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Relations between PTSD symptoms and pain interference among older adults

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RELATIONS BETWEEN PTSD SYMPTOMS AND PAIN INTERFERENCE AMONG OLDER ADULTS

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Abstract

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Both the older adult population and the frequency of natural disasters (e.g., hurricanes) increase in the U.S. each year. Consequently, understanding the health experiences that affect older adults following a natural disaster is important for providing effective healthcare and promoting health expectancy. For example, the extent to which PTSD symptoms following a natural disaster contribute to pain severity (beyond the contributions of other psychosocial experiences such as depression) among older adults is not yet clear, and whether this contribution differs by gender or age has yet to be established. The aims of this study were (1) to determine whether symptoms of PTSD after a natural disaster uniquely contribute to pain interference in daily activities, and (2) to examine the potential moderating effects of gender and age on this relation. Secondary analyses were conducted using an existing longitudinal dataset from the Ongoing Research on Aging in New Jersey: Bettering Opportunities for Wellness in Life (ORANJ BOWL) project (N =1,809, M_{Age} = 67.7 years, 68% women). Results showed that PTSD symptoms are a unique contributor to pain interference and that avoidance symptoms accounted for the greatest amount of variance among the PTSD symptoms subscales. However, neither age nor gender moderated the relation between PTSD (and avoidance) symptoms and pain interference. These results may assist public health officials with response planning to natural disasters, as resources and treatments can be provided to address the relation between PTSD and pain interference in the increasing population of older adults.

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Chapter 1
Introduction

An estimated 50 million adults in the U.S. report chronic pain, with higher prevalence among those at older ages (Dahlhamer, 2018). Both gender and age are associated with the presentation of pain, with older adults reporting greater pain problems compared to younger individuals (Schofield, 2007), and more widespread pain among older women compared to men (Leveille, Zhang, McMullen, Kelly-Hayes, & Felson, 2005). The prevalence of chronic pain among those 60 or older ranges from 39%-78%, with women and those endorsing mood disorders reporting chronic pain at higher rates (relative to men and those without chronic pain; Larsson et al., 2017; Stompór, et al., 2019). Less is known about relations between Post Traumatic Stress Disorder (PTSD) symptoms and the typical experience of pain among older adults who report chronic pain, especially when PTSD presentation follows a natural disaster such as a hurricane. Additional information about this relation could be useful for understanding the maintenance, assessment, and treatment of pain in this population.

Chronic Pain

Chronic pain is defined by the International Classification of Disease as "persistent or recurrent pain lasting longer than 3 months" (Treede et al., 2015), with additional categories for classification to specify the type of chronic pain. Chronic pain conditions include neuropathic pain, complex regional pain syndrome, chronic musculoskeletal pain, chronic or recurrent abdominal pain, and headaches (Rajapakse, Liossi, & Howard, 2014). Chronic pain among adults is most commonly reported as widespread pain, shoulder pain, and lower back pain (McBeth & Jones, 2007). Many chronic pain conditions negatively impact an individual's quality of life; for example,

those with chronic pain (compared to those with acute pain) report greater difficulty falling and staying asleep, poorer sleep quality, decreased employment productivity, and less enjoyment of the time spent with their significant other, resulting in an overall decreased quality of life (McCarberg, Nicholson, Todd, Palmer & Penles, 2008). A review of 68 studies examining the effects of chronic pain on daily activities and health-related quality of life found that individuals with chronic pain also experienced negative impacts on their relationships with their family, work, and social environments (Dueñas, Ojeda, Salazar, Mico, & Failde, 2016). The annual cost of chronic pain in the United States, including the cost of lost productivity due to pain, is estimated to be between $560 and $635 billion (Gaskin & Richard, 2011).

Historically, diagnoses such as chronic pain were explained by the biomedical model, which accounted for an individual's symptoms as a product of a flaw in their biological system (National Research Council Committee [U.S.], 1998). This model did not include the psychological, social, and behavioral factors that are now understood to affect health. To account for these elements, a new model – the biopsychosocial model – was proposed in 1977 by George Engel. This model included recognition that psychological and social circumstances can impact the onset and course of a disease (e.g., an individual's level of social support protecting against heart disease). As psycho-physiological responses in daily life can impact the severity and course of a disease, an individual's perception of their illness also needs to be taken into account (Engel, 1977). This model is largely accepted in scientific communities today as a more humanized and holistic approach to medical care, relative to the biomedical model (Borrell-Carrio, Suchman, & Epstein, 2004). This model is also one of the most commonly used for pain,

as the perception of pain can be considered multidimensional and affected by psychological, social, and biological factors (Meints & Edwards, 2018). This concept is further supported by the changes in pain perception following psychotherapy, which successfully reduces psychological factors that increase pain perception, as well as the behavioral expression of pain (i.e., posture adjustments, activity level, etc.; Zanini, Voltolini, Gragnano, Fumagalli, & Pagnini, 2018; Songer, 2005; Morley, Eccleston, & Williams, 1999).

Individual Differences in Chronic Pain Experiences and Symptoms: Gender, Age, and Emotional Experiences

An important feature of chronic pain is that individual differences may be associated with perceptions of pain, such as age (Lautenbacher et al., 2005) and gender (Bartley & Fillingim, 2013). For example, women are more likely to receive diagnoses of pain conditions and report stronger pain severity than men, and pain severity also is positively associated with higher pain catastrophizing, severe insomnia, high anxiety levels, and older age (Park et al., 2016). Older adults tend to have more pain problems compared to younger individuals (Schofield, 2007), and more widespread pain is reported among older women compared to men (Leveille, Zhang, McMullen, Kelly-Hayes, & Felson, 2005). The prevalence of chronic pain among those even 60 years or older ranges from 39%-78% (Larsson et al., 2017; Stompór, et al., 2019) and older adults (65 years and older) also tend to experience other health conditions that have been associated with increased pain perception, such as depression (Skoog, 2011) – and, among women, increased BMI (Flegal et al., 2016).

Pain also impacts emotional experiences; increases in pain are associated with increased negative affect and decreased positive affect that may carry over to the next day among older adults, and is especially seen among individuals with lower levels of functioning (Katana, Rocke, Spain, & Allemand, 2019). Functioning is impacted by pain, and among older adults, there is an increased rate for disability (Makino et al., 2019), poor physical performance (Bryant, Grigsby, Swenson, Scarbro, & Baxter, 2007), and increased frailty and exhaustion (Nakai et al., 2019). Pain also is associated with emotional functioning more broadly (i.e., depression, Kroenke et al., 2011; Sheng et al., 2017), as discussed further below.

Thus, existing work suggests that understanding pain experiences among older adults – particularly gender differences in these experiences – would be useful for improving long-term health outcomes. One aspect of pain that has received little attention in this population is its relation with Posttraumatic Stress Disorder (PTSD) symptoms. For example, a recent systematic review identified only three studies from 2000 to January 2020 that examined persistent pain and interpersonal trauma among older adults (Maccarrone, Stripling, Lannucci, & Nierenberg, 2020). Additional information about this relation could be useful for understanding the maintenance, assessment, and treatment of pain in this population.

Post- Traumatic Stress Disorder (PTSD)

PTSD is one of the few disorders for which a causal event can often be identified. A traumatic event leads an individual to associate the fear experienced during trauma with conditioned stimuli (e.g., settings, people, thoughts); it may be described as a failed recovery of fear conditioning, as ideally, over time an individual experiences decreased

fear associated with a stressful event (Kirkpatrick & Heller, 2014). Until recently, PTSD symptoms were categorized into three different clusters: intrusion/re-experiencing symptoms, avoidance symptoms, and symptoms of (hyper-)arousal. The category of negative cognitions and mood was added in the most recent revision of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V; American Psychiatric Association, 2013). Across these definitions, symptoms associated with PTSD also include physical illness complaints such as musculoskeletal, nervous, sensory, cardio-respiratory, gastrointestinal, and vague symptom presentations (Pacella, Hruska, & Delahanty, 2013). PTSD has been associated with poor quality of life and an increased use of health services (Atwoli, Stein, Koenen, & McLaughlin, 2015).

Among adults ages 65 and older who had been diagnosed with PTSD at one time point, 30% were re-diagnosed with PTSD at a later period, suggesting the need for increased access to effective treatment in this population (Chopra et al., 2014). Even among those with comorbid depression and generalized anxiety, symptoms of PTSD were independently associated with worse mental health quality of life (Chopra et al., 2014). Paired with developmental changes, increased life stressors present greater challenges for older adults (compared to younger adults), such as loss of mobility, decreased income, increased health problems, and loss of friends, may present additional difficulties when an individual has unresolved trauma (Cook, 2001). Individuals may seek to manage PTSD symptoms in early adulthood and during midlife by taking part in avoidance-based coping strategies, such as drinking alcohol (Read, Griffin, Wardell, & Ouimette, 2014), which may become less effective with increasing age due to other factors, such as medication interactions (Moore et al., 2006). Older adults who experience

a greater number of chronic stressors may also tend to rely on coping strategies associated with cognitive avoidance and emotional discharge (i.e., attempting to ignore a stressor, using behaviors such as shouting to reduce tension; Moos, Brennan, Schutte, & Moos, 2006).

Individual Differences in PTSD Experiences and Symptoms

PTSD can be comorbid with clinically significant anxiety, depression, and lower mental health quality of life, especially in men (Chopra et al., 2014). However, women have also been found to have a higher risk of developing PTSD than their male counterparts (Olff, 2017), and have a higher lifetime prevalence rate of PTSD (12.8%) than men (5.7%) (Kilpatrick, 2013). Women in the midlife and older adult age ranges (45 years and older) may also be more likely to have experienced intimate partner violence as a form of interpersonal trauma than men in these age ranges, and may have experienced this type of trauma for longer periods if they remained in a violent relationship (Wilke & Vinton, 2005). In addition, compared to younger individuals, older adults are twice as likely to experience PTSD symptoms after being exposed to a natural disaster (e.g., less likely to receive early technology warnings for evacuation, experience greater loss, have lower social support, etc.; Parker et al., 2016).

Symptoms of PTSD may be overlooked in older adults because PTSD as a formal diagnosis is relatively new; it first appeared as a diagnosis in 1980 with the third version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III; Crocq, 2000). Thus, older adults who had exposure to traumatic events early in life may have had symptoms that were not identified or optimally classified at that time (Thorp et al., 2011), and may continue to experience PTSD symptoms without a formal diagnosis.

Comorbidity Between Chronic Pain and PTSD

Chronic pain and PTSD are commonly comorbid (Brennstuhl, Tarquinio, & Montel, 2015; Outcalt et al., 2015; Asmundson, Coons, Taylor, & Katz, 2002). These conditions share similar mechanisms of fear, avoidance, anxiety sensitivity, and catastrophizing (Otis, Keane, & Kerns, 2003). The two disorders also have a shared neuroanatomy and neurobiology (Scioli-Salter et al., 2015); specifically, researchers have suggested that the co-prevalence of the two disorders is due to the shared pathophysiological mechanisms that involve stress-stimulated responses of the peripheral and central nervous systems (Scioli-Slater et al., 2015). There is also a shared dysregulation of the opioid, endocannabinoid, and immune systems in both chronic pain and PTSD (Scioli-Slater et al., 2015). This is significant because it lends support to the idea that these two disorders may be treated together, as they rely on some of the same systems, and evidence has shown that treatment using an interdisciplinary pain rehabilitation program is effective (Scioli-Salter et al., 2015; Gilliam et al., 2020).

The Mutual Maintenance Model

Sharp and Harvey (2001) proposed a model that sought to explain the bidirectional relation between PTSD and chronic pain, which they called the Mutual Maintenance Model. This model explains the comorbidity of PTSD and chronic pain as each having components that maintain one another. For example, chronic pain from a traumatic event may serve as a reminder of that event each time it is experienced, which may then increase pain perception due to the elevated anxiety caused by PTSD (Sharp & Harvey, 2001). This relation suggests a number of shared areas that can be targeted in behavioral interventions, including attentional and reasoning biases, anxiety sensitivity,

reminders of the trauma, avoidance, depressive symptoms and reduced psychomotor activity, anxiety and pain perception, and cognitive demand from symptoms limiting use of adaptive strategies (Sharp & Harvey, 2001). However, a recent study among injured and non-injured veterans found that the Mutual Maintenance Model may not apply to individuals whose pain is not associated with a trauma-related physical injury (Lee et al., 2019). The study also found that PTSD symptoms did not drive changes in pain interference; rather, reports of higher pain interference contributed to higher PTSD symptoms reported. The study acknowledged that additional research is needed for the examination of these relations in civilian populations.

Several depressive symptoms also appear in the updated definition of PTSD, including negative affect, decreased interest in activities (i.e., anhedonia), difficulty concentrating, and difficulty sleeping (American Psychiatric Association, 2013). Major Depressive Disorder (MDD) is a mood disorder that consists of five or more of the following symptoms present for at least two weeks: depressed mood for most of the day, diminished interest in activities, significant weight loss, insomnia or hypersomnia, psychomotor agitation or retardation, fatigue or loss of energy, feelings of worthlessness or guilt, diminished ability to think or concentrate, and/or recurrent thoughts of death (American Psychiatric Association, 2013). The prevalence of meaningful depressive symptoms appears to increase with age (Solhaug et al., 2012), with an estimated lifetime prevalence of major depression in people 50 years or older at 16.5% (Volkert et al., 2013). Depression among older adults is also likely to be comorbid with at least one other condition, which may limit pharmacologic treatment options as the risk for drug-to-drug interactions and adverse drug events may then be increased (Bradley et al., 2016).

Furthermore, high levels of comorbid MDD have been found in studies of individuals with PTSD, with some results suggesting that the comorbidity is not just due to the overlap in diagnostic criteria (Franklin & Zimmerman, 2001; Flory & Yehuda, 2015). Rather, MDD may represent a subtype of PTSD. Compared to MDD alone, comorbid MDD and PTSD has been associated with more severe depressive symptoms and greater health care utilization (Campbell et al., 2007). The comorbid presentation of PTSD and MDD also tends to be associated with bodily pain that is not classified as chronic and higher reports of somatic symptoms (Armenta et al., 2019). Similarly, comorbid chronic pain and MDD are prevalent among older adults, and research has found that they have a bidirectional relation (Zis et al., 2017), much like the relation between chronic pain and PTSD. As such, it would be useful to differentiate the contributions of PTSD and MDD symptoms to chronic pain experiences among older adults, as an initial step toward informing improvements to existing clinical services for this population.

PTSD Following Natural Disasters

Understanding the boundaries of the relations between PTSD and chronic pain among older adults, above and beyond the contributions of depressive symptoms, is important for promoting quality of life and health outcomes for a growing population. Natural disasters, such as earthquakes, tornadoes, and hurricanes, can cause an increase in PTSD prevalence for those near the events (Farooqui et al., 2017; Niederkrotenthaler et al. 2013; Kessler et al., 2008). The prevalence of PTSD among direct victims of disasters ranges between 30% and 40% (Neria, Nandi, & Galea, 2008), and PTSD may even continue after the disaster, with research indicating an increase 3-9 months later (Wang et

al., 2000), and even a prevalence rate of 11.7% at 3 years post-disaster (Onder et al., 2006). Location and exposure are also indicators of the prevalence rate of PTSD, as rates may increase the closer an individual is to the epicenter of the disaster (Basoglu et al., 2004). Natural disasters are becoming increasingly common, as climate change affects not only weather, but increases in adverse health outcomes (e.g., decrease in crops and food supply which can lead to malnutrition and famine; increase in water, temperature and moisture can increase vector organisms like mosquitos spread diseases such as malaria; Berlemann & Steinhardt, 2017; Patz et al., 2018).

Climate change increases both the number of natural disasters experienced in the U.S. and their severity, which can change individual living conditions and impact resources as people migrate (Berlemann & Steinhardt, 2017). With continued advancement in technology, more detailed predictions for effects of natural disasters can be made using geographical information system (GIS) mapping, which can help states specify the localities most at risk for effects such as flooding, wind damage, etc. (Holser, 2016). GIS can be used to promote preparedness in those at-risk areas and understand how to best distribute resources to those who may need them. More importantly, by knowing the locations of individuals who may have additional risk factors for PTSD or who may already be experiencing other factors that contribute to a mutual maintenance of multiple comorbid disorders, preventative measures can be taken before a natural disaster occurs within the area (Heid, Pruchno, Cartwright, & Wilson-Genderson, 2017). For example, a social vulnerability index, similar to one used by the Centers for Disease Control and Prevention, could be used to identify vulnerable populations to plan for specific resources to be provided to populations in those areas in the event of a disaster.

Additional tailoring of interventions for a specific subgroup may also be beneficial, and by understanding the boundaries of the relations between PTSD and chronic pain, we would have the ability to increase the quality of life for individuals who may be most vulnerable – especially if preventative measures can be taken for those who may be in the path of a potentially traumatic natural disaster.

As noted, understanding the relation between chronic pain and PTSD among older adults would be informative for a range of clinical services (e.g., assessment, treatment), particularly an examination of additional factors that may impact relations between these two experiences. This information would be useful for identifying individuals who may be at an elevated risk for health consequences of this comorbidity after a traumatic event such as a natural disaster, and providing them with additional resources.

Study Aims and Hypotheses

Together, existing literature suggests that the comorbid experience of chronic pain and PTSD is common among older adults, which may contribute to meaningful functional limitations and poor health expectancy. A better understanding of relations between these comorbid conditions is needed, with particular attention to individual difference characteristics associated with stronger relations between symptoms of chronic pain and PTSD (e.g., age, gender). To address this goal, the current study used secondary data analysis to investigate the associations between PTSD symptoms and pain interference among older adults in New Jersey.

The primary aim (1) of the study was to examine relations between PTSD symptoms and pain interference in the older adult population following a natural disaster, above and beyond the contributions of depressive symptoms and pain severity. We

hypothesized that, when controlling for depressive symptoms and pain severity, overall PTSD symptom severity would be positively associated with pain interference in daily life.

The secondary aim (2) was to determine the relations between the specific PTSD symptom clusters and pain interference in the older adult population, above and beyond any existing contributions from depressive symptoms and pain severity. The first hypothesis for this aim is that, controlling for depressive symptoms and pain severity, greater severity of avoidance symptoms would be positively associated with reported pain interference. Further, that avoidance symptoms would show the strongest positive association between symptoms and pain interference (compared to arousal and re-experiencing symptom clusters).

The tertiary aim (3) of the current study was to determine the boundaries of relations between overall PTSD symptoms and pain interference by examining moderators of this relation (i.e., age and gender), after accounting for the contribution of depressive symptoms and pain severity. The respective hypotheses were that gender and age would moderate relations between PTSD symptoms and pain interference, with a stronger relation between PTSD symptoms and pain interference among women (compared to men) and among those at older ages (compared to younger ages).

The final aim (4) was to determine the boundaries of the relations between avoidance symptoms and pain interference in the older adult population, above and beyond any existing contributions from depressive symptoms and pain severity. The hypothesis for this aim was that, compared to the other symptom clusters, gender and age would moderate the relation between avoidance symptoms and pain interference, with

stronger positive associations among women (compared to men) and among those at older ages (compared to younger ages).

Chapter 2

Methods

Study Overview: Design and Data Collection

This study used secondary analyses examining archival data from the Ongoing Research on Aging in New Jersey: Bettering Opportunities for Wellness in Life (ORANJ BOWL) data set. Data were collected by researchers at Rowan School of Osteopathic Medicine's Institute for Successful Aging to better understand environmental and societal characteristics that support healthy aging. Participants were required to be permanent residents of New Jersey, fluent in English, and between the ages of 50-74 at baseline. Those who met these criteria were contacted via phone between November 2006 and April 2008. They were asked a series of questions at multiple time points; at follow-up assessments, data were collected via both telephone calls and mailed questionnaires. The full ORANJ BOWL sample included 5,688 adults ages 50-74 (2,067 men and 3,621 women), with a mean age of 60.7 years at baseline (*SD* = 7.10).

For the current study, the data from a single time point were used, and this assessment occurred immediately following Hurricane Sandy. In order to access ORANJ BOWL data, researchers completed a formal data request that specifies the rationale for their analyses and the variables desired (see Appendix A). Data requested for the proposed study included responses to demographic items, pain, and PTSD items, as well as variables that may affect the relation between pain and PTSD, such as depressive symptoms.

Participants

The sample size for this study was determined by the number of ORANJ BOWL participants who meet criteria for reporting experiencing pain at both Time 1 (baseline) and Time 4 (after Hurricane Sandy). The resulting sample (i.e., older adults who indicated that they are "Sometimes," "Often," or "Almost always" troubled with pain at both Time 1 and Time 4) included 1,809 adults with a mean age of 67.68 years at T4 (*SD* = 6.96, 68% women). The estimated mean age at the time of Hurricane Sandy (~1 year earlier) was 65.83 years (*SD* = 6.97). Participants were predominantly White (86.8%), non-Latina/o (97.7%); 68.6% of the sample had an education level of some college or higher. See Table 1 for additional demographic information.

Table 1

Sociodemographic Characteristics of Participants

Baseline characteristics	Full sample (*n* = 1,809)	
	n	%
Gender		
Women	1230	68.0
Men	579	32.0
Race/Ethnicity		
Caucasian/White	1526	86.8
African American/Black	180	10.2
Asian or Pacific Islander	22	1.3
American Indian or Alaskan Native	2	0.1
Hispanic/Latino [a]	42	2.3
Other	28	1.6
Highest educational level		
Less than High School	71	3.9

Baseline Characteristics	*n*	*%*
High School or GED	493	27.3
Some College	290	16.1
2-Year College Degree (Associate's)	186	10.3
4-Year College Degree (Bachelor's)	356	19.7
Some Master's Degree Credits	79	4.4
Master's Degree	241	13.1
Some Doctoral Work	24	1.3
Doctoral Degree	66	3.7

Measures

Demographics. Multiple demographic items were assessed at baseline, including race, ethnicity, gender, education level, and age. All demographic information was gathered via self-report. Age was calculated by subtracting the participant's reported date of birth from the date the interview took place. The participants were also asked to choose the race they believed best described them from the interviewer's list: African American or Black, Caucasian or White, Asian or Pacific Islander, American Indian or Alaskan Native, or something else (which they would then be asked to specify).

Pain Items (see Appendix B). Pain was measured using questions targeting presence, severity, and interference in daily activities. For pain presence, participants were asked, "*How often are you troubled with pain?"* to which they had the response options, "*Almost always (1), Often (2), Sometimes (3), Almost never (4), Don't know (98), or Refused (97)*". This question served as the inclusion criterion for the current study. The second question posed to participants was, "*How bad is the pain most of the time (when medicated)?"* The response options for this question were, "*Mild (01), Moderate (02),*

Severe (03), Don't know (98), or Refused (97)." The final question asked was, *"How often does the pain make it difficult for you to do your usual activities such as household chores or work?"* Answer options were "*Almost always (1), Often (2), Sometimes (3), Almost never (4), Don't know (98), or Refused (97).*" Pain interference was chosen as the dependent variable over pain presence and pain severity because interference is a recommended measure to determine the impact of pain on an individual's quality of life (Jensen, 2011).

Post-Traumatic Stress Disorder Symptom Scale-Self Report (PSS-SR; Foa, Riggs, Dancu, & Rothbaum, 1993; see Appendix B). This scale consists of 17 items related to symptoms over the past month, which are rated on a scale of 0 (*Not at all or only one time)* to 3 (*Almost always or five or more times per week)*. The questionnaire is designed to assess symptoms in accordance with the DSM-IV, therefore the subscales consist of re-experiencing, avoidance, and arousal. A total score of 14 or higher indicates potential for clinically significant PTSD. This scale has been found valid and reliable (Foa, Cashman, Jaycox, & Perry, 1997; Coffey, Gudmundsdottir, Beck, Palyo, & Miller, 2006; Mirzamani et al., 2007). For the ORANJ BOWL study, items on the PSS-SR were tailored in order to reflect trauma specific to Hurricane Sandy (e.g., *"Having upsetting thoughts or images about Sandy come to mind when you didn't want them to", "Having bad dreams or nightmares about Sandy", "Reliving Sandy, acting or feeling as if it were happening again"*). The subscales of Avoidance, Arousal, and Re-experiencing were calculated based on the instruction from Foa et al. (1993) that the subscale scores are determined using the same criteria as the PSS-SI. The PSSI Manual (see Appendix B) was used to sum each subscale score. Subscales for PTSD were determined using

indication from Foa et al. (1993) guidelines, and each PSS-SR question was matched respectively with the subscale of Re-Experiencing, Avoidance, and Arousal**.** In the present study, the PTSD scale was found to have good reliability (17 items; α = 0.86). Each subscale also had acceptable internal consistency; Re-Experiencing (5 items; α = 0.77), Avoidance (7 items; α = 0.75), Arousal, 5 items; α = 0.77).

Center for Epidemiologic Studies Depression Scale (CES-D short form; Andresen, Malmgren, Carter, & Patrick, 1994; see Appendix B). The 10 items on this scale are rated from 0 (*None of the time*) to 3 (*Most of the time*), for a total possible score of 30. The score for a potential threshold indicating depression is a score of 10 or higher (Andresen et al., 1994). The CES-D is a valid and reliable measure for detecting depressive symptoms, including in midlife and older adults (Cosco, Prina, Stubbs, & Wu, 2017; Mohebbi et al., 2018). In the present study, Cronbach's alpha was acceptable, although not as high as the PTSD items (10 items; α = 0.65).

Data Analysis

All analyses were conducted using IBM SPSS Statistics software. Descriptive statistics were used to examine the extent of pain interference and PTSD symptoms, as well as depressive symptoms and other variables of interest. The proportion of participants who met or exceeded clinical cutoffs for PTSD and depression measures are described with frequencies. Bivariate correlations and *t*-tests (by gender) were conducted to determine relations between variables of interest prior to conducting formal hypothesis tests.

The primary hypothesis was tested with a general linear model to determine whether PTSD symptoms are uniquely and positively associated with pain interference in

daily life, while controlling for depressive symptoms (Model 1). The secondary hypothesis was tested using Hayes' PROCESS macro for SPSS (Hayes, 2013), to determine (1) whether gender moderates the relation between PTSD and pain interference, with the expectation that this relation would be stronger among women than men (Model 2), and (2) whether age moderates the relation between PTSD and pain interference, with the expectation that older individuals would show stronger relations between these experiences than younger individuals (Model 3). Lastly, the relation between PTSD symptom clusters (i.e., Avoidance, Arousal, Re-Experiencing) and pain interference was examined using a general linear model (Model 4). Specifically, Avoidance was hypothesized to have the strongest relation and account for the most variance compared to the other subscales. Age and gender were then tested as moderators of this relation between Avoidance and pain interference using the SPSS PROCESS macro.

Each of the moderation analyses were created as separate models and model comparisons were used to determine the addition of variance explained, using a formal test of change in R^2. Unique effect sizes of PTSD total score and subscale scores as predictors are expressed as partial eta squared (η_p^2). The current sample size of 1,809 adults afforded power > 0.95 to detect a small effect size ($f^2 = 0.02$) with these analyses.

Missing Data. Across variables of interest, missing data were 13.5% of expected values. To limit potential bias due to missing data, primary analyses were run using both the default listwise deletion approach and multiple imputation. Results were compared to determine the appropriate dataset for the remaining analyses. Although the majority of the models were similar with respect to the change in R^2 (e.g., within 0.1), there were

some differences in individual variable contributions and moderation effects. Consequently, the multiple imputation dataset was used for the remainder of analyses. Listwise deletion analyses are summarized in Appendix C.

Chapter 3

Results

Descriptive Statistics

As noted, included participants were those who met criteria for reporting pain at both Time 1 and Time 4, which included 1,809 adults with a mean age of 67.68 years at T4 (*SD* = 6.96, 68% women). Average age at the time of Hurricane Sandy (~1 year earlier) was 65.83 years (*SD* = 6.97). Pain interference (*M* = 2.83, *SD* = 1.08) met assumptions of normality, and both men and women reported that pain interference sometimes made it difficult to do their usual activities (women, 38.2%; men, 36.5%). Women's reports of pain interference (*M* = 2.91, *SD* = 1.09) were significantly greater than men's reports (*M* = 2.65, *SD* = 1.00); $t[1807] = 4.92$, $p = 0.00$).

Average scores for PTSD symptom severity (*M* = 2.03, *SD* = 3.98) and subscales, Re-Experiencing (*M* = 0.48, *SD* = 1.26), Avoidance (*M* = 0.55, *SD* = 1.74), and Arousal (*M* = 0.99, *SD* = 2.08) were below the clinical threshold and were zero inflated, which contributed to a positive skew of PTSD total scores. Women tended to report more PTSD symptoms (*M* = 2.19, *SD* = 4.11) compared to men (*M* = 1.66, *SD* = 3.69), which was significantly different ($t[1807] = 2.65$, $p = 0.008$). Approximately 2.9% (*n* = 53) of participants met the clinical threshold for PTSD, scoring 14 or higher on the PSS-SR. Of this group, 67% (*n* = 36) were women (*M* = 19.58, *SD* = 5.34) and 32% (*n* = 17) were men (*M* = 17.71, *SD* = 3.31). There was no significant difference between gender for PTSD clinical threshold ($t[51] = 1.33$, $p = 0.19$).

Average scores for depressive symptoms (CESD; *M* = 9.44, *SD* = 4.41) were also below clinical threshold, and had a slight positive skew. Women tended to report a

significantly higher amount of depressive symptoms (M = 9.79, SD = 4.54) than men (M = 8.71, SD = 4.03; t[1807] = 4.90, p = 0.00). Of those who reported depressive symptoms, 10.3% (n = 186) were above the clinical threshold (16 or higher). Women constituted 80% (n = 149) of those with scores of 16 or higher, however there was not a significant difference between gender for those above the clinical threshold (women; M = 18.75, SD = 2.81; men; M = 18.58, SD = 2.67; t[184] = 0.33, p = 0.741).

Finally, pain severity (M = 2.55, SD = 0.67) was more often reported by women than men, with 7.8% of severe pain reported by women, compared to 5.4% of men. Among women, the highest amount of pain severity reported was moderate (46.5%), while men reported more mild severity (52.4%). The difference in pain severity reports between women (M = 2.58, SD = 0.65) and men (M = 2.48, SD = 0.69) was significantly different, with women reporting higher pain severity (t[1807] = 3.06, p = 0.002).

Bivariate analyses showed significant correlations between CESD and pain severity, pain interference, PTSD, and the PTSD subscales (see Table 1). Pain severity and pain interference were also significantly correlated with one another, which was expected. Interestingly, there was a noticeably higher correlation between the Arousal subscale and CESD and Pain Severity scores compared to the other PTSD subscales.

Table 2

Descriptive Statistics and Correlations for Study Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Age	67.68	6.96	—						
2. Pain Severity	2.55	0.67	0.03	—					
3. Pain Interference	2.83	1.07	0.02	0.51**	—				
4. CESD Total Score	9.45	4.41	-0.04	0.25**	0.29**	—			
5. PTSD Total Score	2.03	3.98	-0.02	0.20**	0.22**	0.39**	—		
6. Re-Experiencing Subscale Score	0.49	1.27	-0.02	0.12**	0.13**	0.23**	0.70**	—	
7. Avoidance Subscale Score	0.55	1.75	0.01	0.13**	0.17**	0.29**	0.79**	0.44**	—
8. Arousal Subscale Score	0.99	2.08	-0.04	0.20**	0.19**	0.36**	0.82**	0.37**	0.41**

**Correlation is significant at the 0.01 level (2-tailed); n = 1809.

Relation Between PTSD and Pain Interference

To address Aim 1, general linear models were used to test the hypothesis that, when controlling for depressive symptoms and pain severity, PTSD symptom severity (total score) would be positively associated with pain interference in daily life. The model including only covariates as predictors (i.e., depressive symptoms and pain severity) accounted for 28% variance in pain interference (B = 0.53, SE = 0.9, F[2, 1809] = 367.7, $p < 0.001$). With the addition of PTSD total score, R^2 for the full model was 0.35. The independent contribution from PTSD was significant and positive (B =1.33, SE = 0.92, F[115, 1809] = 1.24, $p = 0.048$, $\eta_p^2 = 0.08$), and the change in R^2 was small but significant, ($\triangle R^2 = 0.004$, $\triangle F$[1, 1805] = 10.06, $p = 0.002$). These results support the hypothesis that PTSD symptoms uniquely and positively contribute to pain interference, above and beyond the contribution of depression and pain severity. Please refer to Table 2 for the full model results and Table 3 for the individual linear predictor results. Figure 1 provides the visual representation of the relation between PTSD and pain interference.

Table 3

Univariate GLM Analysis of PTSD and Pain Interference

	B	SE	df	*MS*	*F*(117, 1809)	η^2
Corrected Model	--	---	117	6.15	7.6***	0.35
PTSD Total Score	---	---	115	1.00	1.24**	0.08
Intercept	1.33	0.92	1	36.87	45.56***	0.03
CESD Total Score	0.03	0.01	1	26.94	33.28***	0.02
Pain Severity	0.74	0.03	1	370.98	458.39***	0.21

** $p < .05$. *** $p < .001$.

Table 4

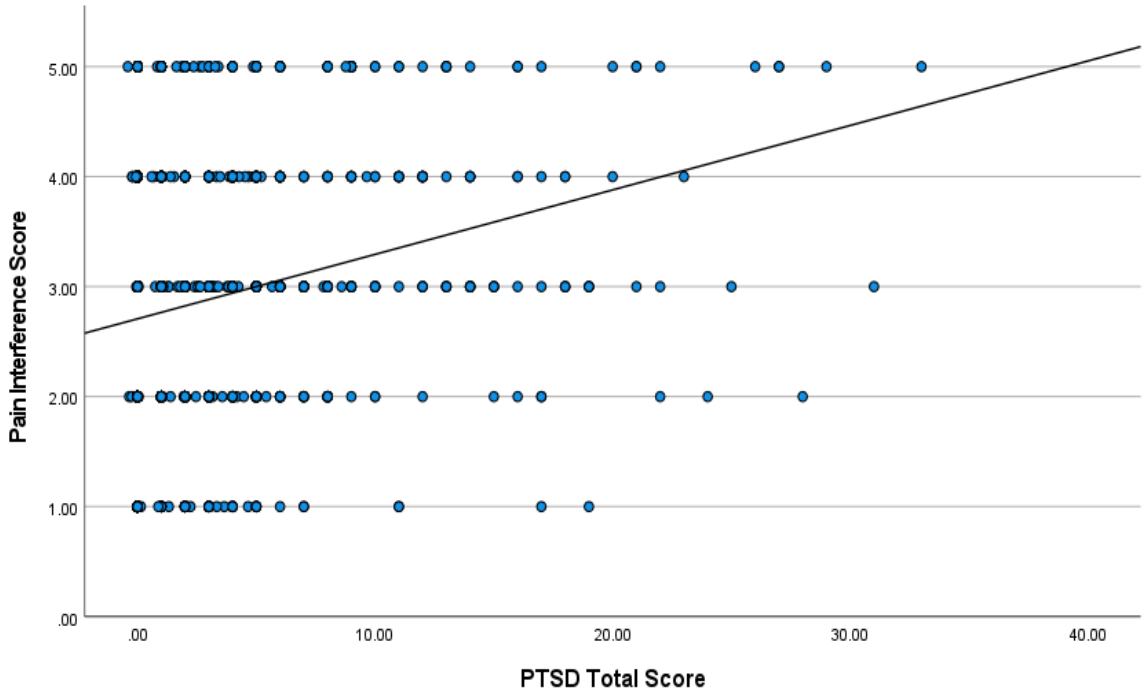
Regression Model Summary of PTSD and Pain Interference

	R^2	ΔR^2	ΔF	df1, df2	*p*	B	SE	F
Full Model	0.29	0.29	0.9	3, 1805	0.000	0.58	0.09	42.25
PTSD Total Score					0.002	0.02	0.01	10.05
CESD Total Score					0.000	0.04	0.01	44.76
Pain Severity					0.000	0.74	0.03	504.90
Reduced Model	0.29	-0.004	0.9	1, 1805	0.000	0.53	0.09	36.24
CESD Total Score					0.000	0.04	0.01	70.06
Pain Severity					0.000	0.75	0.03	524.41

Note. Full model = PTSD Total Score, CESD Total Score, Pain Severity on Pain Interference; Reduced model = CESD Total Score and Pain Severity on Pain Interference; total *N* = 1,808. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

Figure 1

The Relation Between PTSD Score and Pain Interference

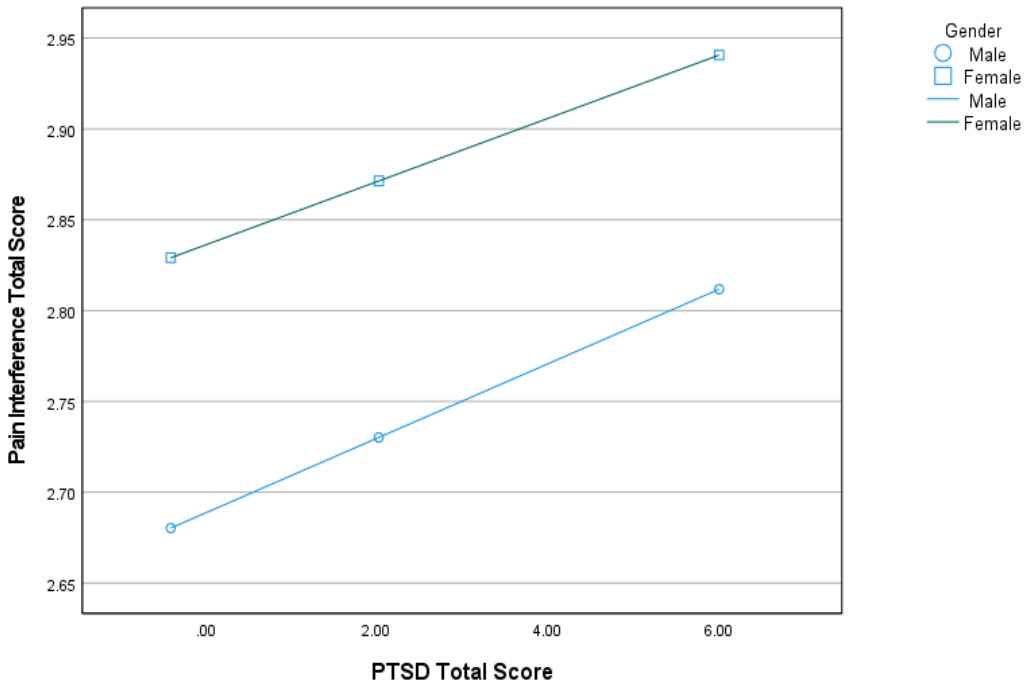


Examining the Moderating Effects of Gender and Age on PTSD and Pain Interference

The second aim was addressed using a moderation analysis in Hayes' PROCESS macro for SPSS (Hayes, 2013), to test the hypotheses that gender would moderate relations between PTSD symptoms and pain interference, with a stronger relation between PTSD symptoms and pain interference among women (compared to men). The full model was significant (B = 0.50, *SE* = 0.09, *F*[5, 1803] = 152.39, $p < 0.001$, R^2= 0.30), and gender was a unique contributor to the model (B = 0.14, *SE* = 0.05, *F*[5,1803] = 8.47, $p = 0.004$). The interaction was not significant, however (*F*[1, 1803]= 0.07, p = 0.79, R^2= 0.00), indicating that gender did not moderate the relation between PTSD and pain interference. See Figure 2 for an illustration of this relation.

Figure 2

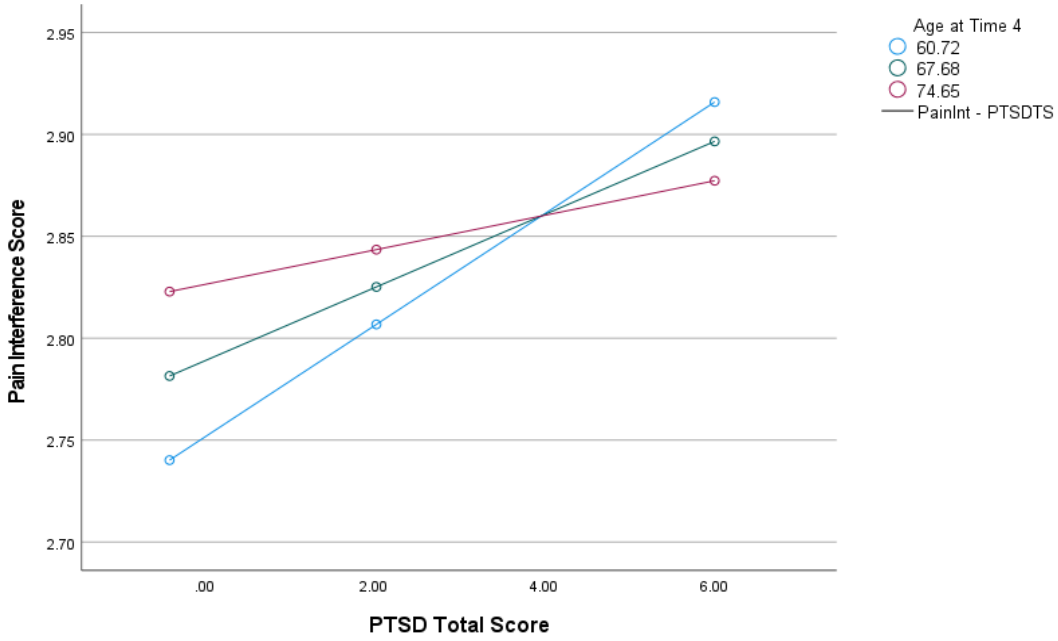
Simple Slopes of the Relation Between PTSD Score and Pain Interference with Gender as a Moderator



We also tested the hypothesis that age would significantly moderate relations between PTSD symptoms and pain interference, with a stronger relation between PTSD symptoms and pain interference among those at older ages (compared to younger ages). The full model was significant (F[5, 1803] = 150.71, p = 0.00, R^2= 0.29), though there was not a significant interaction between age and PTSD symptom score (F[1, 1803] = 3.01, p = 0.08, R^2= 0.001). See Figure 3 for an illustration of these relations. Of note, the visual inspection shows a trend among those at younger ages (60.72 and 67.68) having a steeper slope for this relation than those at older ages (74.65), potentially indicating that the relation between PTSD and pain interference is slightly weaker at older ages. This was reflected in the focal predictors of the moderation analyses, which show the simple slopes of groups ±1 SD from the mean (the low group, 60.72 years old, had a significant conditional as a focal predictor, t[1803] = 3.48, p = 0.0005, as did the mean, 67.68 years old, t[1803] = 3.21, p = 0.0014, but not at the high group, 74.65 years old, t[1803] = 0.71, p = 0.48). Again, however, the interaction was not significant.

Figure 3

Simple Slopes of the Relation Between PTSD Score and Pain Interference with Age as a Moderator



Relation Between Avoidance and Pain Interference

For the third aim, we tested the hypothesis that, when controlling for depressive symptoms and pain severity, the PTSD subscale score of Avoidance would be positively associated with pain interference in daily life. This overall model was significant (B = 2.29, $SE = 0.90$, $F[65, 1809] = 13.19$, $p < 0.001$, $R^2 = 0.33$), and the unique contribution of Avoidance was also significant ($F[63, 1809] = 1.67$, $p = 0.001$, $\eta_p^2 = 0.06$). The change in R^2 was similar to PTSD total score with respect to size and was also significant ($\triangle R^2 = 0.004$, $\triangle F = 9.39$, $p = 0.002$). These results indicate that hypotheses were supported, as avoidance symptoms significantly contributed to pain interference.

The second part of this hypothesis was that avoidance symptoms would contribute to pain interference more so than the other symptom clusters, re-experiencing and

arousal. The overall model for the Re-Experiencing subscale was significant (B = -0.095, SE = 0.92, F[37, 1809] = 20.68, $p < 0.001$, R^2= 0.30), but the unique contribution of Re-Experiencing was not (F[35, 1809] = 0.891, p = 0.653, η_p^2 = 0.02), and change in R^2 was not significant, ($\triangle R^2$ = 0.001, p = 0.06). Similarly, the overall model for the Arousal subscale was significant (B = 1.19, SE = 0.92, F[37, 1809] = 14.99, $p < 0.001$, R^2= 0.32), but its unique contribution was not (F[52, 1809] = 1.30, p = 0.07, η_p^2 = 0.04). There was a significant change in R^2 for Arousal, although smaller than the change associated with adding the Avoidance subscale score to the reduced model ($\triangle R^2$ = 0.002, $\triangle$F = 4.61, p = 0.03; see Figures 4 and 5 for illustrations). These results indicate partial support of the hypothesis, with the Avoidance subscale score contributing more to explaining the variance in pain interference than the other PTSD symptom subscales.

Figure 4

The Relation Between the PTSD Subscales (Re-Experiencing, Avoidance, Arousal) and Pain Interference

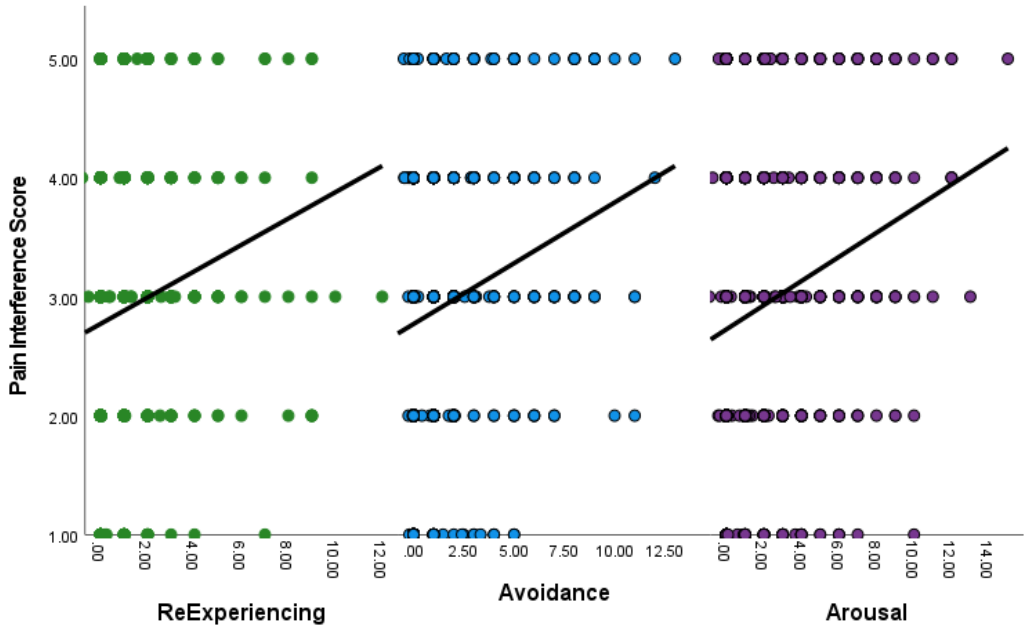
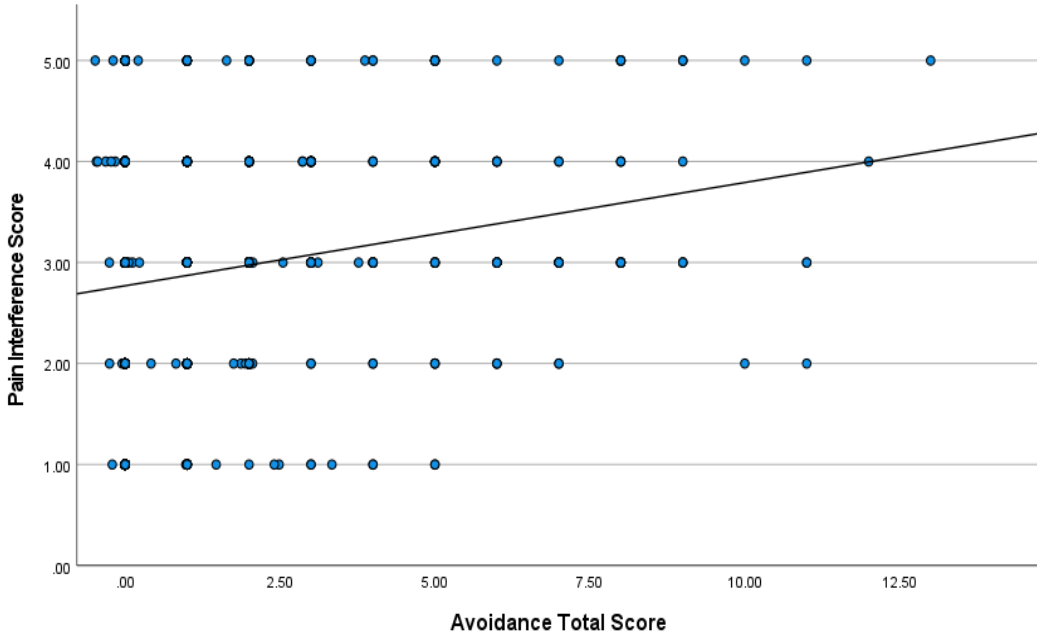


Figure 5

The Relation Between the Avoidance Subscale and Pain Interference

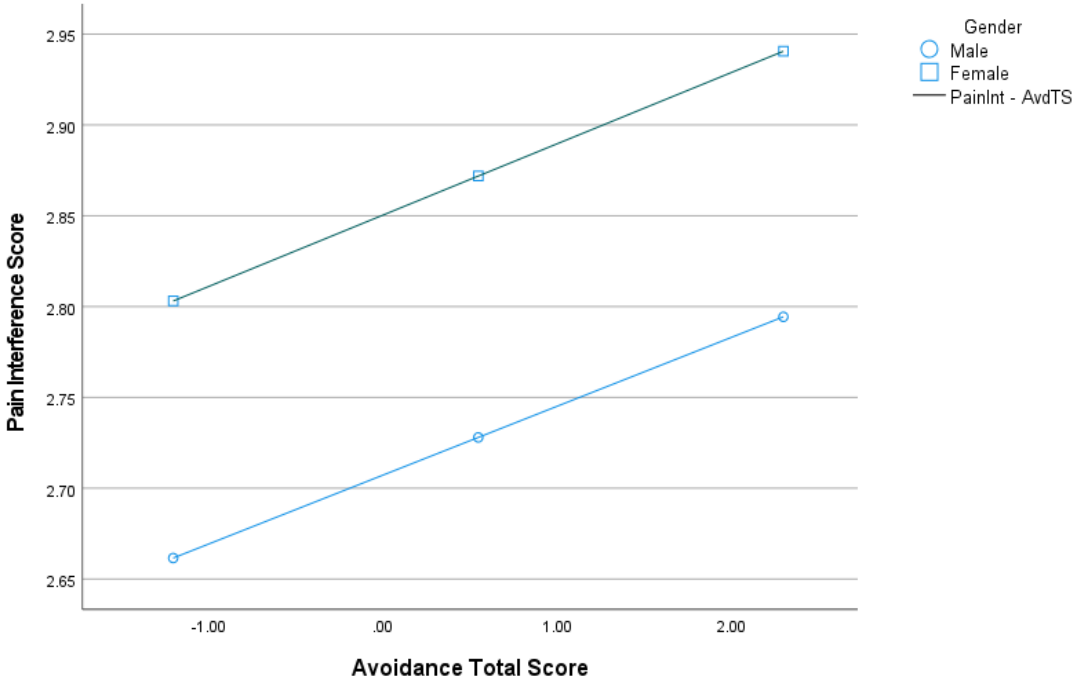


Examining the Moderating Effects of Gender and Age on Avoidance and Pain Interference

Additional models tested the hypothesis that gender and age would significantly moderate the relation between avoidance symptoms and pain interference, controlling for depressive symptoms and pain severity. For gender, the hypothesis was that there would be a stronger relation between avoidance symptoms and pain interference among women (compared to men). Gender did not moderate this relation (F[1, 1803] = 0.002, p = 0.96), however, with zero change in R^2 (B = 0.14, SE = 0.05, F[1, 1803] = 0.002, p = 0.96, R^2 = 0.00). It should be noted that the overall model was significant (B = 0.49, SE = 0.09, F[5, 1803] = 152.25, p < 0.001, R^2= 0.29), and indicated that gender was a unique contributor to pain interference (B = 0.14 , SE = 0.05, F[1, 1803] = 8.94, p = 0.002). See Figure 6 for a visual representation of this relation.

Figure 6

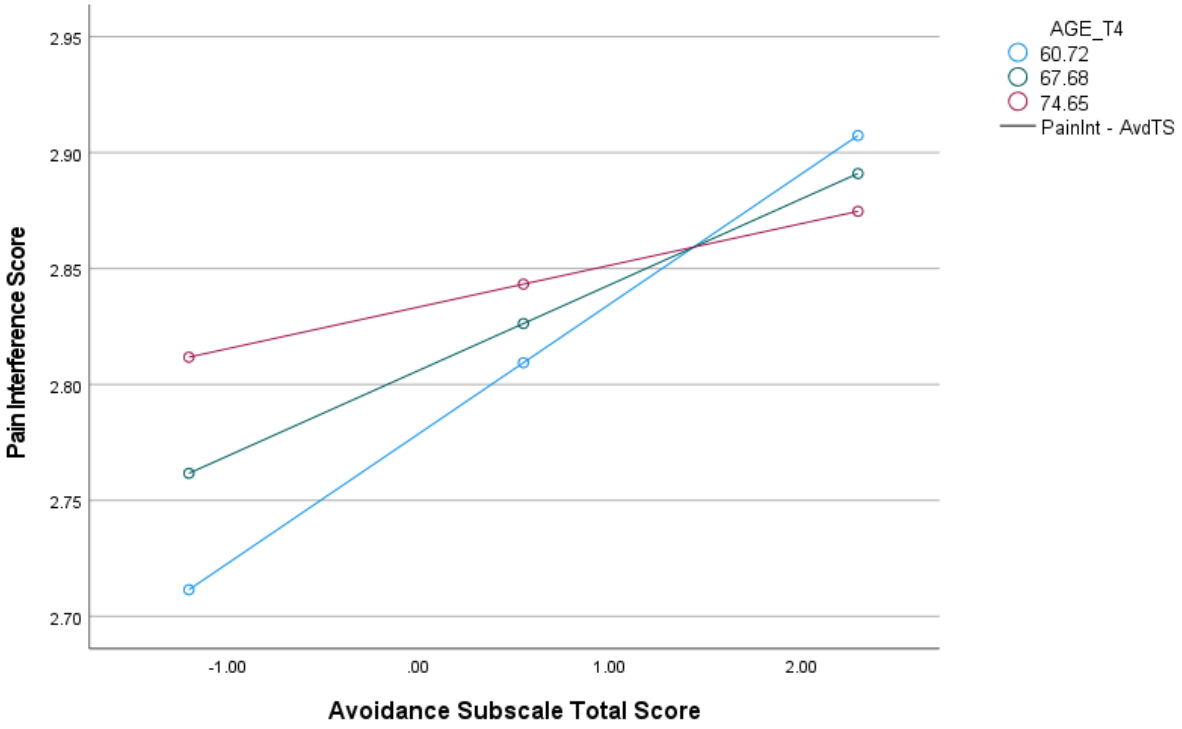
Simple Slopes of Relation Between Avoidance Subscale and Pain Interference with Gender as a Moderator



Finally, the second part of this hypothesis was that age would significantly moderate the relation between avoidance symptoms and pain interference (controlling for depressive symptoms and pain severity), with a stronger relation between avoidance symptoms and pain interference among those at older ages (compared to younger ages). Age did not significantly moderate the relation between avoidance and pain interference (F[1, 1803] = 2.34, p = 0.13), with the change in R^2= 0.001 (p = 0.13). However, the overall model was significant and accounted for meaningful variance in pain interference (B = 0.29 , SE = 0.24 , F[5, 1803] = 150.28, p < 0.001, R^2= 0.29). The visual representation of age as a moderator (Figure 7) indicates a similar trend as the one seen between PTSD total score and pain interference.

Figure 7

Simple Slopes of Relation Between Avoidance Subscale and Pain Interference with Age as a Moderator



Chapter 4

Discussion

Chronic pain is a common experience among midlife and older adults, though the mental health experiences that contribute to the extent of pain interference in daily life have been understudied in this group. The present study was a set of secondary analyses conducted to examine the unique contribution of PTSD to pain interference among older adults who experienced a natural disaster, and whether this relation is moderated by age and gender. The specific symptom clusters for PTSD were also examined to determine the unique contributions of avoidance, re-experiencing, and arousal to pain interference. Due to its data gathered following a natural disaster (i.e., Hurricane Sandy), this study capitalized on a unique opportunity to examine these relations in a population exposed to a particular stressful event.

Relation Between PTSD and Pain Interference

PTSD clinical presentation within this sample was surprisingly low (2.90%) compared to the general population (5%-10%; Goldmann & Galea, 2014). This may be due to participants perceiving the questions as only pertaining to Hurricane Sandy and how they felt thinking back to the event the year prior. The PTSD presentation in the general population also tends to be higher in women (10-12%) compared to men (5-6%; Olf et al., 2017), which was not found in the current study. The current study showed that 2.9% of both women and men met the clinical threshold of 14 on the PSS-R, with no statistically significant difference in symptom severity between genders. The zero inflation could also be due to a lack of proximity to the epicenter of the storm, as

previous research has found that the closer to the storm an individual is, the more likely they are to develop PTSD symptoms (Basogul et al., 2004).

However, the results of this study support the hypothesis that PTSD is a unique contributor to pain interference among older adults, above and beyond the contribution of depression and pain severity. Although PTSD accounted for a small change in variance, it was a unique contributor to the model predicting pain interference. These results are consistent with previous research findings showing that individuals with both chronic pain and PTSD have worse interference in daily life due to pain (Outcalt et al., 2014; Ruiz-Parraga et al., 2014), and extends this relation to the population of older adults.

Much of the current literature on the relation between PTSD and pain experiences is from the military and veteran population, whose PTSD and pain symptoms tend to stem from the same traumatic event (Lee et al., 2019; Reisman et al., 2016). Consequently, the present study adds to the current literature on the relation between PTSD and pain interference in a civilian population, whose pain may or may not be associated with their psychological trauma. Although some research has been conducted among individuals who were seeking pain treatment due to an event unrelated to their psychological trauma (Andersen et al., 2014), additional research on the individual impact of events such as natural disasters is needed to determine the extent to which these events influence PTSD and pain experiences in daily life.

Relation Between Avoidance and Pain Interference

As predicted, avoidance symptoms significantly contributed to pain interference and appeared to account for more variance in pain interference than re-experiencing and arousal. The variance accounted for by avoidance symptoms was comparable to overall

PTSD variance, which may indicate that avoidance symptoms drive the overall relation between PTSD and pain interference. This may be due to avoidance being a common factor between both pain and PTSD, as individuals experiencing chronic pain partake in avoidance behaviors (e.g., disengagement from activities, changing posture, reducing activity; Volders et al., 2015; Linton & Shaw, 2011) as do individuals with PTSD (e.g., avoidance of internal and external trauma-related cues; Weiss et al., 2020). This finding is consistent with previous evidence regarding the link between chronic pain and PTSD (Cyders et al., 2011).

Knowing that avoidance is a specific factor associated with pain interference among older adults, above and beyond the contribution of depressive symptoms and pain severity, allows clinicians a specific set of behaviors to screen for in this population following a natural disaster. This can help increase treatment effectiveness, especially if reducing these behaviors and symptoms assists in decreasing pain interference. Current treatments for chronic pain management include components for addressing fear-avoidant behaviors. For example, Cognitive Behavioral Therapy (CBT), which focuses on the behavioral component using activity pacing, graded activation, behavioral activation, and increase in physical activity, and Acceptance Commitment Therapy (ACT), which focuses on disrupting the negative thoughts associated with pain using cognitive defusion to decrease the avoidant behavioral responses to those thoughts (e.g., “My pain will get worse if I move around, so I won’t move at all;” Roditi & Robinson, 2011), may warrant further emphasis.

Arousal was also a significant contributor to pain interference, which has equivocal support in prior research; some studies have found arousal to be associated

with pain intensity and functioning (Tsui et al., 2011; Cho et al., 2011), whereas others have found arousal to have a direct effect on pain severity, but not pain-related disability (Cyders et al., 2011). Additionally, Cho et al. (2011) found that *hyper*arousal that is characteristic of PTSD only affected daily functioning when pain avoidance was present, indicating an additional relation between avoidance and arousal symptoms and pain experiences.

Examining the Moderating Effects of Gender and Age on PTSD and Pain Interference

Findings from the present study also showed that women tended to report greater pain interference than men, which is consistent with previous research (Bartley & Fillingim, 2013; Naylor et al., 2019; Runnals et al., 2013; Driscoll et al., 2015; Bartley & Fillingim, 2013; Eslami et al., 2017). Despite this consistent interest in examining gender differences in both PTSD and pain, to our knowledge, the present study is the first to examine gender as a moderator of their relation. The trend seen in the visualization of the data in the present study (Figure 2) indicates that both men and women with a higher (vs. lower) PTSD score tended to report a higher pain interference. Contrary to expectations, however, gender did not moderate the relation between PTSD symptoms and pain interference (i.e., overall PTSD or avoidance symptoms). It is possible that gender may moderate relations between PTSD symptoms and another pain experience, such as pain severity, particularly given wording of the item used to assess pain interference (explained further below).

Age also was not a significant moderator of the relation between PTSD and pain interference, in contrast to expectations. There are several possible explanations for these

results. One reason may be that chronic pain, such as lower back pain, has a high prevalence in the age range of 55-64 years (Freburger et al, 2015). Although the presence, frequency, or intensity of pain may increase with age, adults may create and implement additional compensatory strategies for handling their pain as they age, so that it interferes less with their daily lives (e.g., increasing social support, coping self-statements, activity pacing; Molton et al., 2009). One study showed that patients preferred their health care professionals to not only believe their experience with pain, but also discuss compensatory strategies rather than talk about pain intensity (Yorkston et al., 2009). An additional explanation may be that many older individuals are already retired, as the average age for retirement is 65 (Employee Benefit Research Institute, 2019). This would make the question regarding pain interference, ("How often does the pain make it difficult for you to do your usual activities such as household chores or work?") less representative of their interference. If they are no longer working, their pain may no longer be perceived to have a high interference in this domain.

The Mutual Maintenance Model

The findings of this study lend further support to the Mutual Maintenance Model of Chronic Pain and PTSD, in that they specify that PTSD symptoms are uniquely associated with pain's interference in midlife and older adults' daily activities (particularly symptoms of avoidance). To our knowledge, the mutual maintenance model has not been applied to the context of exposure to a natural disaster. Consequently, this study extends the application of this model to a new population and context. While the present analyses only examined PTSD symptoms as a unique contributor to pain interference, chronic pain may reciprocally contribute to PTSD symptoms following a

natural disaster. To further improve our understanding of mutual maintenance between PTSD and pain experiences, future research should examine the potential of bidirectional relations between chronic pain and PTSD following natural disasters.

Strengths and Limitations

Strengths of this study include a large sample size and use of validated measures of experiences such as depressive symptoms. Limitations of this study are its reliance on self-report. Although self-report can be valid if used consistently (Niedzwiedzka et al., 2015), it may be subject to over- or under-reporting of symptoms and other experiences (Taylor et al. 2006; Gorber et al., 2007; Gosse, 2014). To address this limitation, future work should include multiple measures and modalities (e.g., self-report scales, clinical assessment, behavioral observations) for assessing PTSD (Cody et al., 2017; Matto, McNiel, & Binder, 2019) and clinical assessments of pain (Severgnini et al., 2016). Other limitations include the lack of validated questions to assess pain and lack of specificity for assessing pain experiences, including location and chronicity of pain presentation. This additional information would be useful for additional tailoring of treatment, especially if differences between pain presentations changes the relation with PTSD further (e.g., migraines vs. back pain).

An additional limitation to be acknowledged is that the PSS-SR was not given during the timepoints preceding Hurricane Sandy. Although the original authors attempted to specify the PSS-SR questions by referring to Hurricane Sandy (see Appendix B), there may still be individuals who may have had previous PTSD diagnoses; therefore, the index trauma was not Sandy. Thus, Sandy may have introduced symptoms for some older adults and exacerbated symptoms for others, which may have distinct

implications for the experience of chronic pain. The PSS-SR used in this study also does not reflect the current diagnostic categories for PTSD, which include an additional cluster, negative cognitions and mood, to account for the behavioral symptoms commonly seen with PTSD (American Psychiatric Association, 2013). However, a benefit is that an overlap in symptoms assessed between Major Depressive Disorder and PTSD in the present study may be limited. Nonetheless, the proposed study should provide useful information about relations between older adults' physical and psychological health experiences that could help to inform future clinical services.

Future Directions

As noted, much of the available research on relations between chronic pain and PTSD symptoms have come from the population of military veterans. Compared to the national lifetime prevalence rate of PTSD in the general population (6.8%; Kessler et al., 2005), veterans have noticeably higher prevalence rates, with one study finding the prevalence rate among Iraq and Afghanistan veterans at 13.5% (Eber et al., 2013). The experience of PTSD may differ depending on exposure to combat (vs. not) and the specific combat theater, with Vietnam veteran PTSD prevalence rate ranging from 16.9%-22% (Goldberg et al., 2016). It will be important to determine whether the results of this study are generalizable across both veteran and non-veteran older adults, as this will assist in the tailoring of prevention and treatment efforts. Should veterans show stronger relations between PTSD and pain interference, focusing treatment on older adult veterans should be a priority following exposure to a natural disaster.

Another focus of future research should be to examine the relations between PTSD and pain interference among a sample of individuals that score higher than the

clinical threshold for PTSD. This would allow a deeper look into the contribution of PTSD when at a higher severity level, which can be overlapped with the research on proximity to a natural disaster, as proximity can impact the severity of PTSD symptoms (Basogul et al., 2004). This will provide insight to public health professionals who may be in charge of providing or preparing aid following a natural disaster, to assist with targeted distribution of aid to the most vulnerable populations. This should also extend to examining the PTSD subscale scores, as this may provide clinicians a symptom set to be aware of, such as avoidant behaviors, in a population that has been exposed to a natural disaster.

Conclusions

In summary, findings from the present study indicate that PTSD is a unique contributor to pain interference above and beyond the contribution of depressive symptoms and pain severity. This relation is an important finding in a population of older adults who experienced a natural disaster. The finding of avoidance symptoms as prominent contributors to pain interference is also important, as this can provide additional insight and support to the focus on treatments targeting behavioral avoidance in individuals with both PTSD and chronic pain. Gender and age did not moderate these relations, which is a surprising finding as much of the literature focuses on women and older adults exhibiting greater symptoms within both diagnoses. If possible, additional studies should examine symptom presentation at a baseline prior to a natural disaster, to obtain a greater understanding of the added toll exposure may have, especially with regard to the proximity of the event. As both natural disasters and the aging population

increase within our nation, understanding the prevalent and co-occurring disorders is essential for successful prevention and treatment efforts.

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Appendix A

Data Use Application

ORANJ BOWL℠

Data Use Application

In order to access ORANJ BOWL data, please fill out the following forms and submit to Rachel Pruchno, Ph.D., at pruchnra@rowan.edu for review. All applications will be reviewed by the ORANJ BOWL team before data are made available for use.

NAME: Laura Travers, M.S.

INSTITUTION: Department of Psychology, Rowan University

ADDRESS: 201 Mullica Hill Drive, Robinson Hall, 109H

PHONE: (856)256-4872 **E-MAIL**: traver22@students.rowan.edu

Outline the purpose of your request for data use, indicating your intended use of the data, plans for dissemination (e.g., manuscript development, class, thesis/dissertation, presentation), and type of data you are requesting:

The purpose of the proposed study is to determine whether PTSD symptoms uniquely contribute to chronic pain severity after a natural disaster (Hurricane Sandy), over and

above the contributions of depressive symptoms. Previous research using ORANJ BOWL data has shown that participants who experienced greater pain in the years before Hurricane Sandy had an increased risk of developing PTSD symptoms post-Sandy, compared with those who experienced less pain, among other factors such as depressive symptoms. We request to examine the unique contribution of PTSD to pain symptoms at Time 4 only, and to test for gender differences in this relation. The results of this study will be submitted for publication in a peer-reviewed journal and presented at national conferences (e.g., as posters oral presentations). These results will be beneficial in helping understand relations between chronic pain and PTSD and may inform interventions for individuals who experience natural disasters.

Specify any collaborators on the project with their name, role on project (i.e., academic advisor), and title and institution. (*Note*: if a collaborator is outside of your institution, they may be required to also sign the enclosed data terms of use):

Name	Role on Project	Title and Institution
Danielle Arigo, Ph.D.	Co-author	Assistant Professor, Department of Psychology, Rowan University
Megan Brown, B.S.	Data manager	Research Coordinator, Clinical Health And Social Experiences Research Team

Summary of your anticipated study:

The overall goal of the present study is to examine relations between PTSD and chronic pain among older adults affected by a natural disaster, and to determine to what extent this relation differs by gender.

Brief background/significance of the study:

Past research suggests an association between chronic pain and PTSD, in that the two conditions are often comorbid (Otis, Keane, & Kerns, 2003; Asmundson et al., 2002; Brennstuhl, Tarquinio, & Montel, 2014). There is also neurological significance in shared brain activity when experiencing chronic pain and PTSD (Scioli-Slater, et al. 2015). These findings suggest that a change in one condition may affect the other and supports Sharp and Harvey's proposed Mutual Maintenance Model (2001), which describes how PTSD reinforces chronic pain, and chronic pain in turn reinforces PTSD. However, the relations between chronic pain and PTSD among older adults should be further examined to determine how much variance PTSD accounts for in pain symptoms (beyond the contributions of other psychosocial experiences such as depression), and whether this differs by gender.

Study aims:

1. To examine associations between PTSD symptoms and pain presence/severity post-Hurricane Sandy, after accounting for the contribution of depressive symptoms.
2. To determine the presence of any gender differences in the relation between pain presence/severity and PTSD symptoms.

Study hypotheses/questions:

1. When controlling for depressive symptoms, PTSD will be uniquely and positively associated with pain presence/severity.
2. This relation will be stronger among women than men.

All data files shared through ORANJ BOWL must be secured to prevent unauthorized access. Please describe how and where the data will be stored by addressing each of the following points for each device the data will be stored on:

a. **Device type.** Desktop PC
b. **Does this device have internet access?** Yes
c. **Is there firewall protection technology in place for devices that are connected to the internet?** Yes, firewall protection is in place through Rowan University's network.
d. **Does this device require a login and password at startup and after a period of inactivity?** Yes
e. **Is the directory containing the data restricted to authorized users?** Yes
f. **Is there anti-virus software installed on the device?** Yes
g. **Where is the device stored?** In a research suite on Rowan University's campus
h. **Describe the physical security of the location where the device is stored.** The device is stored in a locked room inside a locked suite in a university building. Only authorized study team members have access to this device.

Please use the ORANJ BOWL construct chart that outlines all constructs and variables in the data repository (available upon request from the project team) to identify the variables that you would like to use to answer your research questions. Submit your list with this form.

ORANJ BOWL℠

Data Use Application Terms of Use

This Data Use Agreement ("Agreement") governs the disclosure and use of non-protected health information (PHI) data in the ORANJ BOWL database which is owned and maintained by Rowan University School of Osteopathic Medicine. Rowan University's ORANJ BOWL team reserves the right to classify persons as authorized users of ORANJ BOWL data. Only authorized users may access ORANJ BOWL data. Approval is contingent upon review of the Data Use Application and completion of this Data Use Application Terms of Use. All ORANJ BOWL users must read and agree to the terms of use in this Agreement before access to the data will be granted, by signing at the bottom of this form.

As a data repository, all ORANJ BOWL users must also adhere to the Institutional Review Board (IRB) requirements put forth by Rowan University School of Osteopathic Medicine. This agreement does not act in place of an IRB approval. All approvals of data use must

then be submitted for IRB approval as a secondary data analysis project with de-identified data through Rowan University School of Osteopathic Medicine's IRB and/or the investigators home institution (pending institution regulations). All necessary human subjects training must be completed at this time.

Privacy of Research Subjects

A research subject is a person who responded to ORANJ BOWL surveys or any other person who authorized the subject to provide information on that person's behalf. Any intentional identification of a research subject or unauthorized disclosure of his or her confidential information violates the agreement of confidentiality given to all participants. Therefore, the undersigned agrees to:

- Ensure that the data are kept in a secured environment and that only authorized users will have access to the data;
- Use these data solely for research or statistical purposes and not for investigation of specific research subjects;
- Not attempt to establish the identity of, or attempt to contact any of the research subjects; and
- Make no use of the identity of any research subject discovered inadvertently and to advise the ORANJ BOWL team (pruchnra@rowan.edu) of any such discovery immediately.

Redistribution of Data

An authorized user is an individual who has been given written permission by the ORANJ BOWL team to access and use the data or is a listed collaborator on an approved project. Therefore, the undersigned agrees to:

- Not redistribute data or other materials without the written agreement of the ORANJ BOWL team unless collaborating with another authorized user to analyze the data for research or instructional purposes;
- Include all accompanying files with the data, including terms of use, when sharing data or other materials with collaborating users;
- Ensure that collaborating users have appropriate administrative, physical and technical safeguards in place to prevent use or disclosure of data other than as provided for by this Agreement;
- Require that collaborating users promptly report any use or disclosure of data that does not comply with the guidelines established by this Agreement; and
- Require all collaborating users to abide by the ORANJ BOWL terms of use.

Citing Data

The undersigned agrees to consult with project director, Rachel Pruchno, Ph.D., for all funding acknowledgements prior to any data use and shall include such acknowledgements in all applicable distribution of work. The undersigned agrees to reference the data in the following way with acknowledgement to the funding sources identified by Dr. Pruchno:

> Rachel Pruchno. ORANJ BOWL℠ (Ongoing Research on Aging in New Jersey: Bettering Opportunities for Wellness in Life) Project, Stratford, NJ: Rowan University School of Osteopathic Medicine.

Authors of publications and presentations based on ORANJ BOWL data are required to send citations of their published work and copies of final manuscripts to the ORANJ BOWL team (pruchnra@rowan.edu) for inclusion in a database of ORANJ BOWL work. Copies of presentations on ORANJ BOWL must also be submitted to pruchnra@rowan.edu within one month after the presentation was given.

Disclaimer

The undersigned acknowledges that the original collector of the data and the relevant funding agency bear no responsibility for use of the data or for interpretations or inferences based upon such uses. The undersigned agrees to indemnify, defend and hold harmless Rowan University and the ORANJ BOWL team from any or all claims and losses accruing to any person, organization or other legal entity as a result of violation of this Agreement.

Violations

If the ORANJ BOWL team determines that the terms of this Agreement have been violated, Rowan University will act according to the following policy on terms of use violations. Sanctions include, but are not limited to:

- Rowan University may revoke this Agreement, demand the return of the data in question, and deny all future access to ORANJ BOWL data;
- Rowan University may report the violation to the Research Integrity Officer, Institutional Review Board, or the user's institution, for necessary sanctions to be enforced. If the confidentiality of human subjects has been violated, Rowan University may report the case to the Federal Office for Human Research Protections. This may result in an investigation of the user's institution, which can

result in institution-wide sanctions including the suspension of all research grants; and/or

- A court may award the payment of damages to any individual harmed by breach of this Agreement.

My signature indicates that I understand the terms of this Agreement and that I agree to comply with its terms.

Laura Travers _____ 10/31/19

PRINTED NAME SIGNED NAME DATE

APPLICANT

Signature below indicates approval of data use for the above signed applicant:

_____ _____

_____

PRINTED NAME SIGNED NAME DATE

ROWAN UNIVERSITY REPRESENTATIVE

Appendix B

Measures

Pain Items

{PAIN1} How often are you troubled with pain:

Almost always,	01
Often,	02
Sometimes, or	03
Almost never?	04
DON'T KNOW	98
REFUSED	97

{PAIN2} How bad is the pain most of the time: (IF TAKING PAIN MEDICATION, RATE SEVERITY OF PAIN WHEN MEDICATED)

Mild,	01
Moderate, or	02
Severe?	03
DON'T KNOW	98
REFUSED	97

{PAIN3} How often does the pain make it difficult for you to do your usual activities such as household chores or work:

Almost always,	01
Often,	02
Sometimes, or	03
Almost never?	04
DON’T KNOW	98
REFUSED	97

Post-Traumatic Stress Disorder Symptom Scale-Self Report (PSS-SR)

The grid on the next two pages presents difficulties that people sometimes have after experiencing a stressful event such as Hurricane Sandy (referred to simply as "Sandy"). Please read each item carefully and indicate how often each has bothered you DURING THE PAST MONTH.

	Not at all or only one time	Once a week or less – only once in a while	2 to 4 times per week – often	5 or more times a week – almost always
a. Having upsetting thoughts or images about Sandy come to mind when you didn't want them to.	☐	☐	☐	☐
b. Having bad dreams or nightmares about Sandy.	☐	☐	☐	☐
c. Reliving Sandy, acting or feeling as if it were happening again.	☐	☐	☐	☐
d. Feeling very emotionally upset when you were reminded of Sandy (e.g., feeling scared, angry, sad, guilty, etc.).	☐	☐	☐	☐
e. Experiencing physical reactions when you were reminded of Sandy (e.g., breaking out in a sweat, heart beating fast).	☐	☐	☐	☐
f. Trying not to think, talk, or have feelings about Sandy.	☐	☐	☐	☐
g. Trying to avoid activities, people, or places that remind you of Sandy.	☐	☐	☐	☐
h. Not being able to remember an important part of Sandy.	☐	☐	☐	☐
i. Having much less interest or participating much less often in activities that were important before Sandy.	☐	☐	☐	☐
j. Feeling distant or cut off from people around you.	☐	☐	☐	☐
k. Feeling emotionally numb (e.g., being unable to cry or being unable to have loving feelings).	☐	☐	☐	☐
l. Feeling as if future plans or hopes will not come true (e.g., will not have a career, marriage, children, or long life).	☐	☐	☐	☐
m. Having trouble falling asleep or staying asleep.	☐	☐	☐	☐
n. Feeling irritable or having fits of anger.	☐	☐	☐	☐

o. Having trouble concentrating (e.g., drifting in and out of conversations, losing track of a story on television, forgetting what you read).	☐	☐	☐	☐

Grid continues on the next page

	Not at all or only one time	Once a week or less –only once in a while	2 to 4 times per week – often	5 or more times a week – almost always
p. Being overly alert (e.g., checking to see who is around you, being uncomfortable with your back to a door).	☐	☐	☐	☐
q. Being jumpy or more easily startled than before (e.g., when someone walks up behind you).	☐	☐	☐	☐

Center for Epidemiologic Studies Depression Scale (CES-D, short form)

Below are some statements about feelings. Please indicate how often each has described you DURING THE PAST WEEK.

	Rarely or none of the time	Some or a little of the time	Occasionally or a moderate amount of the time	Most or all of the time
a. I was bothered by things that usually don't bother me.	☐	☐	☐	☐
b. I had trouble keeping my mind on what I was doing.	☐	☐	☐	☐
c. I felt depressed.	☐	☐	☐	☐
d. I felt that everything I did was an effort.	☐	☐	☐	☐
e. I felt hopeful about the future.	☐	☐	☐	☐
f. I felt fearful.	☐	☐	☐	☐
g. My sleep was restless.	☐	☐	☐	☐
h. I was happy.	☐	☐	☐	☐
i. I felt lonely.	☐	☐	☐	☐
j. I could not get "going".	☐	☐	☐	☐

Appendix C

Listwise Deletion Summary

Listwise Deletion Summary

- The primary aim (1) of the study was to examine relations between PTSD symptoms and pain interference in the older adult population following a natural disaster, above and beyond the contributions of depressive symptoms and pain severity. We hypothesized that, when controlling for depressive symptoms and pain severity, overall PTSD symptom severity would be positively associated with pain interference in daily life.
    - Full Model: B = 0.107, SE = 0.92, F[32, 1587] = 21.13, p = 0.00, R^2= 0.30
        - Contribution of PTSD: ΔR^2 = 0.005, ΔF[1, 1583] = 10.4, p = 0.001
- The secondary aim (2) was to determine the relations between the specific PTSD symptom clusters and pain interference in the older adult population, above and beyond any existing contributions from depressive symptoms and pain severity. The first hypothesis for this aim is that, controlling for depressive symptoms and pain severity, greater severity of avoidance symptoms would be positively associated with reported pain interference. Further, that avoidance symptoms would show the strongest positive association between symptoms and pain interference (compared to arousal and re-experiencing symptom clusters).
    - Full Model with Avoidance: B =2.28, SE = 0.91, F[15, 1618] = 45.31, p = 0.00, R^2= 0.29
        - Contribution of Avoidance: ΔR^2 = 0.004, ΔF[1, 1614] = 9.64, p = 0.002

- Full Model with Arousal: B =0.28, *SE* = 0.92, *F*[15, 1626] = 44.36, *p* = 0.00, R^2= 0.29
  - Contribution of Arousal: ΔR^2 = 0.002, ΔF[1, 1622] = 5.66, *p* = 0.017
- Full Model with Re-Experiencing: B = -0.11, *SE* = 0.92, *F*[13, 1639] = 41.91, *p* = 0.000, R^2= 0.28
  - Contribution of Re-Experiencing: R^2 = 0.001, ΔF[1, 1635] = 2.19, *p* = 0.138

- The tertiary aim (3) of the current study was to determine the boundaries of relations between overall PTSD symptoms and pain interference by examining moderators of this relation (i.e., gender and age), after accounting for the contribution of depressive symptoms and pain severity. The respective hypotheses were that gender and age would moderate relations between PTSD symptoms and pain interference, with a stronger relation between PTSD symptoms and pain interference among women (compared to men) and among those at older ages (compared to younger ages).
  - Full Model with Gender as a predictor: B = 0.54, *SE* = 0., *F*[5, 1581] = 130.70, *p* = 0.00, R^2= 0.29
    - Interaction: B = 0.004, *SE* = 0.013, *F*[1, 1581] = 0.11, ΔR^2= 0.000, *p* = 0.75
  - Full Model with Age as a predictor: B = 0.23, *SE* = 0.26, *F*[5, 1581] = 129.75, *p* = 0.00, R^2= 0.29

        - Interaction: B = 0.002, *SE* = 0.001, *F*[1, 1581] = 3.92, ΔR^2= 0.002, *p* = 0.048

- The final aim (4) was to determine the boundaries of the relations between avoidance symptoms and pain interference in the older adult population, above and beyond any existing contributions from depressive symptoms and pain severity. The hypothesis for this aim was that, compared to the other symptom clusters, gender and age would moderate the relation between avoidance symptoms and pain interference, with stronger positive associations among women (compared to men) and among those at older ages (compared to younger ages).
    - Full Model with Avoidance and Gender as predictors: B = 0.51, *SE* = 0.09, *F*[5, 1612] = 130.70, *p* = 0.00, R^2= 0.29
        - Interaction: B = 0.002, *SE* = 0.03, *F*[1, 1612] = 0.004, ΔR^2= 0.000, *p* = 0.95
    - Full Model Avoidance and Age as predictors: B = 0.32, *SE* = 0.25, *F*[5, 1612] = 132.71, *p* = 0.00, R^2= 0.29
        - Interaction: B = 0.004, *SE* = 0.002, *F*[1, 1612] = 4.39, ΔR^2= 0.002, *p* = 0.036