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Mechanisms of resiliency against depression following the Deepwater Horizon Oil Spill

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Abstract

Prior studies of oil spills have reported adverse impacts on mental health, but have not examined some potentially important moderators. In this cross-sectional analysis of n=38,361 responses to the 2010–2011 Gulf States Population Survey, we assessed the association of direct oil contact with depression severity following the Deepwater Horizon oil spill, and modification by self-mastery, emotional support, and cleanup participation using Tobit regression models accounting for the complex survey design. Oil contact was associated with increased depression severity. Among respondents with oil contact, depression was more severe for those reporting lower self-mastery. However, respondents with oil contact had lower depression severity if they participated in cleanup efforts, compared to exposed individuals who did not participate. This potential protective effect was larger for respondents with lower self-mastery. Our results are consistent with the notion that participation in recovery efforts may reduce depressive symptoms following oil spills among impacted individuals.

Keywords

disaster recovery; emergency response; epidemiology; Centers for Disease Control and Prevention (CDC); Gulf States Population Survey (GSPS); Behavioral Risk Factors Surveillance System (BRFSS)

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CDC Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

1. INTRODUCTION

1.1 Community Mental Health Impacts of the Deepwater Horizon Oil Spill

On April 20, 2010, the Deepwater Horizon oil drilling rig exploded in the Gulf of Mexico, resulting in the largest marine oil spill in history (Graham et al., 2011). The explosion killed 11 rig workers and led to the release of 4.9 million barrels of oil over 87 days, affecting approximately 68,000 square miles of ocean surface and over 600 miles of shoreline from Louisiana to Florida (Norse & Amos, 2010). As large-scale environmental catastrophes, oil spills can harm affected communities through economic and social disruption, toxic chemical exposures, and adverse ecosystem effects (Goldstein et al., 2011). Previous cross-sectional studies of communities affected by the Deepwater Horizon spill reported elevated rates of anxiety and depression following the spill (Fan et al., 2015; Grattan et al., 2011; Osofsky et al., 2011). Studies of the Deepwater Horizon oil spill (D'Andrea & Reddy, 2018) and 1989 Exxon Valdez oil spill (Picou & Martin, 2007) have reported health impacts persisting for years after the spills, including post-traumatic stress disorder.

In the broader literature on mental health impacts of natural, technological, and manmade catastrophes, there is evidence for the buffering role of coping, defined as strategies employed by individuals to improve resilience in stressful situations (Shing et al., 2016; Cherry et al., 2018). Self-mastery can be considered a component of coping, defined as the extent to which individuals view their lives as under their own control, as opposed to a fatalistic view (Pearlin & Schooler, 1978). Self-mastery is related to the concept of locus of control (Rotter, 1966), which posits that individuals view the center of control over their lives as internal (within their control, i.e. high self-mastery) or external (not within their control, i.e. low self-mastery). Social support, including emotional support, may also contribute to resilience and protect against adverse mental health impacts of disasters (Wulff et al., 2015; Platt et al., 2016). Studies to date have not examined the role of self-mastery, and few have examined emotional support, as potential moderators of the relationship between oil spill exposures and depression. Moderation (also known as effect measure modification) refers to situations in which the relationship between two variables differs between levels of a third intermediary variable. Only 9 of 40 major oil spills have been studied in relation to mental health impacts (Laffon et al., 2016), and most prior studies relied on relatively small samples. Consequently, analysis of large-sample, population-representative data from the Gulf States Population Survey (GSPS) can improve on the rigor and reproducibility of the suggestive, but thus-far limited evidence regarding mental health impacts of major oil spills (Bartell, 2019; Button et al., 2013; Fraley & Simine, 2014).

1.2 Mental Health among Deepwater Horizon Cleanup Workers

Most studies of mental health and disaster response have focused on adverse mental health impacts among disaster response workers (Benedek et al., 2007; Brooks et al., 2016); however, many of these studies compare disaster response workers to external populations not directly affected by the disaster. Only a few studies have compared disaster response workers drawn from affected communities against other members of the affected communities who did not participate. These studies reported that response workers derived a protective effect from their participation (Fukasawa et al., 2015; Adams & Boscarino, 2015;

Wang et al., 2013). Prior studies of Deepwater Horizon cleanup workers compared to various other groups have reported increased adverse mental health impacts of cleanup participation, for example, compared to individuals trained as cleanup workers but not ultimately participating in cleanup work (Kwok, McGrath, et al., 2017). However, studies to date have not compared Deepwater Horizon cleanup participants to those who did not participate in cleanup activities within populations directly affected by the spill.

1.3 Knowledge Gaps in Understanding Mechanisms for Resiliency

Considering the important role of disaster response and cleanup workers from affected communities and the potentially long-term mental health impacts of disasters, greater understanding is needed of the relationships between disaster recovery work, mental health, and the moderating role of self-mastery, or people's self-perceived efficacy in managing events impacting their lives (Benight & Bandura, 2004). Prior studies of community members impacted by major oil spills have suggested that social support improves the ability to cope with the stressors created by a spill (Laffon et al., 2016). Studies focused on cleanup workers have largely focused on the negative mental health impacts of exposure to areas affected by oil spills (Kwok, McGrath, et al., 2017), but not on potential moderators of the association between spill exposure and adverse psychological effects.

Our objective in this large sample, population-representative study was to assess the cross-sectional association between direct oil contact and depression severity among Gulf Coast residents following the Deepwater Horizon oil spill, and to evaluate the potential moderation of this association by cleanup participation, self-mastery, or emotional support. Our *a priori* hypotheses based on past literature were that oil exposure would increase severity of depression, and that at least one of these three previously suggested moderators would limit that harm.

2. METHODS

2.1 Data Description

We used data from the Gulf States Population Survey (GSPS), a random digit dialing telephone survey conducted by the Centers for Disease Control and Prevention (CDC) with other local, state, and federal partners across Alabama, Florida, Louisiana, and Mississippi to assess the impacts of the Deepwater Horizon oil spill (Centers for Disease Control and Prevention, 2013). The survey collected data from 38,361 adults in these four states from December 2010 to December 2011.

Outcome—Self-reported depression was assessed using the eight-item Patient Health Questionnaire (PHQ-8). Each item rates the frequency of depression symptoms in the past two weeks from zero (“not at all”) to three (“nearly every day”), with possible total scores ranging from zero to 24. In a study to validate this instrument for use in epidemiologic studies, the PHQ-8 was administered to nearly 200,000 participants in the 2006 Behavioral Risk Factor Surveillance Survey; of the 17,040 respondents with a PHQ-8 score ≥ 10 , 96.4% had a major depressive disorder, other depressive disorder, or depressed mood or anhedonia, and only 3.5% had no evidence of depressive disorder or depressive symptoms (Kroenke et

al., 2009). The PHQ-8 has been shown to have very high correlation with the more widely-used PHQ-9 ($r=0.998$), which has a sensitivity of 0.77–0.88 and specificity of 0.88–0.94 compared to a depression diagnosis made via structured psychiatric interview by a mental health professional (Kroenke et al. 2010). The PHQ-8 omits the ninth item of the PHQ-9, which asks about thoughts of self-harm.

Exposure—Direct oil contact was assessed by the question “Did you have direct contact with the oil from the Gulf oil spill?” (yes/ no).

Moderators—Emotional support was rated by a single indicator (always/ usually/ sometimes/ rarely/ never) in response to the question “How often do you get the social and emotional support you need?”. We derived a confirmatory factor analysis score for self-mastery, a component of coping ability, from respondents’ degree of agreement with the following five statements: “I am confident in my ability to handle unexpected problems”, “I have little control over the things that happen to me”, “What happens to me in the future mostly depends on me”, “I can do just about anything I really set my mind to do”, and “When I need suggestions about how to deal with a personal problem, I know there is someone I can turn to” (factor loadings are shown in Appendix 1) (Pearlin & Schooler, 1978). While the term “coping” generally refers to behaviors that protect individuals from psychological harm due to difficult experiences, “self-mastery” as operationalized in our study refers more specifically to psychological resources stemming from the degree to which individuals view their lives as being under their own control, as opposed to viewing their lives fatalistically (Pearlin & School, 1978). We also tested for moderation by participation in oil spill cleanup efforts, assessed by the question “Did you participate in the Gulf oil spill cleanup activities?” (yes/ no).

2.2 Analysis

Outcome—We modeled underlying trait depression as a latent variable using Tobit regression, assuming that underlying trait depression severity in the population is normally distributed rather than truncated from zero to 24 (Tobin, 1958) as assessed by the PHQ-8. Positive values indicate depressive symptoms assessed by the PHQ-8, and negative values indicate latent positive affect traits such as optimism and confidence, which were not assessed by the survey, but are assumed to exist. Figure 1 presents an overlay of PHQ-8 response scores with modeled Tobit underlying trait depression severity.

Potential confounders—We adjusted models for age (continuous), gender (female/ male), race (white/black/other), Hispanic ethnicity (yes/ no), smoking status (never/former/ current), binge drinking (yes/no), exercise (yes/no), marital status (married/not currently married), employment status (employed [employed for wages, self-employed]/not employed [out of work, unable to work]/other [homemaker, student, retired]), and how often they felt they had the emotional support they needed (always/ usually/ sometimes/ rarely/ never). We further adjusted for income, which due to 17% missing data included a “missing” group (< \$35,000; \$35,000– \$75,000; >\$75,000; missing).

2.3 Assessment of Effect Moderation

We added moderation terms for emotional support and self-mastery. We also tested for moderation between direct oil contact and participation in oil spill cleanup efforts. We further examined the association between cleanup participation and depression in a subpopulation with oil contact, and tested for moderation by emotional support and self-mastery. We performed sensitivity analyses for unpaid and paid cleanup participation, and for whether cleanup participation itself likely involved oil contact (categorized as “yes” if the respondent participated in at least one of the following: beach or marsh cleanup, bird or wildlife cleanup, boom deployment and recovery, off-shore skimming cleanup, well-head or controlled burning, decontamination or waste stream management cleanup; categorized as “no” if their only cleanup participation involved administrative, logistical, or medical support).

2.4 Survey Estimation and Imputation

We used survey estimation methods to account for the survey design (singleton primary sampling units were treated as certainty units), and multiple imputation using chained equations with 40 imputed datasets (Azur et al., 2011) to account for missing data. The variables with the largest percentage of observations with imputed missing data were depression severity (4.8%) and the factor analysis score for coping (3.8%); all other variables were missing for 2% of observations except for income, which we did not impute. We conducted all analyses using Stata S/E 15.1 (StataCorp., 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC).

3. RESULTS

Characteristics of the weighted study population are presented in Table 1, including stratification by oil contact and by cleanup participation. Of a total estimated study population of 224,719, 8.7% or an estimated $n=19,503$ individuals from the GSPS target population had direct contact with oil from the Deepwater Horizon oil spill.

3.1 Oil Contact and Depression

Direct oil contact was associated with higher depression (Table 2), with a β -coefficient for the fully adjusted model of 2.10 (95% CI: 0.44, 3.77). Beta coefficients for all covariates are presented in Appendix 2. There was no difference in the association of oil contact with depression across emotional support levels (F-test $p=0.97$), with β -coefficients ranging non-monotonically from 1.31 (95% CI: $-7.81, 10.44$) for “never” to 2.71 (95% CI: 0.19, 5.23) for “sometimes”. Differences in the association between depression and oil contact by cleanup participation ($\beta= -2.51$, 95% CI: $-5.89, 0.88$; $p=0.15$) and self-mastery as a continuous score ($\beta= -1.13$, 95% CI: $-2.62, 0.37$; $p=0.14$) were in the hypothesized direction but were not statistically significant. When comparing people with lower (minimum in sample: -4.04) self-mastery scores to those with higher (maximum in sample: 3.18) self-mastery scores, there was a greater positive association between oil contact and depression for people with lower scores ($\beta= 6.10$, 95% CI: $-0.36, 12.56$; $p=0.06$) than higher scores ($\beta= -1.72$, 95% CI: $-6.36, 2.91$; $p=0.47$) (Figure 2).

3.2 Cleanup Participation and Depression among those with Oil Contact

Within the subpopulation with oil contact, cleanup participation was associated with lower depression when adjusting for potential confounders (Table 3), with a β -coefficient for the fully adjusted model of -2.77 (95% CI: $-4.92, -0.61$). Beta coefficients for all covariates are presented in Appendix 3. There was no significant moderation between cleanup participation and emotional support level (F-test $p=0.74$), with β -coefficients ranging non-monotonically from -4.40 (95% CI: $-9.64, 0.84$) for “rarely” to -0.28 (95% CI: $-3.81, 3.25$) for “sometimes”. There was a statistically significant moderation of the association between cleanup participation and depression severity by self-mastery as a continuous score ($\beta=2.67$, 95% CI: $0.26, 5.09$; $p=0.03$). When comparing people with lower (minimum in sample: -4.04) self-mastery scores to those with higher (maximum in sample: 3.18) self-mastery scores, the inverse association between cleanup participation and depression was stronger for those with lower self-mastery scores ($\beta= -13.26$, 95% CI: $-23.20, -3.32$; $p=0.01$) than higher scores ($\beta= 6.04$, 95% CI: $-1.94, 14.03$; $p=0.14$) (Figure 3).

3.3 Type of Cleanup Work and Depression: Pay and Activities

When separately assessing the association of unpaid and paid cleanup participation with depression among those with oil contact, results were similar in direction and magnitude to results for all cleanup participants assessed together (Appendix 4). While most model specifications produced similar results for the association between cleanup participation and depression severity for the paid and unpaid participants separately, the greatest difference in β -coefficients between the paid and unpaid groups was -2.93 (95% CI: $-6.89, 1.02$) for paid and -1.58 (95% CI: $-4.32, 1.17$) for unpaid participants in models adjusted for demographics and health behaviors. There was not a statistically significant moderation by whether cleanup participation itself likely involved oil contact ($\beta= -4.46$; 95% CI: $-13.69, 4.76$; $p=0.34$). Having participated in cleanup activities that likely involved oil contact was associated with a decrease in depression severity ($\beta= -2.59$; 95% CI: $-4.81, -0.38$; $p=0.02$), very similar to the results for cleanup participation among all cleanup participants, compared to a slight increase for those only participating in administrative, logistical, or medical support activities ($\beta= 1.87$; 95% CI: $-6.82, 10.55$; $p=0.67$). These analyses were based on a small subset of $n=130$ participants in the administrative/logistical/medical category, contributing to wide confidence intervals. By contrast, most cleanup workers ($n=1,236$ in the actual sample, about 90% of surveyed cleanup workers) participated in various activities likely involving oil contact, thus results were similar to those for the entire sample of cleanup workers described in section 3.2 and in Table 3.

4. DISCUSSION

4.1 Oil Contact, Depression, and Self-Mastery

Our finding of a positive association between oil contact and depression is consistent with our hypothesis based on previous studies documenting adverse mental health impacts from the Deepwater Horizon spill (Fan et al., 2015; Grattan et al., 2011; Gould et al., 2015; Buttke, Vagi, Bayleygan et al., 2012; Rung et al., 2015) and earlier large oil spills (Lyons et al., 1999; Palinkas et al., 1993). The stronger positive association between oil contact and depression among those with poorer self-mastery also agrees with literature demonstrating

that psychological resilience mediates the relationship between disaster exposures and adverse mental health outcomes (Benight & Bandura, 2004; Chung et al., 2005; Lee et al., 2018; Shenese & Langhinrichsen-Rohling, 2015). A previous study using GSPS data (Fan et al., 2015) reported negative associations between higher self-mastery and depression, but did not examine self-mastery as a moderator.

4.2 Cleanup Participation and Lower Depression Severity

To our knowledge, this is the first study reporting lower depression among cleanup participants compared to non-participants among those with oil contact following the Deepwater Horizon oil spill. The significant moderation between cleanup participation and depression by self-mastery suggests that for those with oil contact, cleanup participation may offer greater benefits to those with poorer self-mastery. Previous oil spill studies have focused on negative health impacts of disaster response work, though these often used different comparison groups. An analysis of the Gulf Long-Term Follow-Up (GuLF) Study, a cohort of trained Deepwater Horizon responders, compared those who actually performed cleanup work to those who received training but ultimately did not perform cleanup work (Kwok, McGrath, et al., 2017). The GuLF study found that workers had worse physical health symptoms than trained responders who did not perform cleanup work, and found that worse physical health was associated with higher rates of depression (Lowe et al., 2016). The GSPS included approximately 4,000 cleanup participants from the most affected states, out of approximately 110,000 cleanup workers from across the U.S. (Kwok, Engel, et al., 2017); the negative association between cleanup work and depression may not exist among workers from less affected areas.

4.3 Cleanup Participation and Depression: Similar Findings in the Literature

While this is the first study to report moderation of the relationship between oil spill exposure and depression by cleanup participation, comparable findings have been reported in the broader disaster response literature, possibly indicating a common underlying mechanism by which affected individuals benefit from disaster response participation. A study of government workers in a heavily affected region after the 2011 Great East Japan Earthquake reported adverse mental health outcomes associated with greater personal impact of the quake, but reported reduced rates of mental health distress among workers who participated in recovery efforts (Fukasawa et al., 2015). This protective effect was much stronger among workers reporting greater personal loss, potentially similar to our finding of a greater benefit for cleanup participants with lower self-mastery.

A prospective cohort study of individuals living in New York City during the September, 2011 World Trade Center terrorist attack found that those who had volunteered reported less anxiety and better overall mental and physical health one year later, though volunteering was not associated with differences in depression or post-traumatic stress (Adams & Boscarino, 2015). However, respondents who reported volunteering were also more likely to be from higher income households, to have more education, and to be white, which are factors associated with lower depression rates in the general population.

A qualitative interview-based study of local civil servants involved in relief work in their communities following the 2008 Sichuan earthquake in China reported that despite their experiences of trauma and personal loss, relief workers reported coping better by finding a sense of meaning and purpose in life through their relief work (Wang et al., 2013). These workers also reported the importance of feeling supported and understood by their coworkers in the earthquake's aftermath.

A cross-sectional online survey of n=164 local volunteers who participated in cleanup activities following the 2011 Rena oil spill in New Zealand reported positive experiences from about 90% of respondents, though this study did not assess mental health impacts of the spill itself, nor was it designed to assess an association between volunteering and coping with the oil spill (Sargisson et al., 2012). Outside of the disaster response context, many studies have reported mental health benefits including reduced depressive symptoms resulting from regular volunteering, though the effect appears inconsistent over the life-course (Tabassum et al., 2016; Yeung et al., 2018; Kim & Pai, 2010). In general, community and individual responses may differ by whether a catastrophe was a result of human technological error as with oil spills, natural forces as with earthquakes, or terrorism.

4.4 Potential Explanations for Cleanup Participation and Lower Depression

There are several possible explanations for why participation in response efforts may provide mental health protection to members of communities affected by disasters. Participation in response efforts may improve posttraumatic growth by allowing for positive reappraisal (Prati & Pietrantonio, 2009) and to develop alternative experiences related to the disaster (Stanko et al., 2015); it may also offer mental health protection because participants are interacting through shared prosocial efforts (Tingey et al., 2017). Those who participated in cleanup efforts could have greater dispositional optimism (Cherry et al., 2017), which can aid mental recovery after disasters (Carbone et al., 2017) and could moderate or confound the negative association between cleanup participation and depression.

Some research on the Deepwater Horizon spill's impacts has emphasized the role of Gulf residents' previous encounters with environmental catastrophes, namely hurricanes Katrina and Rita in 2005 (Osofsky et al., 2011), creating preexisting mental health vulnerabilities (Morris et al., 2013; Neria et al., 2008); prior disaster experiences could impact willingness to participate in cleanup activities. Energy expenditure via cleanup participation may also help regulate increased stress hormone levels following a catastrophe such as the Deepwater Horizon spill (Holsboer & Ising, 2010).

4.5 Volunteer versus Paid Cleanup Participation

The Deepwater Horizon spill caused largescale economic disruption (Palinkas, 2012), with the regionally important tourism and fisheries industries each losing billions of dollars of expected revenue (Carroll et al., 2016; Nadeau et al., 2014). Surveys of affected communities found that individuals who lost income after the Deepwater Horizon spill were more likely to report adverse mental health symptoms (Buttke, Vagi, Bayleyegn, et al., 2012; Buttke, Vagi, Schnall, et al., 2012). A study of communities in Spain affected by the 2002 *Prestige* spill reported that both economic and social support better enabled affected

populations to cope with psychological impacts of the spills (Sabucedo et al., 2010). Although previous research suggests that payment received for cleanup work may improve mental health (Lowe et al., 2016), only 30% of cleanup participants in the GSPS reported being paid, with 70% unpaid. When assessing the association between cleanup participation and depression among unpaid volunteers and paid workers separately, we observed comparable results as for the whole sample of cleanup participants. Given that several studies of the Deepwater Horizon spill and other major oil spills have linked economic impacts with mental health impacts (Laffon et al., 2016), it is important to understand how financial compensation for cleanup work could potentially alleviate psychological distress.

4.6 Study Strengths and Limitations

Only 9 of 40 major oil spills to date have been studied to understand human health impacts, including mental health impacts, and many of these studies were surveys with relatively small samples (Laffon et al., 2016). Thus, the strength of our study comes from the use of publicly available data from a large, representative sample with minimal selection bias. The widespread impacts of the Deepwater Horizon oil spill represent exposures to a range of stressors captured by the responses in the GSPS. This study also benefited from our ability to explore the GSPS data based on past proposed moderators grounded in different theories of resilience. While censored positive affect scores in our models may be sensitive to distributional assumptions, we would not expect this to change our conclusions for directional changes in means; Tobit regression accounts appropriately for the censoring limitations of the PHQ-8 measurement instrument.

Our use of secondary data limited our ability to perform in-depth exploration or testing of existing environmental, community, or intrapersonal theories and constructs potentially relevant to understanding the mental health impacts of oil spills (Palinkas, 2012). For example, the Conservation of Resources model (Hobfoll, 1989) posits that catastrophes threaten material (e.g. economic stability, housing), social (e.g. status, relationships), and emotional (e.g. optimism, self-esteem) resources, and that the net actual or perceived loss of these resources shapes stress responses. Similarly, relevant theories of risk and resilience (Bonnano, 2004; Yehuda & Flory, 2007), stress response (Ursin & Eriksen, 2004), and received and perceived social support (Norris & Kaniasty, 1996) were not explored in depth due to limits of the available data. We were also unable to assess the impacts of having experienced multiple disasters, which may be relevant for Gulf Coast state residents who experienced hurricanes Katrina and Rita five years prior to the Deepwater Horizon oil spill (Osofsky et al., 2011). Though we were limited to the use of existing variables, we were able to operationalize concepts of resilience (e.g. self-mastery) and social support (e.g. emotional support) based on variables in our dataset, in addition to indicators of the experiences of direct oil spill contact and cleanup participation. Some measured variables may be imperfect measures that do not fully capture all domains of interest for relevant constructs (Lawshe, 1975). The latent nature of some variables we examined make them more prone to measurement error; better measurement, particularly of the five factor components of self-mastery, would improve our ability to assess our hypotheses.

Despite the strengths of the large, representative dataset we used, the cross-sectional design of the GSPS presents limitations to causal inference, and recall bias could affect our data. The GSPS targeted affected coastal counties, but not specific subgroups that may have experienced greater impacts. The negative association between depression and cleanup participation could be the result of uncontrolled confounders, though the association remained when adjusting for several factors associated with depression and Deepwater Horizon cleanup participation. Depression rates in the U.S. are higher among females, people with lower incomes, non-Hispanic blacks and Hispanics, certain older adults, and unmarried people (Bulloch et al., 2017; Pratt & Brody, 2014). In a separate analysis of GSPS data, we found that cleanup participants were more likely to be young, male, non-Hispanic white, employed, and in good physical health (Sharpe et al., 2019). Another study of 32,608 Deepwater Horizon cleanup participants reported that most were younger (56% <45 years old), male (81%), white (63%), and married (56%); of 89% who provided income data, 34% had incomes >\$50,000/year compared to 26% with incomes <\$20,000/year (Kwok, Engel, et al., 2017). Income data were missing for 17% of GSPS respondents and may have been more subject to reporting bias, however other sociodemographic factors may control for some of the effect of income. Another possible confounder is physical health status, which we did not adjust for since depression may influence self-report of physical health. Although this cross-sectional analysis is limited in its ability to make strong statements of cause and effect, we were able to evaluate testable implications of our causal hypotheses (Popper, 1959) using public data in a large, representative sample.

4.7 Applications and Future Research

If participation in cleanup efforts does indeed provide a beneficial buffer against depression following a major oil spill or other catastrophe, such knowledge could be used to encourage volunteer or paid work opportunities to members of affected communities. Research within the GSPS and other worker populations have revealed demographic disparities in who participates, with groups generally at higher risk for depression participating at lower rates (Sharpe et al., 2019; Kwok, Engel, et al., 2017). Future intervention-focused research could elucidate possible mental health benefits of participation in various recovery activities for affected individuals, which would be beneficial given the important role that local communities play in disaster response efforts and the well-documented mental health harms of disasters. Encouraging participation in recovery activities may improve mental health impacts of disasters and bolster community connections.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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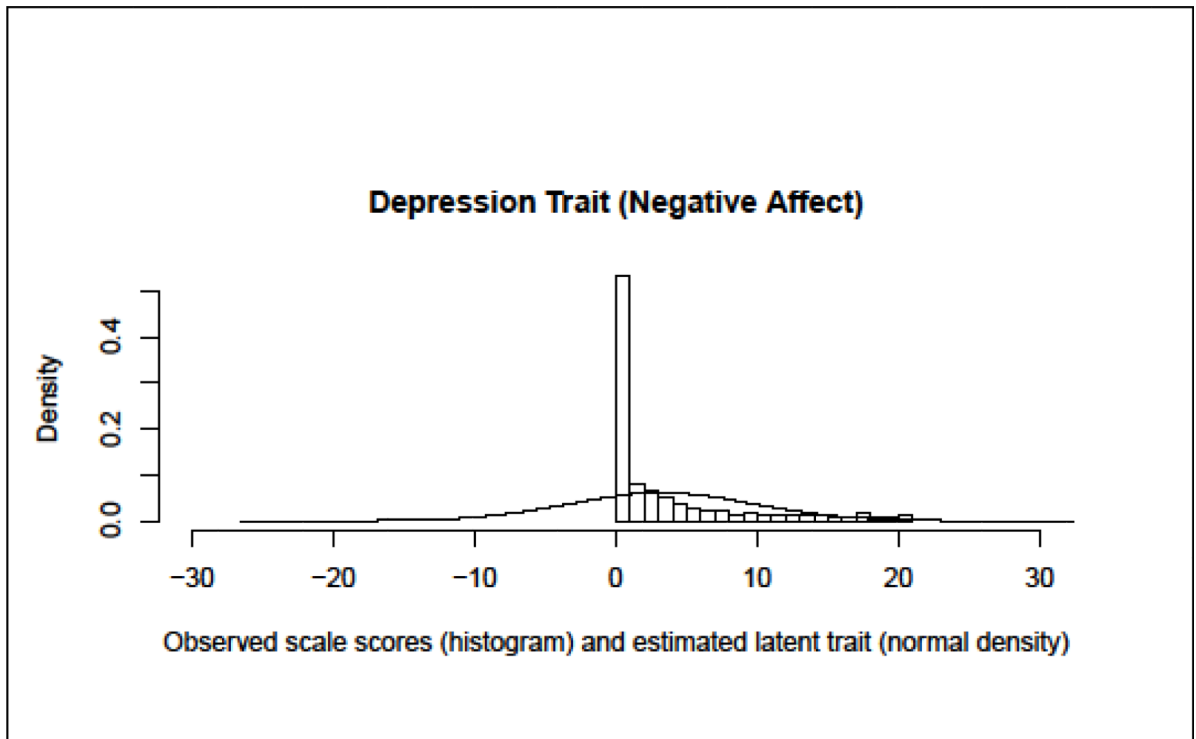


Figure 1. Estimated Latent Trait Depression in the Gulf States Population Survey. Underlying continuous trait depression was estimated using survey Tobit estimation methods. Complex survey weights are applied.

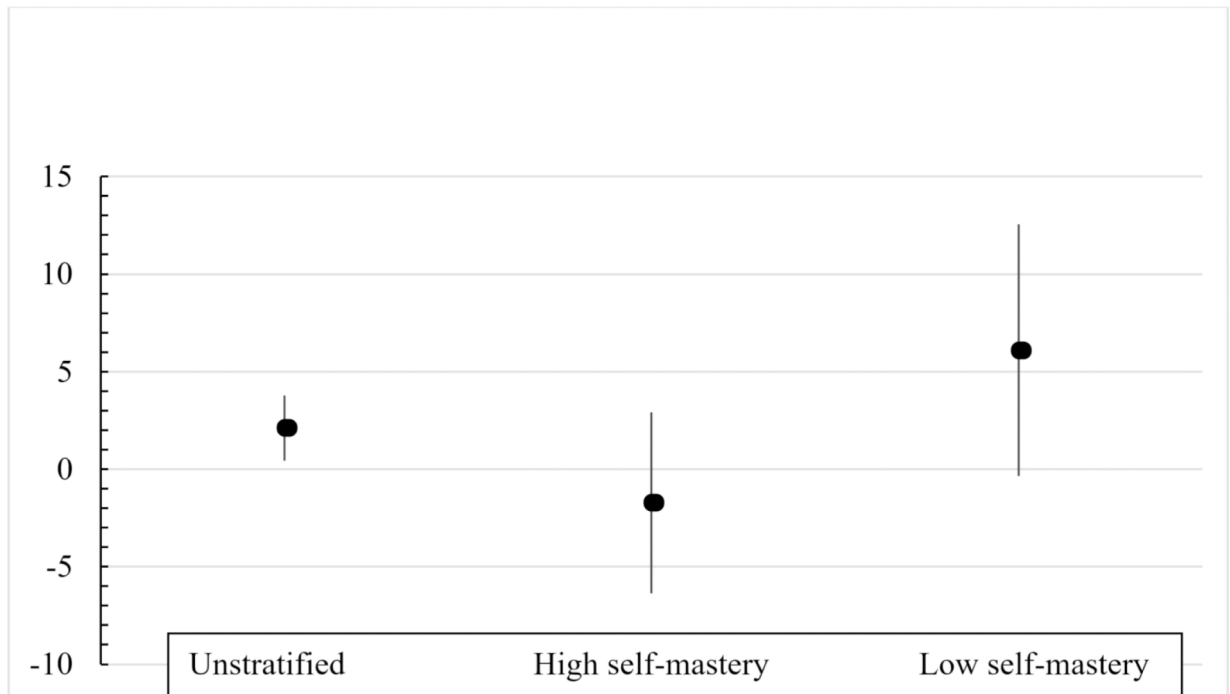


Figure 2. Modification by self-mastery in the association between direct oil contact and depression (β -coefficients and 95% confidence intervals)

Note: Depression was scored from zero to 24 using the 8-item Patient Health Questionnaire (Kroenke et al. 2009). Cleanup participation was assessed by the question “Did you participate in the Gulf oil spill cleanup activities?”. The sample minimum (-4.04) and maximum (3.18) self-mastery scores were used for “low” and “high” self-mastery in this analysis.

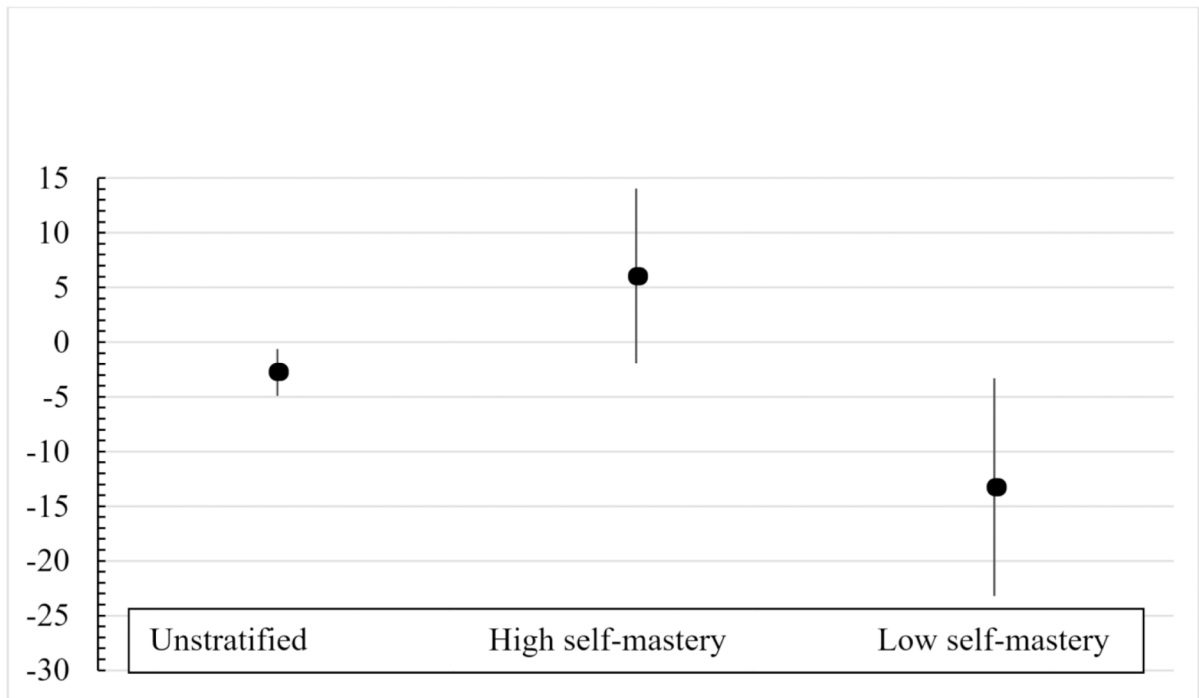


Figure 3. Modification by self-mastery in the association between cleanup participation and depression among those with direct oil contact (β -coefficients and 95% confidence intervals)

Note: Depression was scored from zero to 24 using the 8-item Patient Health Questionnaire (Kroenke et al. 2009). Cleanup participation was assessed by the question “Did you participate in the Gulf oil spill cleanup activities?”. The sample minimum (−4.04) and maximum (3.18) self-mastery scores were used for “low” and “high” self-mastery in this analysis.

Table 1.

Characteristics of the weighted survey population (estimated n=224,719), stratified by whether they had direct contact with oil from the DWH oil spill, and whether they participated in cleanup activities.

Characteristic	All	Direct oil contact (8.7%, estimated n=19,503)		No direct oil contact (91.3%, estimated n=205,216)	
		Participated in cleanup (Estimated n=3,617)	Did not participate in cleanup (Estimated n=15,886)	Participated in cleanup (Estimated n=4,041)	Did not participate in cleanup (Estimated n=201,175)
Mean depression score (95% CI)	4.77 (4.75, 4.79)	6.08 (5.89, 6.28)	5.90 (5.81, 6.00)	5.13 (4.95, 5.31)	4.64 (4.61, 4.66)
Current depression, defined as PHQ-8 score ≥ 10 (%)	15.4	22.1	22.0	19.0	14.6
Gender (%)					
Female	63.0	34.2	53.6	49.6	64.5
Male	37.0	65.8	46.4	50.4	35.5
Mean age (years)	61.0	46.8	56.4	50.6	61.8
Race (%)					
White	70.5	71.0	75.1	70.1	70.2
Black	21.2	16.0	15.5	17.1	21.7
Other race	8.4	13.0	9.4	12.1	8.1
Hispanic ethnicity	4.2	6.0	3.7	7.8	4.1
Income (%)					
<\$35,000	36.4	31.4	30.2	27.5	37.1
\$35,000– \$75,000	17.1	19.0	17.5	19.9	17.0
>\$75,000	12.8	24.4	20.4	21.7	11.8
Missing	33.7	25.1	31.2	30.8	34.1
Employment (%)					
Employed	34.7	64.5	45.3	57.3	32.9
Unemployed	18.2	21.3	22.1	19.9	17.7
Other	47.1	14.2	32.5	22.8	49.4
Marital status (%)					
Married	46.2	48.9	56.1	55.1	45.2
Not married	53.8	51.1	43.9	44.9	54.8
Exercise (%)					
Yes	65.2	77.5	72.4	78.6	64.2
No	34.8	22.5	27.6	21.4	35.8
Binge drinking (%)					
Yes	9.1	25.8	15.6	14.0	8.2

Characteristic	All	Direct oil contact (8.7%, estimated n=19,503)		No direct oil contact (91.3%, estimated n=205,216)	
		Participated in cleanup (Estimated n=3,617)	Did not participate in cleanup (Estimated n=15,886)	Participated in cleanup (Estimated n=4,041)	Did not participate in cleanup (Estimated n=201,175)
No	90.9	74.2	84.4	86.0	91.8
Smoking (%)					
Never	52.8	45.1	49.5	49.5	53.3
Former	26.9	20.8	26.1	25.9	27.1
Current	20.3	34.1	24.4	24.6	19.6
Emotional support (%)					
Always	46.0	39.2	41.4	44.7	46.5
Usually	22.6	26.0	26.0	26.2	22.2
Sometimes	19.2	21.7	16.8	15.3	19.4
Rarely	5.3	4.6	7.1	7.6	5.2
Never	6.9	8.5	8.8	6.2	6.7

Note: Depression was scored from zero to 24 using the 8-item Patient Health Questionnaire (Kroenke et al. 2009). Direct oil contact was assessed by the question "Did you have direct contact with the oil from the Gulf oil spill?". Hispanic ethnicity, binge drinking, and exercise were coded as yes/no. Other categorical variables were coded as follows: race (white/black/other), smoking status (never/former/current), marital status (married/not currently married), employment status (employed [employed for wages, self-employed]/not employed [out of work, unable to work]/other [homemaker, student, retired]), how often they felt they had the emotional support they needed (always/usually/sometimes/rarely/never), and income (<\$35,000; \$35,000– \$75,000; >\$75,000; missing).

Table 2.

Differences in depression severity between persons with (9.7%) and without (90.3%) direct contact with oil from the oil spill in communities participating in the Gulf States Population Survey (n=38,361 total respondents; estimated population size = 24,067,394).

Model	Tobit β (95% confidence interval)	F-statistic
Model 1 ^a	2.25 (0.67, 3.82)	F(1, 1801.6) = 7.78, p=0.0053
Model 2 ^b	2.33 (0.83, 3.84)	F(6, 32771.4) = 4.72, p=0.0001
Model 3 ^c	2.49 (0.93, 4.05)	F(10, 35439.9) = 17.28, p<0.0001
Model 4 ^d	2.44 (0.88, 3.99)	F(13, 36843.2) = 24.23, p<0.0001
Model 5 ^e	2.00 (0.36, 3.65)	F(17, 37612.3) = 33.93, p<0.0001
Model 6 ^f	2.10 (0.44, 3.77)	F(20, 37841.8) = 30.03, p<0.0001

^aUnadjusted

^bAdjusted for age, gender, race, Hispanic ethnicity

^cFurther adjusted for exercise, smoking, binge drinking

^dFurther adjusted for employment and marital status

^eFurther adjusted for emotional support

^fFurther adjusted for income

Note: Depression was scored from zero to 24 using the 8-item Patient Health Questionnaire (Kroenke et al. 2009). Direct oil contact was assessed by the question "Did you have direct contact with the oil from the Gulf oil spill?". Hispanic ethnicity, binge drinking, and exercise were coded as yes/no*. Other categorical variables were coded as follows: race (white*/black/other), smoking status (never*/former/current), marital status (married*/not currently married), employment status (employed* [employed for wages, self-employed]/not employed [out of work, unable to work]/other [homemaker, student, retired]), how often they felt they had the emotional support they needed (always*/usually/sometimes/rarely/never), and income (<\$35,000*; \$35,000– \$75,000; >\$75,000; missing).

* Asterisk denotes referent category in all models.

Table 3.

Differences in depression between persons who participated in oil spill cleanup activities (44.1%) and those who did not (55.9%), among those with direct oil contact in communities participating in the Gulf States Population Survey (n=3,616; 9.7% of n=38,361 total respondents; estimated subpopulation = 1,628,475).

Model	Tobit β (95% confidence interval)	F-statistic
Model 1 ^a	-2.37 (-5.81, 1.07)	F(1, 1804.7) = 2.23, p=0.1356
Model 2 ^b	-2.18 (-4.89, 0.53)	F(6, 6291.8) = 2.96, p=0.0069
Model 3 ^c	-2.27 (-4.97, 0.42)	F(10, 10062.1) = 3.53, p=0.0001
Model 4 ^d	-2.48 (-4.95, -0.01)	F(13, 10385.7) = 4.13, p<0.0001
Model 5 ^e	-2.49 (-4.70, -0.27)	F(17, 10999.3) = 4.30, p<0.0001
Model 6 ^f	-2.77 (-4.92, -0.61)	F(20, 13165.6) = 4.76, p<0.0001

^aUnadjusted

^bAdjusted for age, gender, race, Hispanic ethnicity

^cFurther adjusted for exercise, smoking, binge drinking

^dFurther adjusted for employment and marital status

^eFurther adjusted for emotional support

^fFurther adjusted for income

Note: Depression was scored from zero to 24 using the 8-item Patient Health Questionnaire (Kroenke et al. 2009). Direct oil contact was assessed by the question "Did you have direct contact with the oil from the Gulf oil spill?". Hispanic ethnicity, binge drinking, and exercise were coded as yes/no*. Other categorical variables were coded as follows: race (white*/black/other), smoking status (never*/former/current), marital status (married*/not currently married), employment status (employed* [employed for wages, self-employed]/not employed [out of work, unable to work]/other [homemaker, student, retired]), how often they felt they had the emotional support they needed (always*/usually/sometimes/rarely/never), and income (<\$35,000*; \$35,000– \$75,000; >\$75,000; missing).

* Asterisk denotes referent category in all models.