional distress, combat exposure, and attribution together explained 14.2% of unique variance in shortness of breath (R^2=0.186). Burn pit exposure, dust storm exposure, years spent smoking, and lung disease together explain 9.5% of unique variance in shortness of breath severity, R^2=0.139.

Looking at the entire model all the variables predict about 22.5% of the variance in shortness of breath severity F (19, 207, 281) = 3173.06, R^2= 0.225.

To sum, the emotional distress together with attribution explained the most variance in shortness of breath of any individual piece of our model and predicted around 4% more variance in shortness of breath severity than burn pit exposure, dust storm exposure, number of years spent smoking, and diagnosed lung disease, even with the latter's possible R^2 inflation. Combat exposure with attribution predicted about 2% more variance in shortness of breath severity than the same organic variable combination.

Looking at the full model and the component η^2 values, attribution had the largest individual effect on shortness of breath severity of any of the predictor variables, with η^2=0.051, or a small effect size. Lung disease had the next largest effect at η^2=0.042, or a small effect size. The third largest effect size was emotional distress with η^2=0.030, or a small effect size. Since our attribution variable was tied to service members' concern that something they breathed affected their health (see chapter 2, subsection: variables and appendix A), we examined the relationship between lung disease and attribution. Our model would suggest that higher levels of concern about pulmonary health (attribution) could exacerbate shortness of breath through its bidirectional, dual relationships with emotional distress and shortness of breath (see Chapter 1: subsection proposed model). Our model also assumes that attribution would not affect the impact of organic lung disease on shortness of breath, and would be independent from lung disease (e.g. more concern not simply being a result of worse lung disease). To test this assumption, we examined the relationship between lung disease (binary variable) and attribution (which was a continuous variable). The presence of lung disease was significantly related to higher levels of attribution (R^2= 0.06, *b*= .242, p=0.000); however, lung disease only accounted for 6% of the variance in attribution, supporting our model assumptions, and reinforcing the unique importance of the strength of the emotional distress *plus* attribution relationship with dyspnea.

To check whether the effect of emotional distress on shortness of breath severity could be explained by the effects of lung disease on emotional distress, we tested the relationship between lung disease and emotional distress when controlling for demographics. The results showed a significant relationship, but lung disease only predicted about 5% of the variance in emotional distress, with about 76% of that shared variance being unique and not better explained by demographics. In terms of η^2, the effect of lung disease on emotional distress did not rise to the level of a small effect and was considered negligible. Finally, we conducted a regression comparing the η^2 effect sizes of emotional distress and lung diagnosis on shortness of breath, controlling for demographics. Both had a small effect (η^2(ED) =.050, η^2 (LDx)=.062) on shortness of breath, and neither effect was subsumed by the other. Based on these findings, we concluded that that the relationship between emotional distress and shortness of breath was not being confounded by covariance in emotional distress and lung disease.

In total, our results were consistent with hypothesis 1.b. When we grouped our variables according to our model, emotional distress with attribution and combat exposure with attribution were stronger predictors of shortness of breath than any of the environmental exposures with self-reported diagnosed lung disease. The psychological sub-models out predicted the organic ones, across all configurations. This suggests that the various possible groupings of the psychological variables within our model have a stronger overall effect on shortness of breath severity than the groupings of organic variables. To formally test the significance of the difference between the predictive value of the psychological wing (Figure 3) of our model and the predictive value of the organic wing (Figure 3) we conducted an AIC comparison of the significance of these differences for hypothesis 1.c. (see Chapter 2: Data Analysis).

Hypothesis 1c: AIC Comparison & Wing Goodness of Fit

To test hypothesis 1.c. and determine whether the psychological or organic wing of the model (see Figure 3) had a stronger effect on shortness of breath, we conducted an AIC comparison using the *fitstat* module in STATA 16.1. The AIC assesses the relative goodness of fit of two, unrelated models, with their outcome variable, comparing their value as predictors of that variable. It also penalizes models for predictor count, controlling for goodness of fit inflation due to model overfit. The AIC of the organic wing without covariates was 2.530 and with covariates it was 2.504, with the minimized AIC being the preferred model. In practice, the model with covariates included was slightly preferred, but that preference was very small.

For the psychological wing, the AIC of the psychological wing without covariates was 2.458, and with covariates it was 2.448. With the psychological model, the model with covariates was still slightly preferred, controlling for the risk of overfit. Between the organic and psychological models, the psychological model minimized the AIC by about .05, which is a very small improvement, but which still suggests the psychological model is a better overall predictor of shortness of breath severity.

Putting these numbers in the context of their R^2 values, our psychological wing predicts about 19% of the variance in post- deployment shortness of breath severity, while our organic model predicts about 14% of the variance in post-deployment shortness of breath. In total, our combined wings predict about 23% of the variance in post-deployment shortness of breath severity. The organic wing shares about 60% of its total effect on shortness of breath severity with the psychological wing, while the psychological wing only shares about 14% of its total effect on shortness of breath severity with the organic wing and, in total, the psychological wing of the model outperformed the organic wing (AIC 2.448 vs 2.554). Together, these results suggest our psychological model adds unique value and accounted for variance to our predictive understanding of post-deployment shortness of breath, and, in fact, is a better individual predictor of shortness of breath than the standard organic model. In contrast, our current medical approach towards treating post-deployment shortness of breath, fiscal approach to funding research and tracking exposure, and public health approaches towards protecting service members is almost wholly focused on organic factors and components of the organic model.

In total, the results of our AIC analyses support hypothesis 1.c and suggest that the psychological wing of our model in Figure 3 is a better predictor of shortness of breath than the environmental wing of the model. This also reinforces the results of hypotheses 1.a. and 1.b.

CHAPTER 4: DISCUSSION

Overview

Overall, our results supported our hypotheses. Emotional distress independently predicted a similar amount of variance in shortness of breath as post-deployment lung disease. Combat exposure did not account for as much variance in shortness of breath severity as emotional distress or post-deployment lung disease, but was a stronger predictor than burn pit exposure, dust storm exposure, and years spent smoking. Emotional distress and combat exposure combined with attribution predicted more variance in shortness of breath severity than the additive effects of all environmental exposures and lung disease.

In our formal comparison of the model wings (see Figure 3), the psychological wing outperformed the organic wing as a predictor of post-deployment shortness of breath severity, reinforcing our findings that the psychological variables in our model represent an important, unique contributor to, and predictor of, Veterans' post-deployment respiratory distress. The psychological variables accounted for around 15% of the total 23% of variance in shortness of breath severity predicted by our model and accounted for almost 50% more unique variance than the organic variables.

As discussed in the introduction section, the goal of this paper was not to establish psychological factors as a definitive explanation for post-deployment respiratory distress. Organic factors, including burn pit exposure, dust storm exposure, and smoking are already accepted as potential and likely causes of post-deployment shortness of breath and, more importantly, efforts to examine and treat those factors are already well established and funded. In 2020, the Veterans Affairs Administration received $8,711,600 to fund their Post-Deployment Health Services Department's (PDHS) care & surveillance efforts for Veterans of post-9/11 middle eastern conflicts with post-deployment illness (US Department of Veterans Affairs, n.d.). As part of those duties, the PHDS manages the Airborne Hazards and Open Burn Pit Registry, which is likely the largest public health surveillance effort aimed at post-deployment Veterans (US Department of Veterans Affairs, n.d.). The AHOBPR drives innovation in treatments for post-deployment Veterans, including the almost 100,000 Veterans registered with the AHOBPR who experience respiratory distress and symptoms. In this way, it is not unreasonable to say that the focus of the AHOBPR becomes, and reflects, the US government's intervention and public health efforts with this group of Veterans. Less than one percent (2/318 or .6%) of the questions on the AHOBPR ask about these Veterans' mental health. If this can be assumed to be reflective of the PHDS's treatment priorities, the PDHS is spending 98.4% of its effort focusing on the less robust of two competing models and leaving more than half of the problem entirely untreated.

While none of our variables predicted a large proportion of the variance in shortness of breath, the psychological factors preformed at a level that was at least *comparable to*, if not better than, the organic and environmental variables. The balance of these relationships could shift with more complete data; however, currently, psychological factors seem to be at least as important as organic factors in predicting post-deployment dyspnea in Veterans.

One possible mechanism for this result is illuminated by our attribution variable, which interacted with emotional distress and combat exposure to make them the 1st and 2nd strongest total predictors of shortness of breath severity, respectively. Veteran post-deployment illness, and reactions to the emotional distress of combat, are neither new nor uniform across conflicts (Blasch et al., 2016; Sharkey et al., n.d.; Weese & Abraham, 2009). The level of Veteran concern over airborne hazards, especially burn-pits, *is* unique to conflicts in the middle east and SWA, in part evidenced by the timing of the establishment of the AHOBPR, and in part by AHOBPR

Veterans' own self-report of level of concern. This differential in concern over airborne hazards, which we captured in our attribution variable, is a potential mechanism for the sudden rise of dyspnea in post-deployment Veterans.

The common-sense model of health behaviors would suggest that exogenous factors, such as visible smoke and media attention, could draw Veterans' focus to their breathing, and make them more likely to perceive vague symptoms as respiratory illness (Leventhal et al., 2016). This psychological explanation is especially salient given that the proposed, and logical, organic causal explanations are not leading to effective interventions; post-deployment respiratory distress remains difficult to treat. Also, this type of somatic channeling of emotional distress is already well established within the psychological literature (Aluis et al., 2013; Bailey, 2004; Chenivesse et al., 2014; Giardinoa et al., 2010; Slatore et al., 2018; Vogelea & Leupoldt, 2008; Zvolensky, Schmidt & Stewart, 2003).

The present findings regarding the impact of psychological factors on post-deployment dyspnea, and the relative impacts of organic and psychological factors, has an important implication for treatment. Post-deployment dyspnea in Veterans is notoriously recalcitrant, and some treatments for the organic components of these symptoms, such as albuterol or even allergy medications, are known to carry increased anxiety as a side effect (., Blasch et al., 2016; Sharkey et al., n.d; Weese & Abraham, 2009). Biological reactions to shortness of breath, including over-breathing and hyperventilation, can also worsen distress (Chenivesse et al., 2014). In this way, escalation of care for the organic influencers on dyspnea may worsen the psychological contributors, paradoxically worsening the condition (Bailey, 2004). Even when not anxiogenic, inappropriate additional treatment of organic factors may be benign but unhelpful in reducing residual dyspnea (Bailey, 2004).

Emotional distress and other psychological factors are well-established causes and exacerbators of respiratory distress, with or without the presence of an underlying organic illness. Our findings suggest that, in many cases, Veterans presenting with post-deployment respiratory distress may be experiencing a confluence of psychological and environmental influencers, with psychological and organic factors carrying similar weight in effecting dyspnea. In treating these Veterans, providers need to understand and respect the impact that psychological factors can have on respiratory distress, and tailor diagnostic and treatment strategies to address these factors, while validating patients' concerns about their deployment-related environmental exposures.

Looking forward, the equivalence in predictive power between psychological and organic factors in this study suggests that better psychological data could help improve our, and others', ability to propose treatments to address post-deployment respiratory distress. Research from parallel fields has shown that psychological interventions, in the case of organic disease exacerbated or complicated by emotional distress, can be very helpful in reducing symptoms of dyspnea (Bailey, 2004; Livermore et al., 2015). The evidence of the potential for effective auxiliary and complementary psychological interventions with this population continues to grow; however, without the appropriate types of psychological data to refine and support these interventions, treatment shifts are unlikely to happen or be successful (Abraham et al., 2012; King et al., 2011; Sharkey et al., 2017; Slatore et al, 2019; Szema et al., 2017;). Right now, the medical center of gravity is positioned away from psychological interventions with this population, and additional data collection is needed to challenge that positioning.

Strengths

In terms of strengths, the AHOBPR provided our study with a sample of almost 200, 000 post-deployment Veterans, which allowed us to detect small effect sizes that might otherwise have been unnoticed. Additionally, the AHOBPR is the current gold-standard for post-deployment burn pit and environmental exposure research. This gave us unparalleled access to a sample that is intended to closely approximate the population of post-deployment Veterans with health disturbances.

The robustness of the AHOBPR sample allowed us to examine and compare a number of different types of factors that are often omitted from research into post-deployment dyspnea. Specifically, we were able to examine understudied psychologically related questions and data that were useful in evaluating our hypotheses.

Finally, this study, as a link in a chain of post-deployment health research going back many years, had the benefit of drawing from a copious body of acquired understanding on psychological factors in post-deployment dyspnea. This foundation allowed us to focus on questions that could uniquely be evaluated with the present dataset, especially relating to the relative impacts of psychological and organic factors. In doing this, we were able to draw useful conclusions with limited data, simply by comparing understudied, previously discovered, psychological factors against well understood and quantified organic mechanisms. This places this study as part of the crux between two adjacent conceptualizations of the same problem, that have not quite merged satisfactorily. This study's unique positioning can help push the field towards merging these perspectives in a way that can improve Veteran care.

Limitations

This leads into our discussion of this study's limitations. First, our variables did not explain a large portion of the variance in shortness of breath severity, which suggests that there are some, and probably many, latent variables that are affecting this outcome that were not included in the present study. It is likely that future research with identify additional environmental or psychological variables that might add to, refine, or replace the variables included in this analysis.

Additionally, our variables were approximations of the phenomena we were attempting to operationalize. For example, our combat exposure variable was approximated based on exposure to combat related smoke. The research team felt that these sorts of exposures would be highly related to combat patrols and combat, especially given the limitation on use of combat items or range operations on bases in deployed combat zones. This sort of imprecision leaves open the real possibility that some of the variance attributed to psychological factors could be better accounted for by environmental factors (or vice-versa) with a more precise questionnaire.

Compounding the variable precision issue, the AHOBPR is not designed or intended for researching or analyzing psychological variables and psychological factors influencing its outcomes. In the AHOBPR questionnaire, there are only two questions that directly and clearly ask questions about Veterans' mental health: a question about "depression/anxiety/[or]emotional problem[s]," and TBI diagnoses. This severely limits our, and other researchers', abilities to ask and answer psychological questions.

Finally, there is likely a self-selection bias in our sample. Participants may have had a number of different motivations to register for the AHOBPR, including creating documentation for disability claims, seeking VA medical care, or being directed by their unit to enroll following a deployment. It is also likely that the Veterans who went through the registration process represent individuals with more concerns about their health and exposures than the total population of Veterans with post-deployment respiratory distress. This study sample approximates the population of Veterans with respiratory symptoms or concerns that are registered with the AHOBPR, which is an important population due to its size and resource use. However, the sample may not generalize to the total population of Veterans experiencing some respiratory distress following deployment. Some, or many, Veterans with post-deployment respiratory distress may have not registered with the VA, sought care elsewhere, or not sought care for their symptoms. This is an important limitation to consider when extrapolating these findings into clinical recommendations. The results should be generalized with caution outside of the AHOBPR sample.

Future Research Directions

Future research should include more precise data that includes more psychological predictors of Veteran post-deployment health. Also, sub-population analyses of Veterans of the Gulf War, Iraq, Afghanistan, and other deployment locations would likely allow for a better understanding of what types, severity, and duration of combat exposure places Veterans at most risk for psychologically complicated dyspnea. The same sorts of analyses could include matched date and location cohorts with varying levels of combat exposure, since qualitative combat and environmental exposure experiences could potentially vary greatly across time and location.

Follow-on analyses could also examine differences in symptoms, exposures, and relative variable weights between different age, racial, ethnic, education, and rank groups. It is possible that different racial and ethnic groups may experience their emotional distress in different ways. or might be more or less likely to receive optimized or adequate diagnosis and care. They may also be more or less likely to seek out psychological care for trauma or emotional distress, independent of their understanding of the relationship between their respiratory symptoms and their psychological complaints. Additionally, different education and rank groups might differ in terms of their attributions and level of willingness to endure symptoms without adequate medical control. Further research should examine whether these groups differ in terms of rate and duration of medical services usage, concern over respiratory distress, prescription change and usage rate, and type of medical service use.

Finally, the ubiquity of multi-system illness within this population suggests that these same methodologies might be useful in explaining some of the variance in conditions outside the cardiopulmonary system (VA, 2019). For example, panic disorder can give rise to neurological symptoms, cardiovascular symptoms, sleep disturbances, chronic headache, and others (Burkhardt et al., 2010). The abundance of symptoms and conditions within the post-deployment Veteran community that parallel these known anxiety effects suggest that a similar psychologically augmented model might help explain some of the complexity and recalcitrance in other, known post-deployment syndromes.

Conclusion

Psychologically informed research on post-deployment dyspnea and other conditions is needed to combat the complexity of modern deployment-related disease. As research begins to unravel the complex interactions between psychological and organic factors in these conditions, interventions will naturally begin to follow (Broadbent et al., 2005; Dempster et al., 2018; Leventhal et al., 2016; Paraskevi, 2012). Specifically, interventions can likely target both attribution and disease processes; helping patients and providers increase the specificity, accurateness, and appropriateness of their disease representations, and optimizing biological treatments by avoiding unnecessary or counter-productive pharmacological interventions (Leventhal et al., 2016). The growing body of research on psychological contributors to respiratory distress, as well as the results of this study, strongly suggest that we need to begin to shift and improve our understanding of, and treatments for, Veteran post-deployment respiratory distress. Future interventions and research with this population should include and respect the powerful influence that psychological factors can have on Veterans' experiences of post-deployment respiratory distress.

Appendix A: Specific Requested Data Elements

Demographics: service, current duty status, separation date, and retirement date.
1.2.A – Were you exposed to soot, ash, smoke, or fumes from the Gulf War oil well fires?
1.2.G – On a typical day, how often did smoke or fumes from the burn pit enter your work site or housing?
1.3.A – Were you ever close enough to feel the blast from an IED (improvised explosive device) or other explosive device?
1.3.B – In a typical month, how many days were you near heavy smoke from weapons, signal smoke, markers, or other combat items?
1.3.C – In a typical month, how many days were you in a convoy or other vehicle operations?
1.3.D – In a typical month, how many days did you perform refueling operations?
1.3.E – In a typical month, how many days did you perform aircraft, generator, or other large engine maintenance?
1.3.F – In a typical month, how many days did you perform construction duties?
1.3.G – In a typical month, how many days did you perform pesticide duties for your unit?
1.4.C – In a typical month during your deployment(s), how many days did you experience dust storms?
1.4.D – During your deployment(s), did you experience wheezing, difficulty breathing, an itchy or irritated nose, eyes or throat that you thought was the result of poor air quality?
1.4.E – How many days in an average month did you experience wheezing, difficulty breathing, an itchy or irritated eyes, nose or throat that you thought was the result or poor air quality?
1.4.F – During your deployment(s), did you seek medical care for wheezing, difficulty breathing, an itchy or irritated nose, eyes or throat that you thought was the result of poor air quality?
2.1.F – What condition or health problem causes you to have difficulty with these activities? Check all that apply.
2.1.A – How difficult is it to run or jog one mile on a level surface?
2.1.B – How difficult is it to walk on a level surface for one mile?
2.1.C – How difficult is it to walk a 1/4 of a mile - about 3 city blocks?
2.1.D – How difficult is it to walk up a hill or incline?
2.1.E – How difficult is it to walk up 10 steps or climb a flight of stairs?
2.2.1.A – Have you ever been told by a doctor or other health professional that you had Hay fever or allergies to pollen, dust, or animals?
2.2.1.B – Have you ever been told by a doctor or other health care professional that you had asthma?
2.2.1.C – Have you ever been told by a doctor or other health care professional that you had emphysema?
2.2.1.D – Have you ever been told by a doctor or other health care professional that you had chronic bronchitis?
2.2.1.E – Have you ever been told by a doctor or other health care professional that you had chronic obstructive pulmonary disease also called COPD?
2.2.1.F – Have you ever been told by a doctor or other health care professional that you had some lung disease or condition other than asthma, emphysema, chronic bronchitis or COPD?
2.2.1.G – Have you ever been told by a doctor or other health care professional that you had constrictive bronchiolitis (CB)?

2.2.1.H – Have you ever been told by a doctor or other health care professional that you had idiopathic pulmonary fibrosis (IPF)?
2.2.1.I – When you were told you had asthma, emphysema, chronic bronchitis, COPD, or some other lung disease by a doctor or other health care professional, were you told before, during, or after deployment?
2.2.1.J – Did this lung disease get better, worse, or about the same during deployment?
2.2.1.K – Do you currently have any of the following symptoms? (Check all that apply)
2.2.1.L – In the past 12 months did you have any of the following symptoms? (Check all that apply)
2.2.1.M – How would you rate your shortness of breath or breathlessness? (check the description/grade that applies to you)
2.7.A – In the PAST YEAR, how often did you drink any type of alcoholic beverage. (Included are liquor such as whiskey or gin, beer, wine, wine coolers, and any other type of alcoholic beverage)? On average, how many days per week did you drink?.
3.B –During your deployment(s), do you believe you were sick because of something you breathed?
3.C –Do you currently have a sickness or condition you think began or got worse because of something you breathed during deployment(s)?
3.D –When did the problem start?
3.E – Please rate your concern that something you breathed during deployment has already affected your health.
3.F – Please identify your biggest health concern that something you breathed during deployment has already affected your health.
3.K – What exposure do you think has the biggest overall effect on your health?
5.1.A – Which of the following were you doing last week? (Current Employment Status)
5.1.B – What is the main reason you did not work last week/have a job or business last week?

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