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POST-TRAUMATIC STRESS DISORDER IN A MILITARY POPULATION WITH
TEMPOROMANDIBULAR DISORDER

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– Hillary C. Metcalf

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ABSTRACT

POST-TRAUMATIC STRESS DISORDER IN A MILITARY POPULATION WITH TEMPOROMANDIBULAR DISORDER

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Introduction: Post-traumatic stress disorder (PTSD) occurs following exposure to a stressor or emotional trauma. It frequently co-occurs with chronic pain conditions, to include temporomandibular disorders (TMD). **Objectives:** To assess the prevalence of PTSD in patients with TMD and to explore its association to psychosocial factors.

Methods: This ongoing study collected information from the initial examination of 150 new patients at the Orofacial Pain Center, Naval Postgraduate Dental School. Patient demographics, pain characteristics, psychosocial factors, and primary TMD diagnosis were compared based on PTSD status. Associations of demographics, PTSD status, and TMD diagnosis with pain intensity was evaluated using linear regression. Mediation analyses were completed to explore impact of psychosocial factors on the relationship between PTSD status and pain intensity. **Results:** PTSD prevalence was 19%. Patients

positive for PTSD reported more symptoms of anxiety, depression, sleep disturbance, and more intense pain severity compared to patients not meeting PTSD criteria (all p 's<005). Patients diagnosed with masticatory muscle pain were more likely to have significant symptoms of PTSD compared to TMJ pain patients. **Conclusions:** This study highlights the need for dentists to screen for the presence of PTSD symptoms in patients with TMD and understand how these symptoms can adversely affect management of TMD. This study showcases how anxiety, depression, and insomnia each can influence the relationship between PTSD and TMD.

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LIST OF ABBREVIATIONS

DoD	Department of Defense
DSM-V	Diagnostic & Statistical Manual of Mental Disorders, 5 th ed
GAD-7	Generalized Anxiety Disorder 7-item
ISI	Insomnia Severity Index
LEC-5	Life Events Checklist for DSM-5
OEF	Operation Enduring Freedom
OFP	Orofacial Pain
OIF	Operation Iraqi Freedom
OPC	Orofacial Pain Center
PCL-5	PTSD Checklist for DSM-5
PHQ-9	Patient Health Questionnaire 9-item
PTSD	Post-Traumatic Stress Disorder
TBI	Traumatic Brain Injury
TMD	Temporomandibular Disorder
TMJ	Temporomandibular joint

CHAPTER 1: Introduction

BACKGROUND AND SIGNIFICANCE

Post-Traumatic Stress Disorder (PTSD) involves a characteristic cluster of symptoms following exposure to a stressor or an emotional trauma. (2) The prevalence of PTSD in the general United States (U.S.) population ranges from 3.6 to 6% in males and 9.7 to 12% in females. (5; 26; 34) According to the American Psychiatric Association, it is estimated that one in 11 people will be diagnosed with PTSD in their lifetime, even though it has been estimated that 70% of the adult population have been exposed to traumatic events. (34; 35) Therefore, not everyone who has been exposed to a traumatic event goes on to develop PTSD. (1; 16)

DIAGNOSTIC CRITERIA OF PTSD

According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-V), PTSD is defined as the presence of characteristic symptoms that are associated with exposure to actual or threatened death, serious injury, or sexual violence that persist for greater than one month. (2) PTSD is characterized by four areas of symptoms to include intrusion, avoidance, alterations in cognition and mood, and hyperarousal. (2; 8) Table 1 as well as Figure's 1 and 2 outline the diagnostic criteria associated with PTSD as defined by the DSM-V. (2)

The first symptom is *intrusion* in the form of disruptive memories and nightmares, avoidance of reminders associated with the traumatic event(s), and vivid re-enactments called dissociative episodes, commonly known as flashbacks. (1) Intrusion symptoms can also manifest through trauma-related stimuli that trigger physiological

reactions and/or psychological distress related to the traumatic event(s). (1) The second symptom is associated with persistently (e.g. always or almost always) *avoiding* trauma-related stimuli. This includes the individual avoiding distressing thoughts, memories, feelings, or talking about the traumatic event and to avoid activities, objects, situations, or people that could trigger these symptoms related to the traumatic event(s). (2)

The third area of symptoms pertains to cognition and mood where an individual may experience *altered cognitive processes* to include memory, attention, planning, and problem solving challenges. (22) There may be alteration in beliefs where they may blame themselves or others' believe they are inadequate and/or psychologically weak; develop negative emotional states such as anger, guilt, and/or shame; become disinterested in activities and/or detachment from others; and are unable to experience positive emotions to include, love, pleasure, or enjoyment. (5; 16) The fourth area of symptoms involves alterations in *arousal* or reactivity pertaining to hypervigilance, exaggerated startle response, irritability, reckless behavior, and/or a sleep disturbance. (1; 2)

In order to make a definitive diagnosis of PTSD, these symptoms related to the traumatic event(s) must be present for at least one month, cause significant distress for the individual, interfere with daily functioning to include social and occupational activities, and are not attributed to medication or substance use or another illness. (1; 2)

RELATIONSHIP BETWEEN PTSD SYMPTOMS AND THE MILITARY

Approximately 1.64 million U.S. service members have been deployed to Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) wars since 2001. (24; 45) Approximately 26% of these service members return home experiencing mental

health conditions with PTSD being one of the most common diagnoses where prevalence of PTSD ranges from 11% to 22%. (21; 24; 36; 45) Being exposed to combat environments such as roadside bombs, improvised explosive devices (IED), suicide bombers, being wounded, losing a team member, handling human remains, witnessing violence and/or death, increase the risk for developing PTSD. (21; 31) Risk factors associated with the development of PTSD specific to individuals in the armed forces include non-officer rank, being in the Army (versus other service branches), two or more deployments, deployment-related traumatic brain injury (TBI), discharging/firing a weapon, and exposure to combat. (21) The literature supports that there is a dose-response relationship between traumatic exposure and development of PTSD, such that as the number of traumatic events increase so does the likelihood of developing PTSD. (29)

Compared to past conflicts where the fatality-to-wounded ratios were 1:2.6 in Vietnam and 1:1.7 in World War II, the proportion of servicemembers who have been killed or wounded in OEF and OIF was lower with fatality-to-wounded ratios of 1:5.0 in OEF and 1:7.2 in OIF. (32) These lower numbers of those who were killed or wounded is attributable to improved access to care and body protection. (32) Consequently, this has resulted in more servicemembers returning home with combat-related injuries that may also require mental health services to include treatment for PTSD. (32)

INTERRELATIONSHIP OF PTSD, CHRONIC PAIN, AND PSYCHOSOCIAL FACTORS

The International Association for the Study of Pain defines pain as an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage. (37) Pain that does not resolve and persists beyond 3-6 months is considered chronic pain. (6)

Pain is often associated with physical pathology, however, pain can also be influenced by psychologic factors such as PTSD. The symptoms of PTSD can magnify the subjective perception of pain. (9) Physical health concerns have been shown to be more common in patients with PTSD, where chronic pain is reported to be one of the most frequently co-occurring physical problems. (5) Chronic pain conditions that have been found to commonly co-occur with PTSD include fibromyalgia, headaches, and irritable bowel syndrome. (3; 20; 48) Patients with co-occurring PTSD and chronic pain have reported greater pain severity, affective distress, and pain-related impairment compared to chronic pain patients without PTSD. (33; 34) Furthermore, compared to patients with chronic pain alone, patients with PTSD and chronic pain tend to have maladaptive coping strategies and beliefs about pain which could adversely affect symptom severity and pain management. (33)

There are several reported models examining the relationship between PTSD and chronic pain that describe how the interaction may negatively impact the course and outcome of the management of either disorder. (34) A mutual maintenance model has been proposed in regards to PTSD and chronic pain suggesting that PTSD-related hyperarousal mediates pain symptoms, and pain has a mediating influence on re-experiencing and hyperarousal symptoms in PTSD. (28; 33) In this mutual maintenance model, the cognitive, affective, and behavioral components of both PTSD and chronic pain maintain and potentially exacerbate overall physical and psychological symptoms. (21; 28) This highlights that PTSD and chronic pain may be mutually maintaining conditions whereby both conditions may be involved in the escalation of symptoms and distress following a traumatic event. (41) In addition, another model, the fear-avoidance

cycle that is also associated with PTSD and chronic pain, demonstrates the self-perpetuating nature of pain and maladaptive beliefs of pain to include avoidance that prevents recovery and reinforces the individual's maladaptive beliefs, ineffective behaviors, distressing symptoms, and functional limitations. (5) These studies demonstrate evidence supporting the comorbidity associated with these disorders. (6)

The literature suggests that patients with PTSD exhibit more risk factors for pain such as general medical conditions, psychiatric diagnoses, and substance abuse disorders. (33) As part of the diagnostic criteria for PTSD, sleep disturbances can also contribute to poor clinical outcomes to include poorer perceived physical health, poor daytime function, and increased risk for depression, suicidal ideations, and substance abuse. (33) Patients with chronic psychiatric disorders are at an increased risk of sleep disturbance, and that these sleep disturbances can potentially exacerbate symptoms associated with PTSD and anxiety. (27) Furthermore, patients with PTSD are more likely to be diagnosed with a depressive disorder which may exacerbate or lead to increased pain severity and physical limitations. (34) Based on the available evidence, in addition to chronic pain, PTSD is also suggested to be comorbid with sleep disturbance, and symptoms of anxiety and depression.

INTERRELATIONSHIP BETWEEN PTSD AND OROFACIAL PAIN

Orofacial pain (OFP) is defined as pain and dysfunction affecting motor and sensory transmission in the trigeminal nerve system, and involves pain associated with the hard and soft tissues of the head, face, and neck. (12) OFP encompasses several diagnostic subcategories to include musculoskeletal disorders (e.g. temporomandibular disorder or TMD), neurovascular disorders (e.g. migraine headaches), and neuropathic

disorders (e.g. trigeminal neuralgia). (43) OFP can manifest as chronic pain and can present in patients with PTSD. (28) Patients with OFP and symptoms of PTSD were found to have higher levels of depression and anxiety with increased psychological distress, higher pain severity, and greater disability compared to OFP patients without PTSD symptoms. (3)

TMD, one of the diagnostic subcategories of OFP, includes pain associated with the masticatory muscles and/or temporomandibular joints (TMJ). Masticatory myalgia is associated with pain of muscle origin (e.g. masticatory muscles) in the last 30 days, is altered with jaw movement, function, or parafunction (e.g. grinding and/or clenching of the teeth, chewing gum), and is reproduced upon palpation. (12) When there is pain involving the TMJ in the last 30 days that is associated with jaw movement, function, or parafunction and is replicated upon palpation and/or assessment of jaw range of motion, this would be termed TMJ arthralgia. (12)

Compared to healthy controls, TMD patients are more likely to experience traumatic events. In a study assessing the prevalence of traumatic events in over 600 TMD patients, almost half of the patients reported being exposed to one or more major traumatic event(s), where the traumatic event preceded the onset of pain. (10) In a study using an anonymous survey mailed to adult OFP patients, 68.9% of patients reported a history of abuse, yet 8.5% of patients indicated a history of abuse on a clinic questionnaire. (7; 9) It is suggested that traumatic event(s) and PTSD symptoms can be predictors of TMD development, where these symptoms often occur prior to the onset of TMD symptoms. (15) In a population-based study of over 3,300 inhabitants of West Pomerania who had symptoms of PTSD, it was found that there was a moderate to strong

association between symptoms of PTSD and signs of TMD in the general population.

(28) These studies demonstrate evidence supporting the comorbid nature of these disorders. In addition, demonstrating how TMD and PTSD can be associated with the mutual maintenance model where chronic pain can exacerbate and/or maintain PTSD and how PTSD can exacerbate and/or maintain chronic pain. (6)

In comparison to TMJ pain patients, studies suggest a higher prevalence of PTSD symptoms in masticatory muscle pain patients. (9; 11; 30) Masticatory muscle pain patients compared to TMJ pain patients have reported being more psychologically distressed with reported higher levels of depression, pain-related disability, and exposure to major traumatic events. (3; 10) These findings suggest that there are differences between myogenous and arthrogenous origins of pain and these differences should be considered in the evaluation and management of TMD patients. (10) In addition to psychological dysfunction, in a study of TMD patients with PTSD, both masticatory muscle pain and TMJ pain patients both exhibited more sleep problems compared to TMD patients without PTSD. (3)

There is limited data regarding the prevalence of PTSD symptomology in patients with TMD as well as the differentiation between masticatory muscle pain and TMJ pain patients. There is even less data regarding the prevalence of PTSD in a military TMD patient population. There is limited data regarding the association between PTSD, TMD, and psychosocial factors to include anxiety, depression, and sleep disturbance. This study will utilize and build upon the foundation laid by previous studies assessing the prevalence of PTSD symptoms in patients with TMD, to include differentiating between patients with masticatory muscle and/or TMJ pain. To the best of the authors' knowledge,

no other study in the military has assessed the prevalence of PTSD symptoms in TMD patients and adds to the scientific literature on prevalence of PTSD symptoms observed in a patient population featuring active duty servicemembers, military retirees, and military family members with chronic TMD. The knowledge gained from this data registry study will provide a deeper understanding of the prevalence of PTSD in a military TMD pain population and how symptoms of PTSD can present in chronic TMD patients. Furthermore, this insight could provide the military dental community with a better understanding of the complexities associated with PTSD and chronic TMD with improved quality of care that optimizes military operational readiness.

SPECIFIC AIMS

The primary aim of this study was to assess the prevalence of PTSD in new patients evaluated in the Orofacial Pain Center (OPC) at the Naval Post-graduate Dental School. This study evaluated patients on the presence of PTSD symptoms using standard self-report measures.

This study also included two secondary aims:

1. To explore the relationships between the presence of PTSD symptoms and the type of TMD diagnosis.
2. To explore the relationships among PTSD symptoms and symptoms of TMD pain, anxiety, depression, and insomnia.

CHAPTER 2: Materials and methods

PATIENT POPULATION

This was an ongoing data registry study of new patients seen at the OPC, a tertiary OFP clinic, at the Naval Postgraduate Dental School in Bethesda, Maryland. This clinic serves Department of Defense (DoD) eligible beneficiaries to include active duty servicemembers and retirees of the uniform services, and their family members. As part of the initial standard evaluation protocol, psychometric and sleep disorder data was obtained from all patients who provided consent to be a part of the study during the initial visit. Data of all new consented patients was collected following their initial examination from January 2020 until April 2021. The OPC evaluates and manages patients with chronic OFP conditions to include mostly TMD conditions (e.g. masticatory muscle pain and TMJ pain and dysfunction) as well as other conditions to include headaches and neuropathic pain where these conditions are largely managed conservatively.

INCLUSION / EXCLUSION CRITERIA

Eligible study participants included those who were at least 18 years old, provided consent to be included in the study, and had complete/sufficient data. Exclusion criteria included patients under 18 years of age, did not consent to be included in the study, or had insufficient data.

MEASURES

Demographics and Health History Questionnaire. All participants whom consented to be a part of the study completed a brief demographic and health history questionnaire to include age, sex, and ethnicity of the participant.

Pain Measures. Pain duration (in months) was recorded based on the onset of their pain symptoms from their chief complaint. If the patient provided a range for pain onset (e.g. onset 2010-2011), the larger value was recorded. Patients rated their pain intensity in regards to pain “today,” “average pain intensity,” and “worst pain intensity” based on a numeric rating scale ranging from zero to ten, where zero indicated “no pain” and ten indicated “the worst pain imaginable.” If a patient entered more than one numeric (e.g. 2-3/10) on the numeric rating scale, the higher number (e.g. 3/10) was recorded.

Generalized Anxiety Disorder (GAD-7). The GAD-7 is a 7-item measure used to assess the presence of symptoms of generalized anxiety over the previous two weeks. The GAD-7 is a widely used assessment instrument and has demonstrated good psychometric properties in clinical and research applications. (22)

Patient Health Questionnaire-9 (PHQ-9). The PHQ-9 is a 9-item measure of the presence and severity of depressive symptoms over the previous two weeks. Test-retest reliability, internal consistency, and convergent validity have been established. (8)

Insomnia Severity Index (ISI). The ISI is a 7-item measure that assesses the severity of both nightmare and daytime components of insomnia. It has been validated for use as a screening tool to detect sleep disturbances in research and clinical settings. (25; 38)

PTSD Checklist for DSM-5 (PCL-5). The PCL-5 is a 20-item measure used to assess the presence and severity of PTSD symptoms. Items on the PCL-5 correspond with DSM-5 criteria for PTSD. The PCL-5 can be used to quantify and monitor symptoms over time, to screen individuals for PTSD, and to assist in making a provisional or temporary diagnosis of PTSD. (47) The PCL-5 consists of two sections. The first is the

life events checklist for DSM-5 or LEC-5 that asks the patient to identify any significant stressors from a 16-item experience list as well as an open category for the patient to include “any other very stressful event or experience.” (47) This list includes exposure to military combat, violent attack, terrorist attack, torture, incarceration, natural or man-made disaster, severe accident, life-threatening illness, and other options. Additionally, if it happened to the individual, witnessed or learning about it, was a part of their job, was not sure, or does not apply to them. The second section asks the patient to identify the most significant stressor and to assess how much this significant stressor has bothered him or her in the past month based on a 5-point Likert scale ranging from zero to 4 (0 = not at all, 1 = a little bit, 2 = moderately, 3 = quite a bit, and 4 = extremely) by assessing four symptom clusters (intrusion, avoidance, negative alterations in cognition and mood, and hyperarousal) and three additional items pertaining to blame, negative emotions, and reckless or self-destructive behavior. Items were summed for an overall severity score as well as for individual symptom cluster sums. A score of 33 or higher meets the criteria for likelihood of PTSD diagnosis, based on study normative data. (47) Blevins et al determined that the psychometric properties for the PCL-5 for a U.S. American college convenience sample of subjects who self-identified as having PTSD had an internal consistency $\alpha = 0.94$ and test-retest reliability $r = 0.82$, 95% CI [0.71, 0.89]. (4) In the event that a patient is found to have clinically significant symptoms of PTSD based on the PCL-5, the patient was informed of the provisional diagnosis and the influence PTSD symptomatology could have on their OFP diagnosis, and was given the recommendation to be referred to behavioral health for coordination of care (unless the patient was already under care for this concern).

Diagnosis. A primary, secondary, and tertiary diagnosis was recorded for each patient with completion of their initial examination and placed into one of five diagnostic categories: masticatory muscle disorders, TMJ pain disorders, primary headache disorders, neuropathic pain disorders, and intraoral pain disorders. These diagnostic categories were used based on the American Academy of Orofacial Pain (AAOP) Guidelines for Assessment, Diagnosis, and Management (6th Edition). (12) Masticatory muscle and TMJ disorders was based on the temporomandibular disorders (DC/TMD) Axis 1 diagnoses, primary headache disorders and neuropathic pain disorders was based on the International Classification of Headache Disorders, 3rd Edition (ICHD-3). (39; 44) Intraoral disorders included a variety of oral conditions including odontogenic, periodontal, and mucosal pain with varying diagnostic criteria depending on the specific intraoral condition. Patients will commonly be diagnosed with more than one OFP disorders (e.g. both “myalgia” and “arthralgia.”) The diagnoses were based on the clinical judgement of the clinician that most fit the patient’s presenting history, clinical examination, and diagnostic testing (if necessary) and placed in order from the most to the least clinically applicable diagnosis (e.g. primary, secondary, and tertiary diagnosis). If there was only one or two diagnoses, “no OFP diagnosis” was recorded for the remaining diagnosis (es). The diagnosis was located either in the patient’s chart stored in the OPC and/or the patient’s electronic health record.

STATISTICAL ANALYSES

PTSD STATUS:

The prevalence of PTSD was assessed by determining who met criteria based on the PCL-5 self-report measure. This is a scored measure with a cut-off score of 33 that is

indicative of probable PTSD. (47) For participants that scored above this value would typically exhibit symptoms associated with PTSD and would be considered in the PTSD positive group.

COMPARED PTSD POSITIVE VERSUS PTSD NEGATIVE GROUPS:

Patient demographic, pain-related, and psychosocial characteristics were compared relative to PTSD positive versus PTSD negative groups using standard t-test or Wilcoxon test for continuous characteristics and Fisher's exact test for categorical characteristics.

MEDIATION ANALYSIS:

A Multi-variable linear regression analysis using the PTSD score and average pain intensity score was used to evaluate the extent to which the psychosocial variables (e.g. anxiety, depression, insomnia) mediated this relationship as shown in Figure 3. The PTSD score was the independent variable, the average pain intensity was the dependent variable, and the psychosocial variables were the mediators. Mediation analyses were used to evaluate the extent to which psychosocial characteristics may mediate, or account for, the potential causal association between symptoms of PTSD and average pain intensity.

Given the small sample of non-active duty servicemembers (dependents of active duty servicemembers and retirees) (N = 13) and diagnoses other than TMD (e.g. primary headache disorders, neuropathic pain), these patients were excluded from analyses.

CHAPTER 3: Results

PREVALENCE OF PTSD SYMPTOMS, DEMOGRAPHIC CHARACTERISTICS, PAIN VARIABLES, AND PSYCHOSOCIAL CHARACTERISTICS

Demographic characteristics and pain variables of the 150 patients included in the study based on their PTSD status as either PTSD positive versus PTSD negative groups as outlined in Table 2. PTSD status and psychosocial variables are described in Table 3.

The overall prevalence of PTSD symptoms in this study of a total sample of 150 patients was 29 patients or 19%. Table 4 describes the frequency of traumatic life-events in patients within the PTSD positive group. The most frequently reported stressors that either happened to the participant or directly witnessed the stressor included natural disaster, transportation accident, physical and/or sexual assault, experienced a life threatening illness or injury, and several other types of stressors. Most study participants reported experiencing and witnessing multiple stressors.

Mean age of the PTSD positive group was 39.7 years old (SD 11.7) and the PTSD negative group was 36.8 years old (SD 9.90) where both groups were relatively similar in age. 57% of the sample were females and 43% were males where 59% of males were positive for PTSD symptoms, however, the results were not statistically significant. Most patients were Caucasian (61%), active duty servicemembers (91%), and mostly affiliated with the U.S. Army, however, these findings were not statistically significant.

The average pain severity was 5/10 (SD 1.53) for the PTSD positive group and 4/10 (SD 1.81) for the PTSD negative group on a zero to ten numeric rating scale for which was statistically significant. The mean duration in months of chief complain pain symptoms prior to evaluation was not statistically significant, however, for the PTSD positive group the duration of pain symptoms in months was found to be longer at 54.8

months (SD 57.5) versus 50.2 months (SD 67.7) in the PTSD negative group.

Masticatory muscle disorders were the most common TMD diagnoses, accounting for 83% whereas TMJ pain accounted for 17% of TMD diagnoses.

In assessing the PTSD positive versus the PTSD negative groups relative to psychosocial variables, there was statistically significant findings for the presence of symptoms of anxiety, depression, and insomnia in the PTSD positive group.

MEDIATION ANALYSIS

Table 5 outlines the results from the Multi-variable linear regression model with PTSD as the independent variable, average pain intensity as the dependent variable, and the psychosocial variables (e.g. anxiety, depression, and insomnia) as the mediators.

In first evaluating symptoms of anxiety, when comparing symptoms of PTSD and anxiety independently relative to average TMD pain intensity, the relationship was not statistically significant. Whereas, the total effect of PTSD and anxiety symptoms relative to the average TMD pain intensity was statistically significant ($p < 0.01$). Similar results were found when evaluating the total effect of PTSD and depression relative to average TMD pain intensity as well as the total effect of PTSD and symptoms of insomnia relative to average TMD pain intensity. The main result of this mediation analysis was that symptoms of anxiety, depression, and insomnia all partially mediate a relationship between PTSD symptoms and average TMD pain intensity. These mediators have a role but the relationship between PTSD symptoms and average TMD pain intensity is largely independent of these factors. The results of this mediation analysis were independent of demographic variables (e.g. age, sex) and TMD diagnosis.

CHAPTER 4: Discussion

The present study of a military TMD population demonstrated a 19% prevalence of PTSD symptomology that is above the lifetime prevalence of PTSD symptomatology in the general population ranging from 1% to 14%. (2; 11; 40) The most commonly reported directly experienced traumatic stressors were transportation accident, natural disaster, physical assault, combat, and unwanted sexual experience.

The prevalence of PTSD symptomatology in the present study were higher compared to previous studies of PTSD symptomatology in OFP populations. In a study of over 1400 OFP patients, prevalence of PTSD symptoms was 15%. (10) In a study of 445 TMD patients, reported PTSD prevalence of 12.6%, where 14.9% of masticatory muscle disorders and 9.9% of TMJ pain disorders. (3)

In addition to TMD, higher prevalence rates have been reported in other chronic pain conditions to include fibromyalgia, where the prevalence rates of PTSD and fibromyalgia have been reported to range from 15-56%. (20) Patients with fibromyalgia and concurrent PTSD were reported to have higher pain intensity, disability, and affective stress compared to fibromyalgia patients who did not exhibit symptoms of PTSD. (42) Additionally, patients with chronic pain and high levels of PTSD symptoms were found to have more pain and affective distress than chronic pain patients with low or no levels of PTSD symptoms. (19) These studies demonstrate the evidence supporting the comorbidity associated with PTSD and chronic pain. (6) The results of the present study add to the existing literature supporting the likely comorbid conditions associated with PTSD and chronic pain, to include TMD.

In the present study, despite there being more female participants than males, there was a trend towards more males presenting with symptoms of PTSD than females. This is in contrast to the general population associated with civilian studies where the prevalence of PTSD ranges from 4%-6% in males and 10%-12% in females. (5; 34) The findings of this study may be due to the increased likelihood of being exposed to a traumatic event while serving in the military. This association would potentially be stronger with a larger sample size. Further studies are needed to explore if there is in fact a higher prevalence of PTSD in male versus female patients within a military TMD pain population.

In agreement with previous studies, the current study demonstrated that PTSD symptomatology was more prevalent in masticatory muscle pain patients compared to TMJ pain patients. Although not statistically significant, this study demonstrated that PTSD symptoms were reported by 93% of patients with masticatory muscle disorders and 7% with TMJ pain disorders. Several studies have suggested a higher prevalence of PTSD symptoms in masticatory muscle pain patients compared to TMJ pain patients. (3; 9; 11; 30) In one study assessing prevalence of traumatic events in 1221 TMD patients, 50% of the patients reported one or more exposure(s) to traumatic event(s) where most patients experienced masticatory muscle pain compared to TMJ pain. (10) Compared to TMJ pain patients, masticatory muscle pain patients have reported higher pain intensity, pain-related disability, are more psychologically distressed, have worse symptoms of depression, anxiety, and sleep disturbance. (3) These findings suggest that there are differences between patients with masticatory muscle patients versus patients with TMJ pain and thus may differ in their response to therapeutic modalities.

The findings of this study support previous study findings of a relationship between prevalence of PTSD symptoms and increased severity of pain. In the current study, average pain intensity was statistically significantly higher in the PTSD positive group compared to the PTSD negative group. Additionally, there was a trend towards longer duration of pain measured in months since onset of chief complaint pain symptoms in PTSD positive compared to the PTSD negative group. This association, potentially similar to the trend of more males positive for PTSD symptoms, would potentially be stronger with a larger sample size. Studies have shown that patients with chronic pain report higher rates of PTSD than the general population as well as higher prevalence rates of pain-related conditions in patients with PTSD than those without PTSD. (Porter, 2013)

Previous studies have suggested that masticatory muscle pain patients compared to TMJ pain patients are in more psychological distress. (3; 10) In agreement with previous studies, the current study of TMD patients demonstrated a statistically significant association between prevalence of PTSD and symptoms of anxiety, depression, and insomnia. In a study of 1478 OFP patients, it was found that PTSD-like symptoms were associated with increased pain severity and pain-related disability, psychological distress, anxiety, and sleep dysfunction compared to patients without PTSD. (10) In a study of 445 TMD patients, patients with masticatory muscle pain were found to present with more life interference, affective distress, and sleep disturbances and less life control compared to TMJ pain patients. (3) These studies demonstrated that myogenous TMD pain patients are at increased risk of being exposed to major traumatic

events, have higher levels of pain disability, psychological distress, and symptoms of depression and anxiety. (3; 10)

PROPOSED MECHANISMS FOR PTSD, CHRONIC TMD, AND PSYCHOSOCIAL FACTORS

There are several proposed mechanisms for the relationship between PTSD and chronic pain. One mechanism is in regards to a mutual maintenance model suggesting that pain has a mediating influence on PTSD symptoms to include re-experiencing and hyperarousal and PTSD-related hyperarousal mediating pain symptoms. (28; 33) In this mutual maintenance model, the cognitive, affective, and behavioral components of both chronic pain and PTSD maintain and potentially exacerbate overall physical and psychological symptoms. (21; 28) Additionally, the potential interaction among PTSD and chronic pain may negatively impact the course and outcome of the management of either disorder. (34) The relationship between PTSD symptoms and signs and symptoms of masticatory muscle and/or TMJ pain has been suggested to be due to PTSD initiating muscular hyperactivity that can lead to altered muscle and TMJ biomechanics and which could further result in TMD muscle and/or joint pain. (28) Another proposed reason for this relationship is that TMD pain may be associated with abnormal pain processing within the trigeminal system for which could be initiated and/or aggravated by symptoms of PTSD. (28)

Another important mechanism that be involved in patients with PTSD chronic TMD pain, and psychosocial dysfunction could be explained by dysfunction of the hypothalamic-pituitary-adrenal (HPA) axis. The HPA axis, normally when exposed to a stressor has a negative feedback loop that allows for the individual to produce and release stress hormones (corticosteroids) and regains homeostasis. (13) However, for military

servicemembers who may have been to repeated or severe stressors while deployed, have protracted work periods, a disrupted sleep schedule, as well as separation from family and loved ones could result in over-reactivity of the HPA axis with a chronic release of stress hormones that can adversely affect cognition, emotion, and behavior. (13)

Additionally, the chronic release of stress hormones has been linked to symptoms of anxiety, depression, chronic pain, insomnia, and cognitive challenges. These corticosteroids can be involved with symptoms of hyperarousal for which is one of the cluster symptoms involved in PTSD. (13) A dysfunctional HPA axis has also been associated PTSD and chronic pain. (3) Compared to patients with chronic pain alone, patients with PTSD and chronic pain tend to have maladaptive coping strategies such as resting and/or avoiding activity and beliefs about pain which could adversely affect symptom severity and pain management. (33) These maladaptive coping strategies in patients with PTSD and chronic pain have been associated with more pain interference and greater pain severity. (33) The results of these studies suggests that a dysfunctional HPA axis may have a role in patients with symptoms of PTSD and TMD. Thus, a better understanding of the potential underlying mechanisms involved in patients with PTSD, TMD, and psychosocial factors can ultimately improve the quality of care we are able to provide to our patients as well as to improve long-term treatment outcomes.

Due to the multi-dimensional impact of chronic TMD pain, it is important to consider the interaction of biological, psychological, and social factors that can alter the pain experience such as using the biopsychosocial model. (5) This model integrates the experience of pain with the complex interaction of psychological, behavioral, physical, and sociocultural factors that can complicate the management of comorbid conditions to

include PTSD and TMD. (5) A fear-avoidance cycle is a model that is associated with PTSD and chronic pain and demonstrates the self-perpetuating nature of pain and maladaptive beliefs of pain. These maladaptive beliefs of pain can include avoidance that prevents recovery and reinforces the individual's maladaptive beliefs, ineffective behaviors, distressing symptoms, and functional limitations. (5)

CLINICAL APPLICABILITY

The findings of this study on a military TMD patient population is clinically applicable to dentists for several reasons. Patients with PTSD symptoms often have increased anxiety, fear, pain, and hyperarousal which could pose a challenge to healthcare providers including dentists. (33; 34) PTSD patients may exhibit increased fear and avoidance behaviors, display increased irritability, anger, sense of shame, difficulty with attention, and/or recall of information provided during a medical appointment. (17; 46) This can result in ineffective coping strategies, exhibit avoidance behaviors such as missed or failed appointments, challenges with treatment adherence, and potential difficulty understanding how the symptoms could interfere with the proposed treatment. (14; 41) Patients who have a history of traumatic experiences have been associated with difficulty keeping dental appointments, distress behavior while in the dental chair, and stress-related dental problems (e.g. TMD, gingivitis, bruxism, and exodontia complications). (23) In another study, patients with PTSD symptoms were found to have unusually poor oral health, rampant dental decay, multiple missing teeth, and advanced periodontal disease. (18) These studies suggest the necessity of healthcare providers, to include dentists, to have an understanding of the complexities associated with patients who have comorbid symptoms of PTSD and TMD. Additionally, these

findings suggest the importance of concurrent management of PTSD and TMD for an increased likelihood of positive treatment response, improved quality of life, and reduced pain-related disability.

In an anonymous survey of OFP patients, 69% reported having a history of abuse but only 9% of patients reported this to their provider. (7) This finding suggests that patients may not be forthcoming of their history of physical and/or emotional trauma when completing their health history form. Even though exposure to traumatic events has been reported in up to 70% of the adult general population. (34) Therefore, it is important for dental providers to keep in mind that they are likely to see patients who have been exposed to a traumatic event even if this is not reflected in their health history questionnaire.

In terms of the military, a health, operationally ready, resilient military force depends on a range of physical and psychological factors of every servicemember as well as their dependents. If left untreated, PTSD and chronic pain, to include TMD, can adversely impact military operational readiness. Given the increased risk of experiencing a traumatic event while serving in the military, it behooves the DoD to invest in the understanding of PTSD and chronic TMD. Furthermore, this insight could provide the military dental community with a better understanding of the complexities associated with symptoms of PTSD and chronic TMD with improved quality of care that optimizes military operational readiness.

LIMITATIONS

There were limitations associated with the present study. Due to the study design, it was not possible to demonstrate a causal relationship between PTSD and TMD, nor

was it possible to determine a causal relationship between PTSD, TMD, and psychosocial factors. Another limitation was that this study was conducted in a population who sought treatment for TMD in a military tertiary care center which could potentially overestimate PTSD prevalence and the relationships between PTSD, psychological distress, and sleep disturbances. Thus the results of this study could not be generalized to OFP patients seeking care in other settings as the results could represent a more skewed pain population compared to the general population. However, this study differentiated between masticatory muscle pain and TMJ pain patients in terms of diagnoses to allow for a more accurate sample and thus to allow for the patient population to be more representative of the masticatory muscle and TMJ pain population.

There was a small sample size ($N = 150$) and thus it is difficult to draw stronger associations in terms of our findings. In terms of diagnoses, most of the patients seen were diagnosed with multiple TMD diagnoses. Due to diagnosis being based on the clinician's judgement of order of differential diagnosis, this could potentially adversely affect the order in which a diagnosis was placed for each particular patient. Additionally, given the life circumstances associated with the COVID-19 pandemic, the current patient population may not reflect the typical patient population that is normally seen for care (limited dependents and retirees as our clinic was limited to care for predominately active duty servicemembers) for most of the duration of this study.

CHAPTER 5: Conclusions

The present study supports previous studies assessing the relationship between PTSD and chronic TMD. Approximately 19% of patients reporting to an OPC met the criteria for PTSD symptomatology. A higher prevalence rate of PTSD symptoms was found for patients with masticatory muscle pain at 93% compared to patients with TMJ pain at 7%, although, this was not statistically significant. However, the results of this study supported previous investigations where the prevalence of PTSD symptoms would be higher for patients with masticatory muscle pain versus TMJ pain patients. Our findings revealed that patients positive for PTSD symptoms had statistically significant symptoms of anxiety, depression, and insomnia, compared to patients who were negative for PTSD symptoms. Additionally, psychosocial variables (symptoms of anxiety, depression, and insomnia) all partially mediate the relationship between symptoms of PTSD and average TMD pain intensity.

The results of this study confirmed and build upon previous studies assessing PTSD symptoms in a TMD pain population. Additionally, this study was unique in that PTSD symptoms were evaluated in a military TMD pain population and thus adds value to the existing literature in terms of how PTSD symptoms can present in a military population. Future studies should evaluate the nature of traumatic events and TMD symptoms in patients with PTSD and how the associated symptoms may present in a military TMD population. Additionally, future studies should include a longitudinal design to further assess the relationships found in this study in order to advance our

understanding of symptoms of PTSD, chronic TMD, and psychosocial factors for which can aid in our ability to optimize quality of care and improved long-term outcomes.

Table 1. Diagnostic Criteria for PTSD based on DSM-V.

Intrusion	Avoidance	Alterations in Cognition and Mood	Alterations in Arousal and Reactivity	Additional Criteria
One or more of the following:	One or both of the following:	Two or more of the following:	Two or more of the following:	All of the following:
Recurrent, involuntary, and intrusive distressing memories of traumatic event(s)	Avoidance of or efforts to avoid distressing memories, thoughts, or feelings associated with traumatic event(s)	Inability to remember important details of traumatic event(s) (typically due to dissociative amnesia and not due to other factors such as head injury, alcohol, or drugs)	Irritable behavior and angry outburst (with little or no provocation) typically expressed as verbal or physical aggression toward people or objects	Duration of the disturbance is more than 1 month
Recurrent distressing dreams related to traumatic event(s)	Avoidance of or efforts to avoid external reminders (people, places, conversations, activities, objects, situations) that arouse distressing memories, thoughts, or feelings related to the traumatic event(s)	Persistent and exaggerated negative beliefs or expectations of oneself, others, or the world (e.g. "No one can be trusted.")	Reckless or self-destructive behavior	Disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning
Dissociative reactions (e.g. flashbacks) where the individual feels or acts as if the traumatic event(s) were recurring		Persistent, distorted cognitions about the cause or consequences of the traumatic event(s) that lead the individual to blame themselves or others	Hypervigilance	Disturbance is not attributable to the physiological effects of a substance (e.g. medication, alcohol) or another medical condition
Intense or prolonged psychological distress at exposure to internal or external cues that resemble the traumatic event(s)		Persistent negative emotional state (e.g. fear, horror, anger, guilt, or shame)	Exaggerated startle response	
Physiological reactions to internal or external cues that resemble an aspect of the traumatic event(s)		Markedly diminished interest or participation in significant activities	Problems with concentration	
		Feelings of detachment or estrangement from others	Sleep disturbance (e.g. difficulty falling or staying asleep or restless sleep)	
		Persistent inability to experience positive emotions (happiness, satisfaction, or loving feelings)		

Table 2. Demographic and Pain Characteristics

	PTSD – Negative N=121	PTSD – Positive N=29	p-value
Age – mean (SD)	36.8 (9.90)	39.7 (11.7)	0.22
Sex			
-- Male	48 (39.7%)	17 (58.6%)	0.09
-- Female	73 (60.3%)	12 (41.4%)	
Pain severity (AVG)	4.17 (1.81)	5.14 (1.53)	< 0.01
Pain duration (months)	50.2 (67.7)	54.8 (57.5)	0.24
TMD diagnosis			
-- Masticatory muscle pain	97 (80.2%)	27 (93.1%)	0.17
-- TMJ pain	24 (19.8%)	2 (6.9%)	

Note. Means and Standard Deviations (SD) shown. Pain severity based on 0-10 numerical rating scale.

Table 3. PTSD Severity, Affect, and Sleep Dysfunction

	PTSD – Negative N=121	PTSD – Positive N=29	p-value
GAD-7	5.06 (4.46)	15.5 (5.25)	< 0.01
PHQ-9	4.65 (4.08)	16.3 (6.24)	< 0.01
PCL-C	9.83 (9.0)	53.07 (13.3)	< 0.01
ISI	8.92 (5.60)	19.9 (5.72)	< 0.01

Note. GAD-7, Generalized Anxiety Disorder-7; PHQ-9, Patient Health Questionnaire-9; ISI, Insomnia Severity Index.

Table 4. Frequency of Traumatic Stressors

	Happened to Me	Directly Witnessed It
Natural Disaster	67	10
Fire or Explosion	27	29
Transportation Accident	90	11
Accident (home, work, recreation)	33	23
Toxic Substance Exposure	31	1
Physical Assault	55	13
Assault with a Weapon	21	17
Sexual Assault	33	3
Other Unwanted Sexual Experience	49	4
Combat	52	8
Captivity	3	2
Life Threatening Illness or Injury	17	47
Severe Human Suffering	4	32
Sudden Violent Death	6	33
Sudden Accidental Death	7	19

Serious Injury/Harm/Death You Caused	11	5
Other	73	5

Note. Most study participants reported experiencing and witnessing multiple stressors.

Table 5. Mediation Analyses Pain Severity/PTSD

	Estimate	95% CI	Semi-partial	p-value
GAD-7				
Direct effect of PTSD on Pain	0.10	-0.58-1.37		0.42
Total effect of PTSD on Pain	0.98	0.25-1.70		<0.01
Proportion mediated by GAD-7 score	0.58	-0.06-2.27	-0.02	0.09
PHQ-9				
Direct effect of PTSD on Pain	0.59	-0.39-1.57		0.23
Total effect of PTSD on Pain	0.97	0.29-1.66		<0.01
Proportion mediated by PHQ-9 score	0.39	-0.41-1.73	0.08	0.31
ISI				
Direct effect of PTSD on Pain	0.48	-0.40-1.38		0.26
Total effect of PTSD on Pain	0.98	0.27-1.66		0.01
Proportion mediated by ISI score	0.51	-0.12-1.80	0.08	0.08

Note. GAD-7, Generalized Anxiety Disorder questionnaire-7 (assesses symptoms of generalized anxiety); PHQ-9, Patient Health Questionnaire-9 (assesses symptoms of depression); GAD-7, ISI, Insomnia Severity Inventory (assesses symptoms of sleep dysfunction).

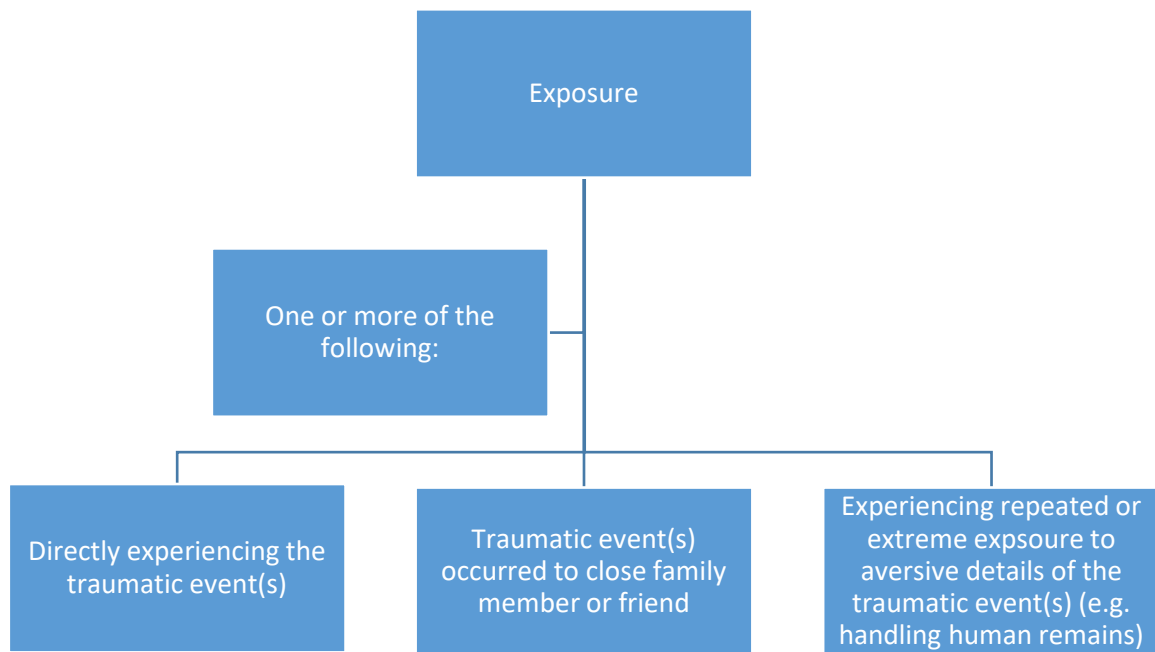


Figure 1. Diagnostic criteria of PTSD as defined by DSM-V.

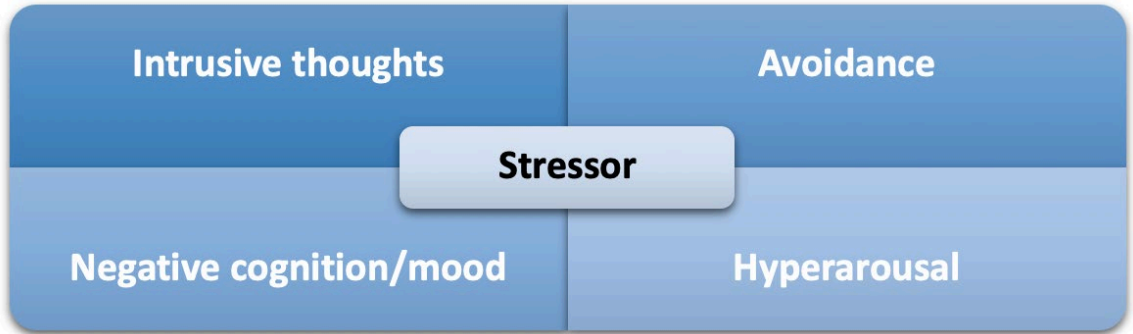


Figure 2. PTSD – Cluster of symptoms

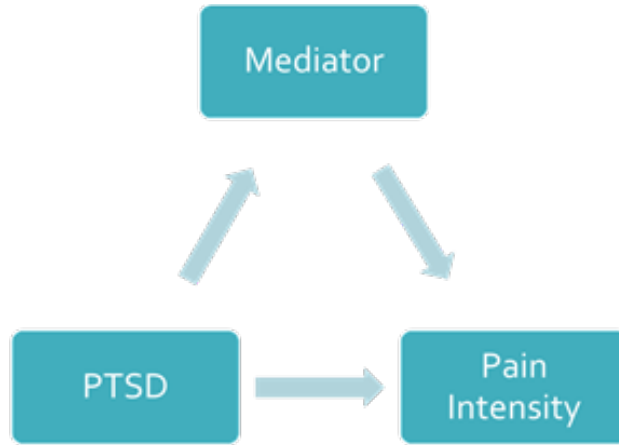


Figure 3. Mediation analysis

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