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PTSD Symptom Profiles Among Louisiana Women Affected by the 2010 Deepwater Horizon Oil Spill: A Latent Profile Analysis

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Abstract

Background: Few prior studies have investigated the latent class structure of PTSD using *DSM-5* symptoms.

Methods: To describe latent PTSD profiles among women who resided in Deepwater Horizon Oil Spill (DHOS)-affected coastal Louisiana communities, we used data from women enrolled in The Women and Their Children's Health (WaTCH) Study. Latent profile analysis was performed on the 20-item PTSD Checklist for DSM-5 (PCL-5) and model fit statistics for 2-class through 6-class solutions were compared. The pseudo-class draws method was employed on the best class solution to compare key covariates (including demographics, mental health indicators, DHOS exposure indicators, and trauma exposures) across classes.

Results: Among 1997 women (mean age 46.63±12.14 years, 56.8% white, mean trauma categories 6.09±2.98, 9.55% previously diagnosed with PTSD), model fit statistics supported a five-class solution: *low symptoms* (mean PCL-5=4.10), *moderate without mood alterations* (mean=19.73), *moderate with mood alterations* (mean=34.24), *severe without risk-taking* (mean=55.75), and *severe with risk-taking* (mean=53.80). Women in the *low-symptom* class were significantly more likely to be white, have finished high school, have an income of at least \$40,001

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per year, be married or living with a partner, and endorse fewer trauma categories than women in the four symptomatic classes. Women with *moderate* to *severe symptoms* often had co-morbid depressive symptoms and no prior PTSD diagnosis.

Limitations: This study was limited by use of self-reported data and one-time assessment of PTSD symptoms.

Discussion: Five distinct latent profiles of DSM-5 PTSD symptoms consisted of notably different individuals. Most affected women did not report prior PTSD diagnosis. Future research and practice identifying and addressing barriers to care for trauma-affected women in these communities is warranted.

Keywords

post-traumatic stress disorders; women; disaster victims

Introduction

Recent research estimates that 90% of the general United States adult population has been exposed to at least one event that would be considered a “trauma” as defined by the Diagnostic and Statistical Manual – 5 (DSM-5) Criterion A (Association, 2013), with 50% of the population exposed to one or more disasters (Kilpatrick et al., 2013). However, the majority of individuals exposed to potentially traumatic events do not go on to develop post-traumatic stress disorder (PTSD). One robust risk factor for PTSD is being a woman, with research consistently showing that, relative to similarly exposed men, women are more likely to develop PTSD (Kilpatrick et al., 2013). Although the pathways that explain this difference in risk remain uncertain, research has shown that the construct of PTSD is similar for both sexes as evidenced by symptom endorsement patterns, factor structures, and symptom profiles (Chung & Breslau, 2008; Hall, Elhai, Grubaugh, Tuerk, & Magruder, 2012; King, Street, Gradus, Vogt, & Resick, 2013). Epidemiological studies of PTSD diagnosis suggest that the lifetime prevalence of PTSD is somewhat lower when measured using DSM-5 criteria compared to the DSM-4 (8.3% and 9.8% respectively). This finding holds for 6-month (3.8% and 4.7%) PTSD prevalence (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995; Kilpatrick et al., 2013). However, research efforts to understand the phenomenology of PTSD have increasingly moved beyond diagnoses determined by diagnostic rules toward a more data-driven approach to understanding heterogeneous subgroups of individuals with unique PTSD symptom profiles using Latent Class Analysis (LCA) or Latent Profile Analysis (LPA) (Hansen, Ross, & Armour, 2017). LPA is an analytic approach through which individuals are categorized into homogenous subgroups based on their individual patterns of responses to a set of predictor variables, permitting characterization of unique *profiles of symptoms* in addition to symptom severity, rather than simply classifying individuals into dichotomous diagnostic categories.

Researchers have adopted a number of strategies aimed at understanding the architecture of PTSD, including multiple studies that have examined PTSD symptoms *in combination with associated symptoms* (such as separate measures of dissociation or affect regulation). For example, some investigations have explored symptoms in military populations (Armour et

al., 2015; Ateka A Contractor, Armour, Shea, Mota, & Pietrzak, 2016; A. A. Contractor et al., 2015; C. Hebenstreit, Madden, & Maguen, 2014; Maguen et al., 2013; Naifeh, Richardson, Del Ben, & Elhai, 2010; Steenkamp et al., 2012; Wolf, Lunney, et al., 2012), with these studies generally focusing on specific subsets of trauma survivors and supporting a 2-3 class solution. These studies have often included additional symptoms that are not presently measured as part of current PTSD diagnostic criteria, with samples who have not always experienced common index trauma(s).

We focus here on understanding PTSD as assessed using the latest edition of the Diagnostic and Statistical Manual of the American Psychiatric Association (DSM-5) to minimize assumptions about the supplemental symptoms available to clinicians and investigators who are likely to use the most recent versions of the DSM to guide assessment and treatment decisions. A number of studies have focused exclusively on DSM-IV PTSD symptoms, generally supporting a 3-5 class solution differing in symptom severity (Breslau, Reboussin, Anthony, & Storr, 2005; C. Hebenstreit et al., 2014; C. L. Hebenstreit, Maguen, Koo, & DePrince, 2015; Maguen et al., 2013; Naifeh et al., 2010; Nugent, Koenen, & Bradley, 2012; Rosellini, Coffey, Tracy, & Galea, 2014; Steenkamp et al., 2012). Importantly, past studies using DSM-IV symptoms have often observed that endorsement of dissociation symptoms serves to discriminate between latent classes of PTSD. The new version of the DSM no longer includes the dissociation symptom that was present in DSM-IV, making it important for researchers to examine whether latent classes emerge using the current diagnostic system. Although two published studies have investigated the latent class structure of PTSD using *DSM-5* symptoms, both investigations added dissociation indicators to the existing DSM-5 symptoms (Blevins, Weathers, & Witte, 2014; Frewen, Brown, Steuwe, & Lanius, 2015).

Natural and technological disasters have been on the rise, leading public health experts to highlight the importance of disaster research aimed at characterizing nuanced understanding of post disaster symptomatology (Leaning & Guha-Sapir, 2013). One investigation to date has used person-centered analyses to examine latent class membership following a natural disaster and found a 4-class solution for DSM-IV PTSD symptoms among Mississippi adults (68.1% female) affected by Hurricane Katrina (Rosellini et al., 2014). Unfortunately, after facing Hurricane Katrina, many in the region subsequently experienced the Deepwater Horizon Oil Spill (DHOS; also called the BP Oil Spill or the Gulf Oil Spill), the largest unintentional marine oil spill in history (Griffiths, 2012; Michel et al., 2013). The DHOS began on April 20, 2010, when an explosion occurred on the *Deepwater Horizon* offshore oil platform, approximately 41 miles off the coast of Louisiana, resulting in the deaths of 11 workers and causing oil to be leaked over the course of 86 days into the Gulf of Mexico (Smith Jr. & Smith, 2011). The oil spill came at great economic cost to coastal communities, as it negatively impacted the fishing, seafood, and tourism industries (Cleveland & Saundry, 2010). The total financial cost of the DHOS to BP, the environment, and the economy in affected coastal communities has been estimated to be \$36.9 billion (Smith Jr. & Smith, 2011). Exposure (both environmental and economic) to the DHOS is associated with a host of physical and health complaints (Peres et al., 2016).

Previous research suggests that man-made or technological disasters, such as oil spills, lead to a higher prevalence of PTSD in affected communities than natural disasters (Galea, Nandi, & Vlahov, 2005). In addition, previous exposure to traumatic events is a predisposing risk factor for PTSD development following subsequent trauma (Breslau, Chilcoat, Kessler, & Davis, 1999). The coastal communities affected by the DHOS have experienced multiple traumatic events overtime, including numerous natural disasters, such as Hurricane Katrina in 2005. Degree of impact by Hurricane Katrina has been found to be predictive of adverse mental health symptoms following the Deepwater Horizon Oil Spill (Osofsky, Osofsky, & Hansel, 2011). Exposure to the DHOS has been linked to various negative physical and mental health outcomes (Drescher, Schulenberg, & Smith, 2014; Galea et al., 2005; S. A. Gaston et al., 2017; Grattan et al., 2011; Mong, Noguchi, & Ladner, 2012; Morris, Grattan, Mayer, & Blackburn, 2013; Ngo, Gibbons, Scire, & Le, 2014; Osofsky et al., 2011; Peres et al., 2016; Rung et al., 2016; Rung et al., 2018). According to one study, in the first 5 months following the oil spill, 28% of a sample of gulf-area residents screened positive for PTSD, with 92% of residents in “at risk” occupations (including fishermen, marine/seafood industry employees, restaurant owners, and oil rig workers) endorsing clinically significant levels of PTSD symptoms (Mong et al., 2012). Another study estimated that 12% of residents of Southeastern Louisiana met criteria for PTSD following the oil spill (Osofsky et al., 2011). Oil spill-related income loss and economic impact is a risk factor for adverse mental health outcomes (S. Gaston et al., 2016; S. A. Gaston et al., 2017; Grattan et al., 2011; Rung et al., 2016; Shenese & Langhinrichsen-Rohling, 2015), while self-perceived resilience is protective against depressive and PTSD symptoms one year following the oil spill (Shenese & Langhinrichsen-Rohling, 2015). Individuals living in communities indirectly impacted by the oil spill have been found to have elevated levels of anxiety and depression comparable to those of individuals living in directly impacted communities (Grattan et al., 2011).

The present study aims to use latent profile analysis to describe: (1) the nature of latent PTSD profiles among WaTCH study women and (2) how the different PTSD profiles are associated with important characteristics, including demographic variables (race/ethnicity, income, age), level of exposure to the DHOS, routine mental health treatment, whether PTSD symptoms exceed the threshold for likely diagnosis, co-morbid mental health conditions, and number of previous traumas.

Methods

Study Design

The Women and their Children’s Health (WaTCH) Study examines health outcomes following the 2010 Deepwater Horizon Oil Spill (DHOS) among a cohort of 2852 women in 7 coastal Louisiana parishes affected by the spill (Orleans, St. Bernard, Jefferson, Plaquemines, Lafourche, Terrebonne and St. Mary). Initially, participants were randomly selected using an address-based sampling frame from Marketing Systems Group. To achieve a large number of participants from the five smaller parishes (other than Orleans and Jefferson) where significant oil spill exposure was more likely, participants were intentionally oversampled. Community recruitment strategies were used to enroll women from affected communities. To be included, participants had to be 18-80 years of age and

reside in one of the seven study parishes at the time of the DHOS (April 20, 2010). Further details are described elsewhere (Peters et al., 2017).

Assessment

Participants meeting inclusion criteria completed a computer-assisted telephone interview comprised of questions addressing participant demographic and occupational characteristics, oil spill exposure, lifestyle characteristics, medical history, mental health, and social support. Wave 1 telephone interviews took place between August 2012 and June 2014. Wave 2 follow-up interviews were conducted between 2014 and 2016, and 2,038 women completed the follow-up interview. Follow-up interviews contained questions on past exposure to potentially traumatic events. Women were asked whether they had ever experienced certain potentially traumatic events using the Life Events Checklist (LEC) for *DSM-5* (Blevins, Weathers, Davis, Witte, & Domino, 2015).

To inform the meaning of class membership, we also utilized participants' responses to the following demographic questions: age in years (Wave 1), race/ethnicity (non-Hispanic white, non-Hispanic black, any other race/ethnicity [Hispanic/Latina, Asian/Pacific Islander, American Indian/Alaska Native, multiracial]), number of children (Wave 1, as the number of lifetime "live births"), highest educational attainment (at Wave 1, less than high school, high school diploma or greater), annual household income (Wave 2, <\$20,000, \$20,000-\$40,000, \$40,001-\$60,000, >\$60,000), and perceived physical health status (Wave 2, as participants' responses to the question "How would you rate your physical health in general?"). When responses that could change over time were available at both waves, we used Wave 2 for consistency with timing of PTSD assessment.

We utilized information on the following behaviors: ever smoking (Wave 2, defined as a positive response to the question "In your lifetime, have you ever smoked a total of 100 cigarettes or more, that is, 5 packs or more (a pack has 20 cigarettes)? Do not include cigars or marijuana"), binge drinking (Wave 2, defined as participants' response to "During the past 6 months, since [date], how many times did you have five or more drinks on one occasion?"), and fights with intimate partner (Wave 1, defined as response to "Since the oil spill, that is, since April 20, 2010, has there been an increase in the number of fights, verbal or physical, you've had with your partner?").

We utilized information on the following BP oil spill-related exposures: self-reported oil spill exposure (Wave 2, defined as responses "Happened to me," "Witnessed it," or both to the Life Events Checklist item "The BP oil spill"), ability to smell the oil (Wave 1, as yes/no response to "After the oil spill, could you smell the oil?"), household oil spill-related income loss (Wave 1, as yes/no response to "Did you or anyone in your household lose any income due to disruption of employment or closing a business because of the oil spill?"), perceived overall negative impact of oil spill on household financial situation (Waves 1 and 2, as response to "How would you rate the influence of the oil spill on your household's current financial situation? Would you say it had: No influence, a very positive influence, a somewhat positive influence, a somewhat negative influence, a very negative influence?").

Finally, in addition to the questions on trauma exposure and PTSD symptoms, we considered participants' responses to the following mental health assessment measures: Center for Epidemiological Studies Depression Scale (CES-D) score (Wave 2) (Radloff, 1977), lifetime history of PTSD diagnosis (Wave 2), and past-year history of mental health treatment (Wave 2, involving meeting with a mental health professional including a psychiatrist, psychologist or counselor).

Statistical Analysis

Out of the 2,038 women who completed a Wave 2 interview, 1,997 women completed the PCL-5 and were included in our analyses. Women were considered to have completed the PCL-5 if they had missing or invalid responses on no more than 10%, or 2 items, of the PCL-5.

Descriptive statistics were generated using SAS, Version 9.4. Latent profile analysis was performed using MPlus Version 7.4. Participants were assigned to their most likely classes based on their responses to the 20 PCL-5 items, and posterior probabilities for class membership were computed. We ran LPA models for 2-class through 6-class solutions and compared model fit statistics including Akaike's Information Criteria (AIC), Bayesian Information Criterion (BIC) and sample-size adjusted BIC, entropy; Lo Mendell Rubin Likelihood Ratio Test (LMR-LRT), and Parametric Bootstrapped Likelihood Ratio Test (Asparouhov et al, 2014).

Once we identified the best class solution based on the model fit statistics, the pseudo-class draws method was employed to compare the means of the following covariates across classes: age, non-Hispanic white race/ethnicity, non-Hispanic black race/ethnicity, having less than a high school vs. >high school education, household income > \$40,001/year vs. < \$40,001/year, being married/partnered, having smelled the oil from the BP oil spill (binary), oil-spill related income loss (binary), perceived overall negative impact of the oil spill on household financial situation at waves 1 and 2 (binary), CES-D score, past-year mental health treatment (binary), history of PTSD diagnosis (binary), PCL-5 total score, PCL-5 score > 38 (binary), total number of event categories endorsed on the Life Events Checklist, and endorsement of each of the 18 Life Events Checklist events (all binary).

Results

Descriptive Statistics

Among the 1,997 women included in our analyses, mean age was 46.63 ± 12.14 years. The majority reported non-Hispanic white race/ethnicity (56.80%), were married or living with a partner (60.69%), had completed at least a high school education (88.73%), and had a Wave 2 annual household income of less than \$40,001 per year (50.44%) (Table 1). Participants scored an average of 15.25 (SD=17.21) on the PTSD Checklist-5 (range 0 to 79), with 12.66% of participants scoring at or above a total score of 38, which is the suggested threshold for PTSD screening on the PCL-5, and corresponds with a DSM-IV PCL-S total score of 50 (Hoge, Riviere, Wilk, Herrell, & Weathers, 2014). Slightly over half of participants (52.54%) endorsed having experienced or witnessed the BP oil spill as part of

the Life Events Checklist. Over one-third (38.41 %) of participants reported having been able to smell the oil from the spill and 25.67% reported their household experienced oil spill-related income loss. At the time of the Wave 1 interview, 37.46% of participants reported the oil spill had an overall “somewhat negative” or “very negative” effect on their household’s financial situation at that time point; at the Wave 2 interview, this percentage had declined slightly to 33.97%.

All 1997 participants included in our final analyses endorsed (defined as reporting “happened to me,” “witnessed” or both) at least one potentially traumatic event on the Life Events Checklist used in the Wave 2 interview (Table 2). The most commonly endorsed events were natural disaster (95.74%), the sudden, unexpected death of someone close (77.15%), transportation accident (65.38%), and life-threatening illness or injury (56.74%). Participants endorsed a mean of 6.09 events on the Life Events Checklist, with a range of 1–16 events.

Class Solutions

When comparing model fit statistics, the Lo-Mendel-Rubin Likelihood Ratio Test p -value supported a 5-class solution, while the Parametric Bootstrapped-LRT p -value supported a 6-class solution (Table 3). Prior simulation studies have shown that the LMR performs well in large samples with continuous indicators (such as used by Nylund et al. 2007) (Nylund, Asparoutiov, & Muthen, 2007). After visually examining the 5-class and 6-class models and comparing smallest class sizes (with the 6-class model including a number of small classes), we determined that the 5-class solution provided the best representation of the data. The 5-class model had a high entropy (0.951) and posterior probabilities demonstrated excellent correspondence of average latent class probabilities for most likely class membership with latent class.

Figure 1 illustrates the classes identified in this sample. The five classes of PTSD symptoms can be described as: *low* (Class 1 (6.01 % of participants), mean PCL-5 total score=4.10), *moderate without mood alterations* (Class 2 (18.1%), mean PCL-5 total score=19.73), *moderate with mood alterations* (Class 3 (13.1%), mean PCL-5 total score=34.24), *severe without risk-taking* (Class 4 (4.8%), mean PCL-5 total score=55.75), and *severe with risk-taking* (Class 5 (3.9%), mean PCL-5 total score=53.80). Each of the five classes of individuals showed patterns of symptoms that differed in terms of severity and across the four DSM-5 PTSD symptom clusters, which were described by Friedman, 2016 (Friedman, 2016). Women in the *low-symptom* class showed no or low levels of symptoms across the entire PTSD Checklist. Individuals in the two moderate classes both showed similar, moderate levels of symptoms across clusters B (Symptoms 1-5, intrusion) and C (Symptoms 6-7, avoidance). However, individuals in Class 2, *moderate without mood alterations*, showed no or low levels of symptoms across cluster D (Symptoms 8-14, negative alterations in cognition or mood), and mild levels of symptoms across cluster E (Symptoms 15-20, trauma-related alterations in arousal or activity), while individuals in Class 3, *moderate with mood alterations*, showed moderate levels of symptoms across clusters D and E. Individuals in the two severe classes showed similar, severe levels of symptoms across all four symptom clusters, with average symptom scores among Class 4 generally slightly higher than for

Class 5. However, individuals in Class 4, *severe without risk-taking*, tended not to endorse symptom 16, “Taking too many risks or doing things that could cause you harm” (mean score for item 16, class 4=0.208) while individuals in Class 5, *severe with risk-taking*, tended to show high levels of risk-taking (mean score for item 16, class 5=2.759).

Class Characteristics

The five latent classes of PTSD symptoms were composed of women with notably different demographic, mental health and trauma exposure characteristics (Table 4). Numerous tested demographic features, behaviors, oil spill exposures, and trauma exposures were significantly different across classes. Women in the *low-symptom* class were significantly more likely to be white (61.8%), have finished high school (92.3%), have a household income of at least \$40,001 per year (59.0%), be married or living with a partner (66.6%), and to self-report fewer trauma categories (mean=5.47) than women in any of the four symptomatic classes. Compared to women in the four symptomatic classes, women with low symptoms were significantly less likely to report an increase in the number of fights with their partners after the DHOS (8.4% vs. 17.6% [women with moderate symptoms with mood alterations] to 30.2% [women with severe symptoms without risk-taking behaviors]).

Our results show that women in more symptomatic classes were more likely to have been impacted by the BP oil spill than asymptomatic women. Women in the *low-symptom* class were significantly less likely than women in any of the symptomatic classes to report smelling the oil from the spill and to experience an overall negative impact of the BP oil spill on their current financial situation at both the Wave 1 and Wave 2 interviews. They were also significantly less likely than women in the three most symptomatic classes (classes 3-5) to endorse experiencing the BP oil spill on the Life Events Checklist.

The five classes differed strongly from each other across various measures of mental health and treatment. Mean CES-D score (which measures depression symptoms) and mean PTSD Checklist total score were all significantly different for all possible combinations of the five classes tested against each other, with the exception of the comparison of the two severe classes—*severe without risk-taking* and *severe with risk-taking*. In general, average CES-D score, prevalence of PTSD diagnosis and PCL-5 score increased as classes increased in symptom severity.

Women in the *low-symptom* class were less likely than women in more symptomatic classes to have been exposed to a number of different potentially traumatic events. They reported fewer traumas and were less likely to report physical assault as well as assault with a deadly weapon but were similarly likely to experience natural disaster compared to more symptomatic classes. Exposure to a transportation accident, life-threatening illness or injury, or war/combat zone were not significantly associated with class membership in our analysis (data not shown). Notably, lifetime prevalence of sexual assault increased as PTSD symptom severity increased across classes. While 15% of participants with low symptoms reported prior sexual assault, almost one-third of participants in the two classes with moderate symptoms and almost half of participants in the two classes with the most severe symptoms reported prior sexual assault.

Discussion

Findings from the present investigation of women residing in coastal Louisiana align with existing evidence that PTSD is a heterogeneous disorder comprised of individuals with different and distinct patterns of symptomatology. This is the first investigation reporting on the WaTCH sample trauma and PTSD, with findings here suggesting that women in this sample report notably high levels of trauma as well as a high prevalence of PTSD. Women in this sample reported an average of 6.09 types of trauma. Past US epidemiological research has reported an average of 3.30 and a mode of 3 lifetime DSM-5 events (Kilpatrick et al., 2013) and a 2012 latent profile analysis of DSM-IV PTSD symptoms in a sample of low-income urban minority adults found an average of 3.88 types of trauma (Nugent et al., 2012). Our results suggest that women in coastal Louisiana communities experience a disproportionate number of traumatic events as compared to the general population. Women in the WaTCH sample also reported higher symptom severity and higher levels of likely PTSD relative to epidemiological samples. Using the DSM-5 definition in a previously collected US epidemiological sample, past 6-month prevalence rates were estimated to be 3.1% of men and 5.3% of women (Kilpatrick et al., 2013). By contrast, 12.7% of women in the WaTCH study sample scored at or above the suggested cut-point of 38 (Hoge et al., 2014) for likely PTSD when reporting past 1-month symptoms on the PCL-5.

This study adds to a body of literature exploring the latent class structure of PTSD. Consistent with a body of literature supporting 4-5 class solutions (Armour et al., 2015; Cao et al., 2015; Ateka A Contractor et al., 2016; Frewen et al., 2015), our findings supported the presence of five distinct classes of PTSD symptoms: *low*, *moderate without mood alterations*, *moderate with mood alterations*, *severe without risk-taking*, and *severe with risk-taking*. Importantly, however, most past studies of DSM-5 symptoms have examined PTSD symptoms in conjunction with other measures. For example, Contractor et al. (2016) found a 5-class solution for DSM-5 PTSD symptoms and “Big Five” personality traits, in a sample of U.S. veterans (n=1097) (Ateka A Contractor et al., 2016). Cao et al. (2015) found a 4-class solution for DSM-5 PTSD symptoms in conjunction with depressive symptoms, in a sample of Chinese earthquake survivors (n=1196) (Cao et al., 2015).

Studies examining PTSD in conjunction with dissociation have concluded 3-5 class solutions that comprised comparable symptom categories to those identified in the current study. Frewen et al. (2014) found a 5-class solution for DSM-5 PTSD symptoms in conjunction with dissociation symptoms, in a sample of internet-recruited participants intended to represent a general population sample (n=557) (Frewen et al., 2015). Armour et al. (2014) found a 4-class solution of PTSD symptoms in conjunction with dissociation in a sample of sexual assault survivors (n=351) (Armour, Elklit, Lauterbach, & Elhai, 2014). Blevins et al. (2014) found a 3-class solution for PTSD symptoms in conjunction with dissociative symptoms in a sample of trauma-exposed college students (n=541) (Blevins et al., 2014). Like our findings, these studies consistently identified one low-symptom group as well as at least one moderate and one severe symptom group.

As the PCL-5 does not contain an item asking about dissociation, for the present study we were unable to consider dissociation in our models. Past research into latent class structure

of PTSD in conjunction with dissociative symptoms demonstrate strong evidence for a dissociative subtype of PTSD. In a sample of the U.S. general population, Frewen et al. (2015) found a 5-class solution for DSM-5 PTSD and dissociative symptoms: *emotional numbing, hyperarousal, moderate dissociative PTSD, severe dissociative PTSD, and severe non-dissociative PTSD* (Frewen et al., 2015). Other studies that assessed DSM-IV PTSD symptoms in conjunction with dissociative symptoms also found evidence for a dissociative subtype (Armour et al., 2014; Blevins et al., 2014; Wolf, Miller, et al., 2012).

Analyses also revealed differences among classes in demographic factors, exposure to the DHOS, mental health symptoms, and prior traumas. For instance, compared to women with low symptom severity, women with moderate to severe symptoms were more likely to be non-white, report lower income as well as education, be non-married, and report greater DHOS exposure. An increase in the number of fights with intimate partners, which was reported in the first assessment after the DHOS, was also associated with subsequent higher PTSD symptom severity. Furthermore, prevalence of prior traumas, especially various forms of assault, often increased with symptom severity. Although we did not specifically assess physical and sexual assault that may have happened between participants and partners, past research supports a positive association between negative mental health outcomes and intimate partner violence post-disaster (Bell & Folkerth, 2016) as well as positive associations between storm damage following Katrina and increases in verbal and physical intimate partner violence (Harville, Taylor, Tesfai, Xu, & Buekens, 2011). Future research of intimate partner violence over the life course and post-disaster is warranted.

In general, findings showed that overall severity of PTSD symptoms was associated with mental health symptoms: classes characterized by higher levels of PTSD symptoms evidenced corresponding increases in depression severity (CES-D score) and prevalence of lifetime history of PTSD diagnosis. Previous investigations from this sample suggested that increased oil spill exposure (physical and economic) was significantly associated with depression symptoms over time (S. A. Gaston et al., 2017; Rung et al., 2016; Rung et al., 2018). This pattern of findings is consistent with a rich literature suggesting that PTSD and depressed mood frequently co-occur and have shared risk factors (Campbell et al., 2007; Goldstein et al., 2016; Spinhoven, Penninx, van Hemert, de Rooij, & Elzinga, 2014; Wisco et al., 2016). Some of this co-occurrence may be partly explained by overlapping symptomatology, particularly given changes to the DSM-5 version of PTSD which added a “negative alterations in cognitions and mood” (Criterion D) (Gros, Price, Magruder, & Frueh, 2012). Researchers have also proposed that co-occurring PTSD and depression may reflect a trauma-related phenotype with unique neurobiological underpinnings (Flory & Yehuda, 2015). The current results highlight the importance of considering not only lifetime trauma exposure but social and economic disadvantage as well as comorbid mental health conditions in post-disaster research and intervention settings.

Our analysis reveals that a sizable number of women in the WaTCH study communities suffer from PTSD symptoms, with roughly 13% of our sample meeting or exceeding the score threshold for probable PTSD on the PTSD Checklist-5 (total score > 38) (Hoge et al., 2014), and even more women reporting subthreshold levels of PTSD symptoms. Despite this, the majority of women in our sample do not report having received a formal PTSD

diagnosis or mental health treatment, even among the most symptomatic classes. Although the two most severely symptomatic classes (4 and 5) had the highest prevalence of lifetime PTSD diagnosis, less than half of the women received a PTSD diagnosis. Similarly, less than half reported receiving past-year mental health treatment. This suggests that the majority of women in these communities with probable PTSD and/or high levels of PTSD symptoms may not receive needed mental health care.

Limitations

Our study has several limitations. First, PTSD was assessed once which prevents any conclusions about causal relationships in our analyses. Although we assessed past-month PTSD symptoms and lifetime exposure to traumatic events, we did not gather information on the onset or duration of PTSD symptoms or age at prior trauma exposure. Thus, we are unable to determine associations with adverse childhood experiences or which events in a woman's life may have preceded the onset of her PTSD symptoms. Furthermore, PTSD assessments were completed by trained interviewers rather than clinicians; however, standard training protocol reduced potential bias. It was difficult to determine whether stressful events endorsed by women met Criterion A necessary for PTSD diagnosis. Criterion A requires that an individual be exposed to "death, threatened death, actual or threatened serious injury, or actual or threatened sexual violence" through direct exposure, witnessing in-person, learning a close friend or relative was exposed to the trauma, or repeated indirect exposure to details of traumatic events, such as during professional duties (Friedman, 2016). With some of the events on the Life Events Checklist, such as natural disaster, transportation accident, other accidents, exposure to toxic substances, exposure to BP oil spill, or sudden, unexpected death of a loved one, it is difficult to determine whether an event may or may not have met criterion A, as there is a wide possible range in severity of the event, and WaTCH participants were not asked to provide details of the events they endorsed on the LEC. Future studies with criterion A assessments are warranted. Lastly, the WaTCH study was conducted among a unique sample of women residing in coastal Louisiana communities affected by multiple past natural disasters, including Hurricane Katrina. While our analysis provides valuable insight into the characteristics and PTSD symptom profiles among women in areas affected by multiple community-level traumas, such as natural and technological disasters, the findings may not be generalizable to individuals residing in communities with different characteristics. Furthermore, although research supports the likelihood that the structure and profile of PTSD is similar in men and women, it is likely that there are different emotional, cognitive, and neurobiological mechanisms underpinning PTSD for men and women (Pineles, Arditte Hall, & Rasmusson, 2017). Accordingly, the present findings as related to these mechanisms may not completely generalize to men.

In conclusion, results of the present LPA of the recent 20-item PCL-5 suggested five distinct PTSD profiles among women affected by the DHOS. The five classes consisted of women with notably different PTSD symptoms and characteristics. The most severe classes were of a lower SES and experienced more traumas as well as more types of oil spill exposure compared to the class with low PTSD symptoms. Despite symptom severity, most of the highly PTSD-affected women lacked mental health treatment in the past year and formal

PTSD diagnosis. Importantly, results of the current study provide a number of important contributions to PTSD literature including assessment of PTSD profiles among a population-based cohort with high levels of trauma exposure, a racially/ethnically diverse female sample, and a large number of participants. Addressing mental health and access to mental health care is important in this highly affected population that resided in southeastern coastal Louisiana, a particularly vulnerable region of the United States.

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Highlights

- Latent profile analysis of the PCL-5 supported five distinct PTSD classes.
- Women with a low-symptom profile had fewer traumas and socioeconomic risk factors.
- Women with severe PTSD symptoms had more traumas and socioeconomic risk factors.
- Most women with severe PTSD symptoms had no prior PTSD diagnosis.

the stressful experience?	people, or the world?		
(5) Having strong physical reactions when something reminded you of the stressful experience?	(10) Blaming yourself or someone else for the stressful experience or what happened after it?	(15) Irritable behavior, angry outbursts, or acting aggressively?	(20) Trouble falling or staying asleep?

Figure 1.
5-Class solution for PTSD symptoms, WaTCH Cohort, n=1997

Table 1.

Key Characteristics of the WaTCH Study Population Included in Analyses, Wave 2 (n=1997)

	N or Mean	% or Standard Deviation (SD)	Range
DEMOGRAPHICS			
Age, years *	46.63	12.14	18-80
Number of Children *	2.41	1.35	0-10
Annual Household Income			
\$20,000	572	29.44	
\$20,001-\$40,000	408	21.00	
\$40,001-\$60,000	289	14.87	
> \$ 60,000	674	34.69	
Race/ethnicity *			
NH White	1102	56.80	
NH Black	713	36.75	
Other/Multiracial	125	6.44	
Marital Status			
Married or Living with Partner	1212	60.69	
Not Currently Married	785	39.31	
Education *			
Less than high school	225	11.27	
High school diploma or greater	1771	88.73	
Physical Health			
Good, Very Good, or Excellent	1421	71.19	
Fair or Poor	575	28.81	
Ever Smoker			
Yes	689	34.52	
No	1307	65.48	
Binge Drinking, # episodes in past 6 months	1.63	8.89	0-180
Increase in # of fights with partner since oil spill *			
Yes	257	12.91	
No	1397	70.17	
No partner since oil spill	337	16.93	
MENTAL HEALTH			
CES-D score	14.51	13.54	0-57
Ever diagnosed with PTSD	190	9.55	
PCL-5 Total Score ^a	15.25	17.21	0-79
PCL-5 Score 38 ^a	250	12.66	
Past-Year Mental Health Treatment			

	N or Mean	% or Standard Deviation (SD)	Range
Yes	277	14.94	
No	1356	85.23	
DHOS EXPOSURE			
Self-reported oil spill exposure			
“Happened to me” and/or “Witnessed it”	1046	52.54	
Neither	945	47.46	
Able to smell oil *			
Yes	733	38.40	
No	1176	61.60	
Household oil spill-related income loss *			
Yes	510	25.67	
No	1477	74.33	
Influence of oil spill on current household financial situation, Wave 1 *			
Somewhat or Very Negative	739	37.46	
Neutral, Somewhat or Very Positive	1234	62.54	
Influence of oil spill on current household financial situation, Wave 2			
Somewhat or Very Negative	674	33.97	
Neutral, Somewhat or Very Positive	1310	66.03	

* Assessed at Wave 1 interview

^a22 women missing values for PCL-score

Abbreviations: SD (standard deviation); NH (non-Hispanic); CES-D (Center for Epidemiologic Studies Depression Scale); PTSD (posttraumatic stress disorder); PCL-5 (PTSD Checklist for DSM (Diagnostic and Statistical Manual of Mental Disorders)-5)

Table 2.

Trauma Experiences Among the WaTCH Study Cohort (N=1997)

LIFE EVENTS CHECKLIST: Experienced or Witnessed	N	%
Natural disaster	1912	95.74
Fire or explosion	645	32.31
Transportation accident	1305	65.38
Serious accident at work, home or during recreational activity	525	26.32
BP oil spill	1046	52.54
Exposure to toxic substance (for example, dangerous chemicals, radiation)	432	21.72
Physical assault	594	29.79
Assault with a weapon	373	18.70
Sexual assault (rape, attempted rape, made to perform any type of sexual act through force or threat of harm)	443	22.26
Other unwanted or uncomfortable sexual experience	535	26.88
Combat or exposure to a war-zone (in the military or as a civilian)	58	2.91
Captivity (for example, being kidnapped, abducted, held hostage, prisoner of war)	64	3.21
Life-threatening illness or injury	1132	56.74
Severe human suffering	733	36.80
Sudden, violent death (for example, homicide, suicide)	442	22.17
Sudden, unexpected death of someone close to you	1540	77.15
Serious injury, harm, or death you caused to someone else	21	1.05
Any other very stressful event or experience	378	18.94
Total Number of Trauma Categories	6.09 (mean)	2.98 (SD) 1-16 (Range)

Table 3.

Model Fit Statistics for 2-6 Class Solutions, PCL-5 Symptoms, WaTCH Study Cohort (n=1997)

# of Classes	AIC	BIC	SSA-BIC	Entropy	LMR-LRT <i>p</i> -value	Parametric Bootstrapped-LRT <i>p</i> -value
2	110843.88	111185.45	110991.65	0.980	<0.0001	<0.0001
3	106614.60	107073.75	106813.23	0.966	<0.0001	<0.0001
4	104814.94	105391.68	105064.44	0.968	0.0137	<0.0001
5	103480.76	104275.09	103781.13	0.951	0.0081	<0.0001
6	102550.19	103362.10	102901.43	0.957	0.5664	<0.0001

Abbreviations: AIC (Akaike Information Criterion); BIC (Bayesian Information Criterion); SSA-BIC (Sample size-adjusted Bayesian Information Criterion); LMR-LRT (Lo-Mendell-Rueben Likelihood Ratio Test)

Table 4.

Characteristics Across Latent Classes of PTSD Symptoms, Louisiana WaTCH Study Cohort

	1: Low	2: Moderate without mood alterations	3: Moderate with mood alterations	4: Severe without risk-taking	5: Severe with risk-taking	Overall <i>p</i>-Value
DEMOGRAPHICS						
Age (mean)	47.13 ⁵	46.00	46.51	45.13	44.07 ¹	0.120
Race/ethnicity: NH White (vs. NH Black/Other)	61.8% ^{2,3,4,5}	51.7% ^{1,5}	51.4% ¹	42.4% ¹	38.7% ^{1,2}	<0.001
Race: NH Black (vs. NH White/Other)	33.2% ^{2,3,4,5}	39.5% ¹	41.2% ¹	46.7% ¹	52.0% ¹	0.001
Education: < High School	7.7% ^{2,3,4,5}	12.2% ^{1,4,5}	18.0% ¹	22.9% ^{1,2}	26.0% ^{1,2}	<0.001
Income: \$40,001/year	59.0% ^{2,3,4,5}	44.0% ^{1,3,4,5}	34.9% ^{1,2,4,5}	22.1% ^{1,2,3}	13.5% ^{1,2,3}	<0.001
Married/Living with partner	66.6% ^{2,3,4,5}	57.2% ^{1,5}	50.2% ¹	45.8% ¹	39.0% ^{1,2}	<0.001
Increase in #of fights with partner since oil spill (yes vs. no/no partner)	8.43% ^{2,3,4,5}	18.3% ^{1,4}	17.6% ^{1,4}	30.2% ^{1,2,3}	20.2% ^{1,4}	<0.001
BP OIL SPILL EXPOSURES						
Able to smell oil	33.5% ^{2,3,4,5}	41.8% ^{1,4}	48.2% ¹	53.2% ^{1,2}	46.1% ¹	<0.001
Had household oil spill-related income loss	22.3% ^{2,3}	32.3% ¹	28.6% ¹	30.5%	31.2%	0.004
Negative Overall Impact of Oil Spill on Current Household Financial Situation, Wave 1	33.3% ^{2,3,4,5}	41.0% ¹	45.0% ¹	46.3% ¹	50.0% ¹	<0.001
Negative Overall Impact of Oil Spill on Current Household Financial Situation, Wave 2	27.5% ^{2,3,4,5}	39.8% ¹	45.2% ¹	50.0% ¹	50.7% ¹	<0.001
MENTAL HEALTH						
CES-D Score (mean)	8.71 ^{2,3,4,5}	15.29 ^{1,3,4,5}	25.75 ^{1,2,4,5}	35.85 ^{1,2,3}	36.16 ^{1,2,3}	<0.001
Had Past-Year Mental Health Treatment	7.7% ^{2,3,4,5}	18.3% ^{1,3,4,5}	25.6% ^{1,2,4,5}	43.0% ^{1,2,3}	46.2% ^{1,2,3}	<0.001
Ever Had PTSD diagnosis	1.3% ^{2,3,4,5}	4.4% ^{1,4,5}	8.5% ^{1,4,5}	18.8% ^{1,2,3}	26.0% ^{1,2,3}	<0.001
Total PCL-5 Score (mean)	4.10 ^{2,3,4,5}	19.73 ^{1,3,4,5}	34.24 ^{1,2,4,5}	55.75 ^{1,2,3}	53.80 ^{1,2,3}	<0.001
PCL-5 Score ≥ 38	0.0% ^{3,4,5}	0.3% ^{3,4,5}	33.7% ^{1,2,4,5}	97.9% ^{1,2,3,5}	87.0% ^{1,2,3,4}	<0.001
TRAUMA EXPOSURE						
Number of trauma categories endorsed (mean)	5.47 ^{2,3,4,5}	6.66 ^{1,4,5}	7.00 ^{1,4}	7.99 ^{1,2,3}	7.70 ^{1,2}	<0.001
Natural Disaster	96.2%	94.8%	95.4%	97.9%	94.8%	0.486
BP oil spill	48.2% ^{3,4,5}	53.6% ³	65.4% ^{1,2}	60.4% ¹	62.3% ¹	<0.001
Physical assault	23.4% ^{2,3,4,5}	34.6% ^{1,4}	39.1% ^{1,4}	55.2% ^{1,2,3}	42.9% ¹	<0.001
Assault with a weapon	12.9% ^{2,3,4,5}	23.5% ^{1,4,5}	26.1% ^{1,4,5}	36.8% ^{1,2,3}	39.0% ^{1,2,3}	<0.001
Sexual assault (rape, attempted rape, made to perform any type of sexual act through force or threat of harm)	14.6% ^{2,3,4,5}	27.4% ^{1,4,5}	31.5% ^{1,4,5}	52.1% ^{1,2,3}	48.1% ^{1,2,3}	<0.001

Note: Numbered superscripts indicate significant differences between each class and the class numbers indicated.

* Unable to obtain chi-square value for 0% vs. 100%.

Abbreviations: NH (non-Hispanic); CES-D (Center for Epidemiologic Studies Depression Scale); PTSD (posttraumatic stress disorder); PCL-5 (PTSD Checklist for DSM (Diagnostic and Statistical Manual of Mental Disorders)-5)

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