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Risk factors for acute mental health symptoms and tobacco initiation in Coast Guard Responders to the *Deepwater Horizon* oil spill

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Abstract

Acute mental health symptoms experienced during oil spill response work are understudied, especially among nonlocal responders. We assessed potential risk factors for acute mental health symptoms and tobacco initiation among U.S. Coast Guard responders to the 2010 *Deepwater Horizon* (DWH) oil spill who completed a deployment exit survey. Cross-sectional associations among responder characteristics, deployment-related stressors (deployment duration, timing, crude oil exposure, physical symptoms, injuries), and professional help-seeking for stressors experienced with concurrent depression/anxiety and tobacco initiation were examined. Log-binomial regression was used to calculate adjusted prevalence ratios (a*PR*s) and 95% confidence intervals. Sensitivity analyses excluded responders with a history of mental health conditions using health encounter data from the Military Health System Data Repository. Of the 4,855 responders, 75.5% were deployed from nonlocal/non-Gulf home stations, 5.8% reported concurrent depression and anxiety, and 2.8% reported the initiation of any tobacco product during oil spill response. Self-report of concurrent depression and anxiety was more prevalent among female responders and positively associated with longer deployments, crude oil exposure via inhalation, physical symptoms and injuries, and professional help–seeking during deployment, a*PR*s = 1.54–6.55. Tobacco initiation was inversely associated with older age and officer rank and positively associated with deployment-related stressors and depression/anxiety during deployment, a*PR*s = 1.58–4.44. Associations remained robust after excluding responders with a history of mental

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health– and tobacco–related health encounters up to 3 years before deployment. Depression, anxiety, and tobacco initiation were cross-sectionally associated with oil spill response work experiences among DWH responders, who largely originated outside of the affected community.

The *Deepwater Horizon* (DWH) oil spill was the largest marine oil spill in U.S. history. The explosion of the Deepwater Horizon drilling rig in the Gulf of Mexico on April 20, 2010, resulted in over 200,000,000 barrels of oil spilled into the Gulf until the well was capped on July 15 of that year (Graham & Reilly, 2011). From April 20 through December 17, 2010, the U.S. Coast Guard led an interagency response and deployed over 8,500 Coast Guard personnel to carry out a wide range of oil spill response and clean-up activities before (precapping), during (pericapping), and after the well was capped (postcapping). Across deployment duration and timing, Coast Guard responders witnessed the detrimental environmental impacts of the spill, were potentially exposed to hazardous chemicals in crude oil and oily water, and experienced deployment-related occupational stressors (i.e., health symptoms, injuries, sleep deprivation, prolonged deployment; Rusiecki et al., 2018). Occupational stressors, such as those experienced in disaster response work and military deployment, have been associated with adverse mental health outcomes and tobacco initiation, which researchers have hypothesized to be a maladaptive coping behavior to stress (Hermes et al., 2012; Palinkas et al., 1993; Smith et al., 2008). Investigating the characteristics of oil spill response work associated with adverse mental health outcomes is urgently needed as responders continue to mobilize in response to new oil spills.

Studies assessing the acute mental health outcomes of oil spill response work are sparse. Evidence that various measures of direct and indirect oil spill exposure are associated with adverse mental health outcomes have largely been reported among populations residential to spill-affected areas (Aguilera et al., 2010; Fan et al., 2015; Laffon et al., 2016). Compared with the research examining residents living in the proximity of the spills, few studies have detailed the mental health outcomes among oil spill responders, and these reports are mixed. The findings from surveys conducted during the 1989 *Exxon Valdez* oil spill and the 2007 *Hebei Spirit* oil spill indicated that clean-up activities were significantly associated with depression, anxiety, and posttraumatic stress (Palinkas et al., 1993; Song et al., 2009). In contrast, studies from the Gulf States Population Survey suggested that participation in the DWH oil spill clean-up activities was not associated with mental distress, and protectively associated with depression (Fan et al., 2015; Kaufman et al., 2019). However, in the first study to document the impact of DWH oil spill response work on the mental health of clean-up workers, the Gulf Long-Term Follow-up (GuLF) Study, researchers found that in standardized mental health inventories administered 1–3 following the spill, both quantitative and qualitative experiences of oil spill response work were significantly associated with depression and posttraumatic stress disorder (PTSD; Kwok, McGrath, et al., 2017).

Knowledge gaps remain in understanding adverse mental health outcomes in oil spill response workers. First, responders from outside the affected communities are rarely studied. In the GuLF Study, little is known about the effects of the DWH oil spill response work on individuals who are not local to the Gulf Coast, as 82% of the cohort were residents

of Gulf states at enrollment, and mental health outcomes were only studied among these participants (Kwok, Engel, et al., 2017; Kwok, McGrath, et al., 2017). Nonlocal responders are of particular interest due to possible differences in social support, community resilience, and natural hazard burden compared to residents of Gulf states (Finucane et al., 2020). Second, although the GuLF Study observed adverse mental health impacts through assessing symptoms 1–3 years postspill, more evidence is needed to understand acute mental health symptoms workers experienced during and shortly after DWH oil spill deployment. Finally, whereas combat exposure, deployment, and posttraumatic stress have been associated with smoking and smokeless tobacco initiation in the military (Meadows et al., 2018; Smith et al., 2008), tobacco initiation in the acute setting is understudied among disaster response workers.

The *Deepwater Horizon* Oil Spill Coast Guard Cohort study (DWH-CG) is uniquely positioned to address these research gaps and adds dimensionality to understanding the acute mental health outcomes experienced during oil spill response work. Most Coast Guard responders originated from outside of the affected community and were deployed from home stations outside of the five Gulf Coast states (i.e., Alabama, Florida, Mississippi, Texas, and Louisiana). As members of the military, Coast Guard responders are relatively young, have few preexisting comorbidities, and are beneficiaries of a health care system designed to ensure equal access. The present study aimed to examine how responder characteristics and deployment-related stressors were cross-sectionally associated with acute mental health symptoms and with tobacco initiation in a sample of Coast Guard responders to the DWH oil spill.

METHOD

Participants and procedure

This cross-sectional study was based on data from the DWH-CG Study, which has been previously described (Rusiecki et al., 2018). Briefly, 8,686 Active Duty or Select Reserve Coast Guard responders who were deployed to the DWH response between April 20 and December 17, 2010, were identified via U.S. Coast Guard administrative databases. Among the responders, 55.8% ($n = 4,855$) completed a self-administered, computerized "exit survey" upon the conclusion of their oil spill response deployment. The survey queried information related to deployment (timing, duration, mission type), relevant oil spill response exposures (crude oil or oily water, oil dispersants, engine exhaust), acute physical and mental health symptoms, and lifestyle factors. Participation in the exit survey was voluntary, and no compensation was provided. The median response time of completion was 5 months after the end of deployment (Rusiecki et al., 2018). All responders who completed this survey were included in the current analysis. In total, 6.0% of survey respondents ($n = 292$) reported having been deployed multiple times, and data reported from their first deployment only were included in this analysis. The study was approved by the Institutional Review Boards (IRBs) of the Uniformed Services University, the U.S. Coast Guard, and the University of North Carolina, Chapel Hill. A waiver for informed consent was approved by the IRB of the Uniformed Services University.

Measures

Depression and Anxiety—Due to the immediacy of the oil spill response, time sensitivity of the exit survey, and rapid mobilization of responders, resources to incorporate empirically based tools and a standardized mental health screening process were limited. Additionally, health screening questions were designed to be brief, self-reported, single-item assessments. For mental health symptoms, participants were asked if they ever experienced depression or anxiety during deployment, with response options of "never," "sometimes," and "most of the time." Few responders reported "most of the time" for depression (0.7%) or anxiety (1.2%). Thus, for the present analyses, we dichotomized the responses and categorized whether responders ever experienced (e.g., "most of the time" or "sometimes") or never experienced each mental health indicator. Among responders who experienced depression during deployment, 71.1% also reported experiencing anxiety during deployment, whereas 39.6% of responders who reported ever experiencing anxiety also reported experiencing depression during deployment.

As depression and anxiety often occur concurrently (Brown & Barlow, 2009), and self-report of experiencing depression and/or anxiety might not adequately reflect a clinical diagnosis (Turon et al., 2019), the main outcome of interest in this study was the endorsement of both mental health symptoms during deployment. Responders were categorized as reporting concurrent depression and anxiety during deployment if they responded either "most of the time" or "sometimes" to both anxiety and depression items on the exit survey. We also evaluated concurrent depression and anxiety as a potential risk factor for tobacco initiation during deployment, where responders who reported never having experienced either mental health symptom during deployment were the referent group. In addition to concurrent depression and anxiety, we separately analyzed the endorsement of either depression or anxiety in supplemental analyses. Henceforth, concurrent depression and anxiety will refer to the report of both depression and anxiety.

Tobacco initiation—The initiation of either cigarette smoking or smokeless tobacco during deployment was assessed as a binary variable using responses from two survey questions. Responders reported the frequency of smoking during deployment by packs per day (ppd) smoked ("None," "< 1 ppd," "1 ppd," "2 ppd," or "3+ ppd"), the frequency of smokeless tobacco use during deployment ("never," "rarely," "sometimes," "most of the time," or "all of the time"), and indicated their prior history of predeployment tobacco use. Responders were classified as initiating smoking during deployment if they answered "no" to smoking at least 100 cigarettes total before deployment and reported any amount of cigarette smoking during deployment. Responders were classified as initiating smokeless tobacco use during deployment if they reported never using smokeless tobacco prior to deployment and reported any use of smokeless tobacco during deployment. Tobacco initiation was classified as the initiation of either cigarette smoking or smokeless tobacco use during deployment. The reference group comprised responders who either never used tobacco products during deployment or used tobacco products both before and throughout deployment.

Responder characteristics—Sex, age, grade/rank, race, highest educational attainment, and responder home station location were identified via Coast Guard administrative databases. Age was categorized into three groups: younger than 25 years (reference group), 25–34 years, 35–50 years, and older than 50 years. Due to few responders who were over 50 years of age, this group was combined with the 35–50-year-old group. Grade or rank in the Uniformed Services denotes both pay grade and level of responsibility in the military chain of command and was categorized as: junior enlisted (E1–E5), senior enlisted (E6–E10), and officer (O1–O10, W2–W4), with junior enlisted as the reference group. All officers were combined into one category due to the small sample of Senior Officers (O5–O10) and Warrant Officers (W2–W4). The responder's duty station before deployment to the DWH oil spill was assessed using Coast Guard administrative databases. Responders whose home stations were located on the Gulf Coast in Alabama, Florida, Mississippi, Texas, and Louisiana were categorized as Gulf Coast (i.e., local) responders and were the reference group. Responders who originated from home stations outside the Gulf Coast were classified as non–Gulf Coast (i.e., nonlocal) responders.

Deployment-related stressors—We examined the following deployment-related stressors that were included in the exit survey: deployment duration and timing in relation to oil well capping; mission type, categorized by oil exposure opportunity; self-reported exposure to crude oil; sleep deprivation; physical symptoms; and injuries. We also examined professional help-seeking for stressors experienced during oil spill response work. Deployment duration was empirically categorized as 30 days or less (reference group), more than 30 days to 60 days, and more than 60 days, given that the median duration of deployment duration was 47 days ($M = 58$ days, $SD = 66$, interquartile range [IQR] = 29–59 days). Exposure to fresh oil and other clean-up–related stressors likely differed relative to when the leaking well was capped on July 15, 2010 (Boufadel et al., 2014). Therefore, we created a combined duration–timing metric to consider the combined effects in exposure on clean-up–related stressors in the pre-, peri-, and postcapping periods. For the combined duration–timing metric, we categorized responders into three groups: longer precapping and pericapping deployments (duration of 30 days or longer), shorter precapping and pericapping deployments (duration of fewer than 30 days), and postcapping deployments of any duration (reference group).

Responders performed varied and often multiple missions during deployment. To capture the overall oil spill clean-up experience of each responder, unique missions and combinations of missions were evaluated by a former Coast Guard industrial hygienist as well as two investigators and categorized by crude oil exposure opportunity (i.e., none, low/medium, and high). The reference category was characterized by no opportunity for oil exposure and included responders who carried out only administrative-type missions. The low/medium oil exposure category included responders who carried out missions with a low potential for crude oil exposure or a mix of missions that included the varied potential for exposure. The high exposure category included responders who carried out only missions with a higher potential for crude oil exposure.

The frequency of exposure to crude oil was assessed in the exit survey with the question, "During your deployment, while engaged in your missions, how often was any part of your

body submersed in the spilled crude oil or oily water/how often did you swallow the spilled crude oil or oily water/how often did the spilled crude oil or oily water come in direct contact with your skin/how often did you inhale vapors from the spilled crude oil or oily water?" Response options were "never," "rarely," "sometimes," "most of the time," and "all the time." We created a three-level categorical variable for oil inhalation exposure by combining responses options "rarely" and "sometimes" into a low exposure category and "most of the time" and "all of the time into" a high exposure category; the third category was characterized by no exposure (i.e., responses of "never"). An "ever" or "never" crude oil exposure metric was then created to encompass all exposure routes by combining all responses that indicated any exposure (i.e., ever-exposed group), with the never-exposed responders as the reference group.

Prolonged sleep deprivation was assessed by reported hours of sleep per night and deployment duration. Responders were asked, "How many hours did you sleep per night during this deployment?" There were four response options: "1 to < 4 hours," "4 to < 6 hours," "6 to < 8 hours," and "8+ hours." A sleep deprivation metric was created to classify responders into four levels of sleep deprivation based on a priori cutoffs of a 30-day deployment length, and 6 hr of sleep per night due to a sparse number of responders who endorsed "1 to < 4 hours" (1.7%) or "8 + hours" (7.9%). Sleep deprivation severity was categorized by least sleep-deprived, characterized by shorter deployments (i.e., 1 month or 30 days) and endorsement of more hours of sleep per night during deployment, to most sleep-deprived, characterized by longer deployments (i.e., longer than 1 month) and the endorsement of fewer hours of sleep per night during deployment. The reference group was the least sleep-deprived group (6 hr or more of sleep per night, deployment less than 30 days), followed by moderate-low sleep deprived (6 hr or more of sleep per night, deployment of 30 days or longer), moderate-high sleep deprived (less than 6 hr of sleep per night, deployment of fewer than 30 days), and most/highest sleep-deprived group (less than 6 hr of sleep per night, deployment of 30 days or longer).

We created a composite score for physical symptom severity score to encompass physical health symptoms responders experienced during deployment. This score was derived from responses to 39 questions from the exit survey that asked individuals to indicate the frequency of physical symptoms experienced during deployment, by organ system. Responders were asked "During deployment, did you experience any of the following?" for a series of general, neurologic; musculoskeletal; dermatological; gastrointestinal; genitourinary; respiratory; cardiovascular; and ear, eyes, nose, and throat symptoms, with symptom frequency rated as 0 (*never*), 1 (*sometimes*), or 2 (*most of the time*). Responses to all physical symptoms were summed to create a physical health symptom severity score ($M = 4.03$, $SD = 5.46$, $Mdn = 2$, $IQR = 0$–6, range: 0–50) and categorized empirically by a cut-point at the 75th percentile (i.e., a score of 6). Individuals with a low symptom severity score (i.e., less than 6) were considered the reference group. Responders reported physical injuries sustained during deployment (i.e., "During deployment, did any of the following injuries occur that required medical treatment?"), by answering "yes" or "no" to having experienced scrapes or abrasions, puncture wounds (e.g., stepping on a nail), burns other than sunburn, a fracture or broken bone, deep cuts or lacerations, or a sprain. We categorized

responder responses into groups characterized by no reported injuries (reference group) and any reported injury.

Professional help-seeking behaviors related to specific stressors experienced during deployment were also assessed. Responders were asked whether they sought professional assistance for physical abuse; sexual assault; moral, occupational, or work conflicts; marital, family, or relationship issues or conflicts; legal or financial issues; substance abuse; bereavement or loss; "other," with a free-response option; or none of these concerns. Of the 77 responders who selected the "other" option, 71 responders were recoded as "none" because those responders selected the "other" option only for providing free-text responses about physical and mental health symptoms which had already been assessed in the exit survey. The remaining six responders had already indicated that they sought professional assistance for an adverse life experience and used the free-text response option to add further detail. Responders who sought professional assistance for any of the adverse life experiences listed were compared to those who responded with "none", or did not indicate that they sought professional assistance.

Data analysis

Cross-sectional analyses of the exit survey data were carried out using log-binomial regression to calculate adjusted prevalence ratios (a*PR*) and 95% confidence intervals of concurrent depression/anxiety and tobacco initiation, separately, among responders in relation to each potential risk factor. Educational attainment analyses excluded 126 responders with an unknown education attainment level. The COPY method (Deddens & Petersen, 2008) was used with 1,000,000 copies in the event of nonconvergence. To evaluate exposure–response associations, tests for trend were conducted by modeling the ordinal categories as a continuous variable in each model to calculate the p value for the trend (i.e., p-trend). The adjusted prevalence ratios and 95% confidence intervals in cells with counts less than 10 were not reported due to potentially unstable estimates.

Each potential risk factor–outcome relationship was adjusted for the minimum sufficient adjustment set of confounders identified by directed acyclic graphs (Supplementary Figure S1), which were constructed using the R package *daggity* (Greenland et al., 1999; Shrier & Platt, 2008; Textor et al., 2017) and informed by prior knowledge of deployment and DWH oil spill literature (Erickson et al., 2019; Hermes et al., 2012; Kwok, McGrath, et al., 2017). Models were adjusted for factors from the following list as appropriate, based on each model's minimum sufficient adjustment sets and indicated in the table footnotes: deployment duration (continuous), employee class (active duty, select reserve), environmental heat exposure (low time outdoors and median heat index less than 95 °F, low time outdoors and a median heat index of 95 °F or higher, high time outdoors and median heat index less than 95 °F, high time outdoors and a median heat index of 95 °F or higher), home station (Gulf Coast, non–Gulf Coast), hours of sleep during deployment (less than 4 hr, 4 hr or less but less than 6 hr, 6 hr or more but less than 8 hr, 8 hr or more), mission type (low, medium, or high oil exposure opportunity), oil exposure (ever, never), physical symptoms score (high, low), professional help-seeking (ever, never), rank/ grade (junior enlisted, senior enlisted, officer), and responder sex (male, female). All tests of

statistical significance were two-sided with an alpha value of .05. Analyses were conducted in SAS (Version 9.4) and R (Version 4.0.2).

Sensitivity analyses—To account for the potential influence of preexisting mental health conditions on reports of depression and anxiety, a sensitivity analysis was conducted in active duty members only and excluded individuals with relevant preexisting mental health diagnoses for each symptom (Supplemental Table S1). Analyses were performed only among active duty responders because only they received care in the Military Health System and, therefore, had complete health encounter data, whereas select reserve members did not. Health encounters were coded using the *International Classification of Diseases* (9th rev.; *ICD-9*) and captured in the Military Health System Data Repository (MDR). This study queried all health encounters for active duty members dating back to October 1, 2007 (Rusiecki et al., 2018) and defined diagnoses of conditions related to depression, anxiety, and history of tobacco use as having either one inpatient or two outpatient health encounters with the relevant *ICD-9* code for that condition, diagnosed at any time before the start of the responder's deployment.

Stratified analyses—Stratified analyses were conducted to investigate the potential for effect modification by sex (male/female) and home station location (Gulf Coast/non–Gulf Coast). Categories with fewer counts were combined to maintain counts greater than 10. Stratified analyses for tobacco initiation were not reported due to sparse counts throughout. Effect modification was assessed through the *p* value for interaction (*p*-int) by including a multiplicative interaction term in each regression model.

RESULTS

Responders were predominantly men (85.0%), younger than 35 years of age (60.8%), enlisted (73.0%), active duty (63.9%), White (77.1%), and deployed from non–Gulf Coast duty stations (75.5%; Table 1). Just over half of the deployments (53.7%) lasted between 30 to 60 days, and 67.9% of deployments occurred during the precapping or pericapping periods. Over half of responders (55.9%) reported crude oil exposure via any route. Approximately one quarter of responders (26.3%) reported the highest level of sleep deprivation (less than 6 hours per night and deployment of 30 days or longer), 26.4% had a high physical symptom composite score, 9.9% reported one or more physical injuries, and 4.8% reported seeking professional assistance during deployment. For self-reported experiences of mental health symptoms, 5.8% (*n* = 281) of responders reported experiencing concurrent depression and anxiety during their deployment, 8.8% reported experiencing anxiety only, and 2.3% reported experiencing depression only. Regarding tobacco initiation, 2.8% (*n* = 136) of responders reported initiating smoking or smokeless tobacco during deployment.

Concurrent depression and anxiety was associated with female sex, a*PR* = 1.77, 95% CI [1.36, 2.25], and was not associated with race, educational attainment, or home station (Table 2). Concurrent depression and anxiety was associated with increasing deployment duration, a*PR*$_{60/<30 \text{ days}}$ = 1.54, 95% CI [1.09, 2.18], *p*-trend = .016, and increasing levels of crude oil inhalation, a*PR*$_{\text{High/None}}$ = 1.60, 95% CI [1.14, 2.24], *p*-trend = .011; increasing

levels of sleep deprivation, $aPR_{Highest\ level}$ = 1.74, 95% CI [1.14, 2.78], p-trend < .001); high physical symptoms score, aPR = 6.55, 95% CI [5.00, 8.67]; one or more physical injuries, aPR = 2.39, 95% CI [1.84, 3.07]; and professional help-seeking, aPR = 4.30, 95% CI [3.25, 5.58], during deployment.

Tobacco initiation was inversely associated with both increasing age, $aPR_{35/<25years}$ = 0.32, 95% CI [0.17, 0.60], p-trend < .001, and with higher rank/grade, $aPR_{Senior/Junior\ enlisted}$ = 0.42, 95% CI [0.27, 0.65] and $aPR_{Officer/Junior\ enlisted}$ = 0.26, 95% CI [0.14, 0.47], p-trend < .001. Tobacco initiation was more prevalent among responders who reported crude oil exposure via any route, aPR = 1.70, 95% CI [1.11, 2.61], and increasing levels of sleep deprivation, with an adjusted prevalence ratio of 2.38, 95% CI [1.27, 4.45], among the most sleep-deprived responders, p-trend = .003. Responders were more likely to report tobacco initiation if they had a high physical symptom score, aPR = 1.58, 95% CI [1.11, 2.25]; sustained any physical injury, aPR = 1.85, 95% CI [1.23, 2.79]; or reported seeking professional assistance during deployment, aPR = 3.43, 95% CI [2.17, 5.41]. Self-report of concurrent depression and anxiety was associated with a four-fold higher prevalence of tobacco initiation, aPR = 4.44, 95% CI [2.98, 6.62].

For self-reported depression only (n = 114) or anxiety only (n = 428), depression was inversely associated with higher rank, p-trend < .007, whereas anxiety was more prevalent among female responders and positively associated with higher rank, p-trend < .001. Both depression only and anxiety only were associated with higher degrees of sleep deprivation, higher composite physical symptoms scores, physical injuries, and professional help-seeking during deployment (Supplemental Table S2).

The direction and pattern of associations remained similar when sensitivity analyses were conducted, which were restricted to active duty responders and excluded participants with a prior history of MDR-based anxiety or depression–related conditions from the anxiety and depression analyses; sensitivity analyses additionally excluded MDR-based history of tobacco use from the tobacco initiation analyses (Table 3). Among active duty responders, associations between concurrent depression and anxiety were modestly strengthened, and experiencing concurrent depression and anxiety was more prevalent among responders from non–Gulf Coast home stations, aPR =1.42, 95% CI [1.01, 2.04], which persisted after excluding responders with preexisting anxiety or depression–related conditions, aPR =1.51, 95% CI [1.20, 2.70]. Associations for tobacco initiation were either stable or modestly strengthened after excluding responders with a medical history of anxiety, depression, or tobacco-related conditions (Table 3).

In sex-stratified analyses for concurrent depression and anxiety, males responders (n = 4,127) had significantly higher adjusted prevalence ratios than female responders (n = 728), with tests for the interaction of deployment stressors and sex indicating significant effect modification by sex for the following stressors: deployment duration, aPR_{Male} = 1.98, aPR_{Female} = 0.73, p-int = .010; oil exposure by mission type, aPR_{Male} = 1.35, aPR_{Female} = 0.72, p-int = .008; any crude oil exposure, aPR_{Male} = 1.61, aPR_{Female} = 1.01, p-int = .002; crude oil exposure via inhalation, aPR_{Male} = 2.21, aPR_{Female} = 0.58, p-int < .001; sleep deprivation, aPR_{Male} = 2.12, aPR_{Female} = 1.29, p-int = .012; and physical injuries, aPR_{Male}

= 7.02, aPR_{Female} = 4.47, p-int = .017 (Supplementary Table 3). In analyses stratified by home station, associations for concurrent depression and anxiety among non–Gulf Coast and Gulf Coast responders were of similar magnitude, except for higher estimates among non–Gulf Coast responders for deployment duration and crude oil exposure via inhalation (Supplementary Table S4).

DISCUSSION

This cross-sectional, survey-based study among Coast Guard responders to the DWH oil spill identified several demographic characteristics and deployment-related stressors associated with self-reported depression, anxiety, and tobacco use initiation. Experiencing concurrent depression and anxiety was associated with longer deployments, self-reported crude oil exposure, higher levels of sleep deprivation, physical symptoms and injuries, and seeking professional assistance for stressors during deployment. Although we observed a higher prevalence of concurrent depression and anxiety among female responders compared to their male counterparts, the associations between deployment-related stressors and mental health outcomes were stronger among male responders in sex-stratified analyses. The initiation of either cigarette smoking or smokeless tobacco use during deployment was associated with younger age, enlisted rank, crude oil exposure, higher levels of sleep deprivation, physical symptoms and physical injuries, professional help-seeking, and self-reported concurrent depression and anxiety.

The current study demonstrates that among Coast Guard responders deployed to the Gulf Coast, stressors related to oil spill response work were associated with adverse acute mental health outcomes. These observations are consistent with findings from the GuLF Study, which assessed associations between stressful experiences (i.e., smelling oil, dispersants, or cleaning chemicals and stopping work because of heat) and job type (i.e., response, operations, and decontamination jobs) and depression (Kwok, McGrath, et al., 2017). Whereas the GuLF Study ascertained mental health outcomes 1–3 years after the spill with interviewer-administered standardized mental health inventories, the current study investigated acute mental health outcomes experienced during deployment by ascertaining mental health symptoms via an exit survey (Kwok, Engel, et al., 2017; Rusiecki et al., 2018). The GuLF Study findings suggested that longer oil spill response work was associated with lower symptom levels for major depression and generalized anxiety disorder, potentially because longer response work was associated with higher 2010 household income (Lowe et al., 2016). In contrast, the present findings indicate an association between longer deployments and increased symptoms of depression and anxiety. This could be attributed to how payment for oil spill work was an important source of income in 2010 for many of the GuLF Study participants, whereas Coast Guard responders were military service members whose base pay did not depend on the duration of their oil spill response work. Additional stress in the postcapping period by Tropical Storm Bonnie on July 22, 2010, may have contributed to nonsignificant associations between precapping and pericapping deployment duration–timing.

In our study, non–Gulf Coast-based responders had a higher prevalence of concurrent depression and anxiety compared to local (i.e., Gulf Coast–based) responders. It is possible

this is related to Gulf Coast responders being able to return to their homes or families during deployment, which may have resulted in increased personal and community resilience, a protective factor against mental health distress (Finucane et al., 2020). Associations between physical health symptoms and mental health symptoms are consistent with reports of the Gulf State Population Survey and reflect the larger body of literature linking physical and mental health (Demyttenaere et al., 2007; Fan et al., 2015). The higher prevalence of acute mental health symptoms among responders who reported sleep deprivation is consistent with previous studies and was also observed among Coast Guard service members who responded to Hurricane Katrina in 2005 (Bergan et al., 2015; Vogel et al., 2012).

Consistent with current knowledge of sex differences in the prevalence of anxiety and mood disorders (Altemus et al., 2014), we observed a higher prevalence of anxiety and concurrent depression and anxiety among female responders. In sex-stratified analyses, male responders evinced significantly higher associations between deployment-related stressors and mental health outcomes compared to associations among female responders. Although the responder population was predominantly male (85.0%), the stronger associations with mental health outcomes among male responders could be attributed to a higher prevalence of oil exposure (58.1% vs 43.1%) and missions with high oil exposure opportunities (19.8% vs 10.3%) among male compared with female responders. Though we did not observe associations between race (as a social construct) and mental health indicators, this is likely because we could not sufficiently evaluate diverse racialized groups due to insufficient power and, thus, grouped the remaining minoritized responders using an "other" category. In anxiety-only and depression-only analyses, anxiety was associated with female responders, older age, and higher rank, whereas depression was associated only with lower rank. However, the differences between the associations between sex, age group, and race and depression and anxiety are less interpretable due to the single-item assessment of these symptoms in the survey and the shared features between clinically diagnosed anxiety and mood disorders (Brown & Barlow, 2009).

To our knowledge, this study was the first to identify an association between the experiences of oil spill response work and the initiation of any tobacco products during deployment. Tobacco use is the single most preventable cause of death and disease in the United States, and the use of smokeless tobacco is considerably higher in the military compared to the general population (Meadows et al., 2018). It is, therefore, important to elucidate sources of smoking initiation in military populations. Associations between tobacco initiation and younger age, enlisted rank, depression and anxiety, and deployment-related stressors (i.e., oil exposure, injuries, and sleep deprivation) are consistent with prior findings among deployed service members (Smith et al., 2008). Tobacco initiation is understudied in the Coast Guard and other disaster responders, and the present analysis identified potential risk factors for tobacco initiation during disaster response deployments, which can inform medical providers and disaster response planners of interventions to prevent smoking initiation or relapse.

This study had several strengths, including a large study population, which provided adequate power to detect associations in the main analyses and most subanalyses. The comprehensive exit survey allowed for the assessment of various deployment-related

experiences and tobacco initiation. The analysis benefitted from a comparable reference group to assess the association between crude oil exposure and mental health outcomes, where responders who reported never having been exposed to oil (44.1%) were similar in baseline characteristics (i.e., sex, race, and age) to responders who reported any crude oil exposure (55.9%). The analysis was further refined with medical claims data from the MDR, which allowed for the exclusion of individuals who had medical encounters before the oil spill that were relevant to the targeted mental health conditions, with medical encounter data available for up to 3 years prior to the DWH oil spill. Coast Guard responders are generally relatively young, healthy, and have equal access to health care, which potentially reduced the impact of comorbidities on mental health. Furthermore, active duty responders had consistent monthly pay and guaranteed housing and subsistence allowances, which potentially reduced the impact of socioeconomic factors related to the oil spill on mental health symptoms.

This study should be interpreted considering several limitations. The cross-sectional associations we identified do not imply causality, as temporality between deployment experiences and mental health outcomes could not be assessed. Due to this limitation, we were unable to perform further analyses to examine the potential role of mediators (e.g., sleep deprivation) to understand the associations between deployment experiences and mental health outcomes. Recognizing this limitation, we conducted sensitivity analyses that excluded responders who had a history of mental health or tobacco-related encounters in the MDR. However, not all responders with preexisting conditions may have been captured, as previous research has suggested that 23%–40% of military service members who screen positive for a mental health condition subsequently seek medical care (Hoge et al., 2004). Service members may either avoid medical care or seek health care outside of coverage provided by the military health system because treatment for mental health or other stressors (e.g., physical abuse, sexual assault) is not confidential within the military. Our assessment of mental health outcomes was also limited by these barriers, and we may have only captured responders with the most severe symptoms. The assessment of mental health outcomes was inherently limited by single-item, self-report assessments (Turon et al., 2019), which were not validated by standardized instruments or clinical evaluation. Despite this, the prevalence of self-reported concurrent depression and anxiety in our study population (5.8%) was within the range of pooled prevalence of depression (5.6%–7.1%) in a meta-analysis of studies that used standardized instruments to calculate the prevalence of mental health conditions among active duty and reserve component service members (Cohen et al., 2015). The dichotomous classification of scaled responses may have further limited the specificity of self-reported symptoms and the predictive probability of clinical diagnosis, as observed in a large comparative survey of military mental health (Kessler et al., 2013). Tobacco initiation was not directly assessed but rather ascertained from combined self-report of smoking and smokeless tobacco history and the use of tobacco products during deployment. Additionally, patterns of use of other substances, such as alcohol, were not assessed on the exit survey. Therefore, we could not identify responders who had quit previously and relapsed during deployment or investigate other substances and patterns of usage. Our study may have underestimated professional assistance-seeking as only seven specific stressors were queried in the survey. The assessment of oil spill

response experiences and study outcomes via self-report measures may also be subject to recall bias. However, recall of deployment experiences is expected to be accurate, as there was a relatively short lag time between deployment completion and survey completion (Rusiecki et al., 2018). We were unable to assess other potential confounders, such as prior disaster response deployments, marital status, and family history of mental health diagnoses. Although some statistically significant findings may have occurred by chance because of the number of tests performed, we relied on more than the statistical significance when assessing the potential importance of our findings (e.g., evaluating for context in prior literature, consideration of the magnitude of point estimates, analyzing monotonic exposure–response relationships through tests for trend, and the observation of consistent patterns across sensitivity and stratified analyses).

The present describes mental health outcomes and tobacco initiation associated with stressors related to oil response work and reflects the findings of previous studies of response workers in other disaster recovery settings (Khatri et al., 2019). As crude oil continues to be used to fulfill energy demands in the modern world, the risk of future spills remains (Ji et al., 2017). The identified associations with adverse mental health outcomes and tobacco initiation may inform disaster response planners of potential preventative measures and postresponse services needed to support future responders to these and other disasters. Although this study focused on acute mental health symptoms during the spill response, future analyses should utilize longitudinal military health encounter data to evaluate longer-term mental health outcomes of oil spill response work.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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OPEN PRACTICES STATEMENT

The study reported in this article was not formally preregistered. To protect participant confidentiality, neither the data nor the materials have been made available on a permanent third-party archive; requests for the data or materials should be sent via email to the corresponding author jennifer.rusiecki@usuhs.edu.

TABLE 1

Study population characteristics, deployment-related stressors, self-reported mental health symptoms, and tobacco initiation among U.S. Coast Guard Responders to the Deepwater Horizon oil spill

Variable	*n*	%
Sex		
Male	4,127	85.0
Female	728	15.0
Age (years)		
< 25	827	17.0
25–34	2,128	43.8
35–50	1,738	35.8
> 50	162	3.3
Rank/grade		
Junior enlisted (E1–E5)	2,233	46.0
Senior enlisted (E6–E10)	1,311	27.0
Officer (O1–O10, W2–W4)	1,311	27.0
Employee class		
Active duty	3,102	63.9
Selected reserve	1,753	36.1
Race		
White	3,741	77.1
Black or African American	203	4.2
Other or unknown[a]	911	18.8
Educational attainment		
High school or less	2,740	56.4
Some college or more[b]	1,989	41.0
Other/not indicated	126	2.6
Home station location		
Gulf Coast	1,189	24.5
Non–Gulf Coast	3,666	75.5
Deployment duration (days)		
< 30	1,313	27.0
30–59	2,609	53.7
60	933	19.2
Deployment timing[c]		
Precapping (pre-July 15, 2010)	1,156	23.8
Pericapping (during July 15, 2010)	2,143	44.1
Postcapping (post-July 15, 2010)	1,556	32.0
Deployment duration timing		
All postcapping deployments	1,556	32.0
Shorter pre- or pericapping deployments (< 30 days)	904	18.6

Variable	*n*	*%*
Longer pre- or pericapping deployment (30 days)	2,395	49.3
Oil exposure by mission[d]		
Low	1,446	29.8
Medium	2,516	51.8
High	893	18.4
Self-reported oil exposure[e]		
No	2,142	44.1
Yes	2,713	55.9
Self-reported oil inhalation		
None	2,377	49.0
Low	2,011	41.4
High	467	9.6
Sleep duration (hr/night)		
8	382	7.9
6 to < 8	2,743	56.5
4 to < 6	1,646	33.9
1 to < 4	84	1.7
Prolonged sleep deprivation		
Least (6 hr sleep, deployment < 30 days)	862	17.8
Moderate-low (6 hr sleep, deployment 30 days)	2,263	46.6
Moderate-high (< 6 hr sleep, deployment < 30 days)	451	9.3
Highest (< 6 hr sleep, deployment 30 days)	1,279	26.3
Physical symptom score		
Low (< 6)	3,573	73.6
High (6–50)	1,282	26.4
Physical injuries[f]		
No (no reported injuries)	4,375	90.1
Yes (any reported injury)	480	9.9
Professional help-seeking[g]		
No	4,623	95.2
Yes	232	4.8
Depression		
Never	4,460	91.9
Sometimes	359	7.4
Most of the time	36	0.7
Anxiety		
Never	4,146	85.4
Sometimes	649	13.4
Most of the time	60	1.2
Depression and/or anxiety		
Neither depression nor anxiety	4,032	83.1

Variable	*n*	*%*
Anxiety only	428	8.8
Depression only	114	2.3
Concurrent depression and anxiety	281	5.8
Tobacco initiation[h]		
No	4,719	97.2
Yes	136	2.8

Note. N = 4,855.

[a] American Indian, Alaska Native, Native Hawaiian, and Pacific Islander responders.

[b] Some college or more includes technical school, bachelor's degree, master's degree, and doctoral degree.

[c] Time of deployment relative to the date of well-capping (July 15, 2010).

[d] Exposure to crude oil defined mission type: administrator-like missions (low oil exposure opportunity), low oil/mixed missions (medium oil exposure opportunity), and oil-related missions (high oil exposure opportunity).

[e] Self-reported crude oil exposure via inhalation, direct skin contact, submersion, or ingestion.

[f] Physical injuries include scrapes, abrasions or sprains, burns, lacerations, punctures, and fractures.

[g] Report of seeking professional assistance for the following stressors during deployment: physical abuse, sexual assault, moral/occupational/work conflict, marital/family/relationship issues/conflict, legal and financial issues, substance abuse, or bereavement/loss.

[h] Tobacco initiation was defined as responders who replied to use of any smoking or smokeless tobacco product during deployment and had replied to never using tobacco products or smoked less than 100 cigarettes prior to deployment.

TABLE 2

Adjusted prevalence ratios (aPRs) for cross-sectional associations between responder characteristics and deployment-related stressors, self-reported mental health symptoms, and tobacco initiation status, among U.S. Coast Guard responders to the Deepwater Horizon oil spill

Responder characteristics or deployment stressors	Concurrent depression and anxiety			Tobacco initiation		
	n^a	aPR	95% CI	n^a	aPR	95% CI
Sex [b]						
Male responders	211		Reference	121		Reference
Female responders	70	1.77	[1.36, 2.25]	15	0.72	[0.42, 1.22]
Age (years) [b]						
< 25	31		Reference	51		Reference
25–34	125	1.37	[0.94, 2.06]	63	0.56	[0.38, 0.81]
35	125	1.38	[0.89, 2.20]	22	0.32***	[0.17, 0.60]
Race [b]						
White	218		Reference	95		Reference
Black or African American	5	--		10	1.92	[1.04, 3.57]
Other or unknown	58	1.09	[0.82, 1.42]	31	1.23	[0.83, 1.82]
Rank/grade [c]						
Junior enlisted	114		Reference	98		Reference
Senior enlisted	89	1.33	[1.02, 1.73]	25	0.42	[0.27, 0.65]
Officer	78	1.23	[0.92, 1.64]	13	0.26***	[0.14, 0.47]
Educational attainment [b,j]						
Some college or more	159		Reference	94		Reference
High school or less	118	0.93	[0.72, 1.19]	36	0.86	[0.58, 1.28]
Home station [d]						
Gulf coast	64		Reference	31		Reference
Non–Gulf coast	217	1.13	[0.87, 1.49]	105	1.06	[0.71, 1.59]
Deployment duration (days) [d]						
< 30	52		Reference	31		Reference
30–59	153	1.33	[0.98, 1.83]	67	1.18	[0.76, 1.82]

Responder characteristics or deployment stressors	Concurrent depression and anxiety			Tobacco initiation		
	n[a]	aPR	95% CI	n[a]	aPR	95% CI
60	76	1.54*	[1.09, 2.18]	38	1.50	[0.92, 2.45]
Deployment duration/timing[d]						
All postcapping	73	Reference	Reference	49	Reference	Reference
Shorter pre- or pericapping	35	0.82	[0.55, 1.19]	20	0.70	[0.42, 1.17]
Longer pre- or pericapping	173	1.25	[0.96, 1.64]	67	0.86	[0.59, 1.25]
Oil exposure by mission[e]						
Low	80	Reference	Reference	26	Reference	Reference
Medium	154	1.04	[0.78, 1.39]	81	1.26	[0.76, 2.11]
High	47	0.98	[0.67, 1.43]	29	1.13	[0.62, 2.06]
Self-reported oil exposure[e]						
No	80	Reference	Reference	34	Reference	Reference
Yes	201	1.21	[0.93, 1.60]	102	1.70	[1.11, 2.61]
Self-reported oil inhalation[e]						
None	90	Reference	Reference	46	Reference	Reference
Low	134	1.11	[0.85, 1.45]	64	1.25	[0.83, 1.87]
High	57	1.60*	[1.14, 2.24]	26	1.66	[0.98, 2.81]
Sleep deprivation[f]						
Least	23	Reference	Reference	13	Reference	Reference
Moderate-low	83	0.93	[0.60, 1.50]	55	1.67	[0.91, 3.07]
Moderate-high	29	1.32	[0.78, 2.26]	18	2.42	[1.20, 4.90]
Highest	146	1.74***	[1.14, 2.78]	50	2.38**	[1.27, 4.45]
Physical symptoms[g]						
Low	74	Reference	Reference	76	Reference	Reference
High	207	6.55	[5.00, 8.67]	60	1.58	[1.11, 2.25]
Physical injuries[g]						
Never	211	Reference	Reference	107	Reference	Reference
Ever	70	2.39	[1.84, 3.07]	29	1.85	[1.23, 2.79]

Responder characteristics or deployment stressors	Concurrent depression and anxiety			Tobacco initiation		
	n[a]	aPR	95% CI	n[a]	aPR	95% CI
Professional help-seeking[h]						
No	227	Reference	Reference	116	Reference	Reference
Yes	54	4.30	[3.25, 5.58]	20	3.43	[2.17, 5.41]
Depression/anxiety[i]						
No	--	--		109	Reference	Reference
Yes	--	--		27	4.44	[2.98, 6.62]

Note. Estimates in cells with fewer than 10 cases have been suppressed.

[a]Number of responders who indicated experiencing the mental health indicator.

[b]Adjusted for employee class, environmental heat, hours of sleep, oil exposure, professional help-seeking, and rank/grade.

[c]Adjusted for deployment duration, employee class, environmental heat, mission type, oil exposure, professional help-seeking, and sex.

[d]Adjusted for employee class, environmental heat, hours of sleep, oil exposure, professional help-seeking, rank/grade, and sex.

[e]Adjusted for deployment length, environmental heat, Gulf-state home station, hours of sleep, physical symptoms, and rank/grade.

[f]Adjusted for employee class, physical symptoms, professional help-seeking, rank/grade, and sex.

[g]Adjusted for environmental heat, hours of sleep, and oil exposure.

[h]Adjusted for deployment duration, employee class, Gulf-state home station, and sex.

[i]Adjusted for rank/grade and sex.

[j]Analysis excluded 126 responders with an unknown educational attainment level.

TABLE 3

Sensitivity analysis of cross-sectional associations between responder characteristics, deployment-related stressors, self-reported mental health symptoms, and tobacco initiation status, excluding responders with preexisting conditions [a]

Responder characteristics or deployment stressors	Concurrent depression and anxiety						Tobacco initiation					
	All active duty (n = 3,102)			Active duty, excluding preexisting conditions (n = 2,855)			All active duty (n = 3,102)			Active duty, excluding preexisting conditions (n = 2,596)		
	n[b]	aPR	95% CI	n[b]	aPR	95% CI	n[b]	aPR	95% CI	n[b]	aPR	95% CI
Sex[c]												
Male responders	135	Reference		115	Reference		88	Reference		69	Reference	
Female responders	28	1.44	[0.97, 2.07]	21	1.49	[0.93, 2.25]	11	0.81	[0.44, 1.51]	8	--	--
Age (years)[c]												
<25	25	Reference		23	Reference		40	Reference		32	Reference	
25–34	82	1.37	[0.88, 2.19]	67	1.45	[0.92, 2.37]	46	0.60	[0.38, 0.93]	36	0.67	[0.41, 1.10]
35	56	1.68	[0.97, 2.97]	46	2.03 *	[1.12, 3.76]	13	0.44 *	[0.20, 0.95]	9	--	--
Race[c]												
White	131	Reference		108	Reference		71	Reference		53	Reference	
Black or African American	3	--		3	--		7	--		5	--	
Other or unknown	29	1.00	[0.67, 1.44]	25	1.02	[0.66, 1.52]	21	1.16	[0.72, 1.86]	19	1.33	[0.80, 2.21]
Rank/grade[d]												
Junior enlisted	71	Reference		66	Reference		72	Reference		58	Reference	
Senior enlisted	53	1.31	[0.93, 1.84]	40	1.11	[0.75, 1.62]	19	0.44	[0.27, 0.73]	14	0.45	[0.25, 0.79]
Officer	39	1.11	[0.74, 1.62]	30	0.91	[0.58, 1.38]	8	--		5	--	
Educational attainment[c]												
Some college or more	112	Reference		92	Reference		22	Reference		55	Reference	
High school or less	50	0.90	[0.63, 1.26]	43	1.02	[0.69, 1.47]	73	0.91	[0.56, 1.47]	19	1.00	[0.60, 1.69]
Home station[e]												
Gulf coast	39	Reference		31	Reference		28	Reference		19	Reference	
Non–Gulf coast	124	1.42	[1.01, 2.04]	105	1.51	[1.03, 2.27]	71	0.96	[0.62, 1.48]	58	1.38	[0.81, 2.35]

Responder characteristics or deployment stressors	Concurrent depression and anxiety						Tobacco initiation					
	All active duty (n = 3,102)			Active duty, excluding preexisting conditions (n = 2,855)			All active duty (n = 3,102)			Active duty, excluding preexisting conditions (n = 2,596)		
	n [b]	aPR	95% CI	n [b]	aPR	95% CI	n [b]	aPR	95% CI	n [b]	aPR	95% CI
Deployment duration (days) [e]												
< 30	42	Reference		37	Reference		25	Reference		22	Reference	
30–59	72	1.36	[0.95, 1.99]	54	1.21	[0.81, 1.83]	50	1.51	[0.94, 2.43]	39	1.43	[0.85, 2.39]
60	49	1.80**	[1.20, 2.70]	45	1.99**	[1.31, 3.05]	24	1.63	[0.93, 2.87]	16	1.27	[0.67, 2.42]
Deployment duration–timing [e]												
All postcapping	50	Reference		38	Reference		41	Reference		36	Reference	
Shorter pre- or pericapping	28	0.78	[0.49, 1.21]	23	0.79	[0.47, 1.30]	16	0.55	[0.31, 0.98]	14	0.51	[0.28, 0.94]
Longer pre- or pericapping	85	1.33	[0.95, 1.89]	75	1.51*	[1.03, 2.25]	42	0.83	[0.54, 1.28]	27	0.59	[0.36, 0.97]
Oil exposure by mission [f]												
Low	25	Reference		18	Reference		16	Reference		11	Reference	
Medium	95	1.44	[0.92, 2.32]	79	1.56	[0.93, 2.73]	59	1.09	[0.59, 2.02]	47	0.96	[0.46, 2.00]
High	43	1.60	[0.96, 2.69]	39	1.74	[0.98, 3.19]	24	0.91	[0.46, 1.83]	19	0.74	[0.33, 1.70]
Self-reported oil exposure [f]												
No	34	Reference		24	Reference		22	Reference		17	Reference	
Yes	129	1.48	[1.00, 2.24]	112	1.77	[1.13, 2.89]	77	1.69	[1.01, 2.81]	60	1.78	[1.01, 3.15]
Self-reported oil inhalation [f]												
None	42	Reference		31	Reference		32	Reference		24	Reference	
Low	76	1.21	[0.82, 1.79]	63	1.35	[0.88, 2.14]	47	1.20	[0.75, 1.92]	41	1.49	[0.89, 2.52]
High	45	1.81**	[1.17, 2.81]	42	2.20**	[1.35, 3.62]	20	1.28	[0.69, 2.35]	12	1.19	[0.57, 2.46]
Sleep deprivation [g]												
Least	20	Reference		20	Reference		11	Reference		10	Reference	
Moderate–low	40	0.94	[0.56, 1.61]	31	0.76	[0.45, 1.33]	38	1.99	[1.03, 3.88]	28	1.68	[0.82, 3.42]
Moderate–high	22	1.27	[0.71, 2.31]	17	0.99	[0.52, 1.84]	14	2.34	[1.07, 5.14]	12	2.45	[1.07, 5.62]
Highest	81	1.89***	[1.18, 3.17]	68	1.66***	[1.04, 2.79]	36	2.85**	[1.44, 5.66]	27	2.77**	[1.33, 5.77]

Responder characteristics or deployment stressors	Concurrent depression and anxiety						Tobacco initiation					
	All active duty (n = 3,102)			Active duty, excluding preexisting conditions (n = 2,855)			All active duty (n = 3,102)			Active duty, excluding preexisting conditions (n = 2,596)		
	n [b]	aPR	95% CI	n [b]	aPR	95% CI	n [b]	aPR	95% CI	n [b]	aPR	95% CI
Physical symptoms [h]												
Low	45	Reference		36	Reference		58	Reference		51	Reference	
High	118	6.21	[4.37, 8.98]	100	6.58	[4.46, 9.93]	41	1.52	[1.00, 2.32]	26	1.13	[0.69, 1.85]
Physical injuries [h]												
Never	126	Reference		103	Reference		77	Reference		61	Reference	
Ever	37	2.22	[1.54, 3.11]	33	2.52	[1.71, 3.61]	22	2.20	[1.38, 3.51]	16	2.12	[1.23, 3.65]
Professional help-seeking [i]												
No	134	Reference		115	Reference		87	Reference		68	Reference	
Yes	29	5.07	[3.47, 7.09]	21	5.21	[3.35, 7.65]	12	3.26	[1.84, 5.79]	9	--	--
Depression/anxiety [j]												
No	--	--	--	--	--	--	81	Reference		65	Reference	
Yes	--	--	--	--	--	--	18	4.14	[2.56, 6.69]	12	3.67	[2.06, 6.56]

Note. Estimates in cells with fewer than 10 cases have been suppressed.

[a] Preexisting conditions were identified as *International Classification of Diseases* (9th rev.) diagnosis codes related to depression, anxiety, and tobacco use up to 3 years prior to oil spill response deployment.

Adjusted for employee class, environmental heat, hours of sleep, oil exposure, professional help-seeking, and rank/grade.

[b] Number of responders who indicated experiencing the mental health indicator.

Adjusted for deployment duration, employee class, environmental heat, mission type, oil exposure, professional help-seeking, sex.

[c] Adjusted for employee class, environmental heat, hours of sleep, oil exposure, professional help-seeking, rank/grade, and sex.

[d] Adjusted for deployment length, environmental heat, Gulf state home station, hours of sleep, physical symptoms, rank/grade

[e] Adjusted for employee class, physical symptoms, professional help-seeking, rank/grade, and sex.

[f] Adjusted for environmental heat, hours of sleep, and oil exposure.

[g] Adjusted for deployment duration, employee class, Gulf state home station, and sex.

[h] Adjusted for rank/grade and sex.

*k*Analysis for highest educational attainment excludes 69 responders with unknown education attainment level.

*
$p < .05.$

**
$p < .01.$

***
$p < .001.$