



Published in final edited form as:

Soc Psychiatry Psychiatr Epidemiol. 2013 November ; 48(11): 1729–1741. doi:10.1007/s00127-013-0698-7.

Displacement, county social cohesion and depression after a large-scale traumatic event

Félice Lê, Melissa Tracy, Fran H. Norris, and Sandro Galea

Abstract

Background—Depression is a common and potentially debilitating consequence of traumatic events. Mass traumatic events cause wide-ranging disruptions to community characteristics, influencing the population risk of depression. In the aftermath of such events, population displacement is common. Stressors associated with displacement may increase risk of depression directly. Indirectly, persons who are displaced may experience erosion in social cohesion, further exacerbating their risk for depression.

Methods—Using data from a population-based cross-sectional survey of adults living in the 23 southernmost counties of Mississippi (N = 708), we modeled the independent and joint relations of displacement and county-level social cohesion with depression 18–24 months after Hurricane Katrina.

Results—After adjustment for individual- and county-level sociodemographic characteristics and county-level hurricane exposure, joint exposure to both displacement and low social cohesion was associated with substantially higher log-odds of depression (b = 1.34 [0.86–1.83]). Associations were much weaker for exposure only to low social cohesion (b = 0.28 [–0.35–0.90]) or only to displacement (b = 0.04 [–0.80–0.88]). The associations were robust to additional adjustment for individually perceived social cohesion and social support.

Conclusion—Addressing the multiple, simultaneous disruptions that are a hallmark of mass traumatic events is important to identify vulnerable populations and understand the psychological ramifications of these events.

Keywords

social environment; disasters; displacement; mental health; depression; social cohesion

INTRODUCTION

Large-scale traumatic events cause multiple, simultaneous disruptions to communities' physical and social environments. Current understanding of how this broad range of disruptions affects mental health is limited. Behavioral health studies often address the

Corresponding author: Félice Lê, MPH, Center for Social Epidemiology and Population Health, University of Michigan School of Public Health, 1415 Washington Heights, 2nd Floor Tower, Ann Arbor, MI 48109-2029, USA, felicele@umich.edu, Tel: 617-817-5705, Fax: 734-763-5706.

Co-authors: Melissa Tracy, PhD, Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, USA

Fran H. Norris, PhD, Departments of Psychiatry and Community & Family Medicine, Dartmouth Medical School, Dartmouth, NH, USA

Sandro Galea, MD, DrPH, Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, USA

CONFLICT OF INTEREST

On behalf of all authors, the corresponding author states that there is no conflict of interest.

impacts of single exposures, failing to take into account the simultaneous influence of other changes to the environment. We examined the joint influence of post-event displacement and community social cohesion, two factors that have been individually related to mental health, on the risk of depression in a population affected by a natural disaster. Depression is a common and potentially debilitating consequence of disasters [1–3].

Nearly 15 million people were displaced because of natural disasters in 2011, including over 30,000 in the United States, and an additional 3.5 million were newly displaced within their countries because of violence and conflict [4,5]. Displaced persons may experience higher risk for depression than the nondisplaced because in addition to the trauma of the event itself, they may experience a host of additional stressors that unfold and persist afterwards [6–8]. In addition to material and administrative hardships such as decreased access to medical and social services, worse living conditions, repair or replacement of damaged possessions, application processes for governmental aid, and difficulty finding employment, the loss of social networks, social supports, and normal routines can add to the psychological burden of displacement. Extant research suggests that postdisaster stressors may be an important cause of depression in disaster-affected populations [9,10] and, more generally, has related stressful life events with depression [11,12].

Within the framework of the socioecological model of health—in which individuals are embedded in, and their health affected by, nested levels of social and physical environments [13]—mental health following a large-scale traumatic event may vary depending not only on attributes of affected individuals but also on attributes of their communities [14–17]. Community social cohesion may be one such attribute. Social cohesion describes the attachments between individuals and their

communities; these attachments may be demonstrated in feelings of belonging, willingness and ability to cooperate, and shared values among community members [18]. A small body of work has related residence in communities characterized by high social cohesion with a lower risk of mental health problems, including depression, after taking into account individual-level characteristics [19–21].

After a traumatic event, socially cohesive communities may be better able to respond quickly and effectively by organizing and carrying out relief efforts, gaining aid from outside organizations, assessing damage and identifying community members most in need, mitigating secondary problems such as looting and illness, disseminating information, and organizing rebuilding projects [16,17]. Social cohesion may also provide social supports that buffer community members' experiences of the stressors they do encounter by causing residents to interpret the stressors as less stressful, experience less severe physiological responses to the stressors, or be less likely to respond to the stressors in potentially harmful ways (such as substance abuse) [22,16].

These material and psychosocial benefits of social cohesion may be of particular importance for displaced persons burdened with numerous stressors in the aftermath of the event. In addition, it is plausible that persons who are displaced experience erosion in social cohesion, further exacerbating their risk for depression. Persons jointly exposed to both displacement and low community social cohesion may therefore be a particularly vulnerable population with high risk of depression.

We investigated the independent and joint relations of displacement and county-level social cohesion with depression among residents of the state of Mississippi 18–24 months after Hurricane Katrina. We hypothesized that displaced residents would be at higher risk for depression than nondisplaced residents, and that residents of counties with low social cohesion would be at higher risk than residents of counties with high social cohesion. We

also hypothesized that residents who had both been displaced and resided in counties with low social cohesion would experience a higher risk of depression than would be expected from the independent effects of the two exposures.

METHODS

Study Population

Data came from the Mississippi Community Survey (MCS), a population-based survey of adults 18 years and older living in the 23 southernmost counties of Mississippi prior to Hurricane Katrina. Figure 1 shows the study area. An in-depth discussion of the sampling methods is available elsewhere [23]. Briefly, the sampling frame was created through the enumeration of all addresses existing prior to Katrina in randomly selected census-based segments of areas severely affected by the storm. Extensive tracking using multiple methods was conducted to locate residents who had been living at selected addresses prior to the storm. Random-digit dialing was used in less-damaged areas where there was less hurricane-related resident relocation. One participant was randomly selected from the eligible adults in each sampled household. Interviews were conducted in person and by phone between February and July 2007. Interviews lasted 37 minutes on average and collected information about sociodemographic characteristics, hurricane-related experiences, individual and community support and coping experiences, traumatic events other than Katrina, and mental health symptoms. The study received Institutional Review Board approval from the University of Michigan and respondents gave oral consent to participate.

The community-level units of analysis were counties; each participant's county of residence was identified using the address he/she provided during the interview. The 82 counties comprising the state of Mississippi are well-defined and administratively meaningful units. Each has its own elected board of supervisors, as well as departments providing social and administrative services. We felt that counties' social and administrative relevance to residents made them the most appropriate choice of unit of analysis in this context despite the fact that they are relatively large and heterogeneous. Smaller units would not reflect the same policy and service differences and, in the case of census-defined areas, might not be geographically meaningful to residents. Several previous studies have linked county-level attributes, including characteristics of the social environment, with health [24–27].

This analysis was limited to self-reported non-Hispanic black or white respondents who resided in the same county both before and after Hurricane Katrina. The small number of respondents from other racial or ethnic groups (52 [7%] respondents, including 16 [2%] who reported being Hispanic) would have precluded drawing meaningful conclusions about members of these groups, particularly because the social environment may affect health differently for minority groups in areas such as our study area, in which the non-Hispanic black and white populations make up the overwhelming majority (93–99%). Similarly, forty-six non-Hispanic black or white MCS respondents were excluded because they moved to a different county after Katrina. We would expect the role of social cohesion to differ for these respondents because of their lack of a residential history in the counties where they lived at the time of the interview. These excluded respondents were more likely to have experienced stressors after Katrina related to the hurricane (90% vs. 76% of the included respondents), including displacement (75% vs. 26% of the included respondents). They also tended to be younger and were more likely to be married, although their low number makes meaningful comparisons difficult.

Measures

Displacement was assessed with the question, “Did you move from the place you were living because of Hurricane Katrina?” As mentioned above, at the time of the interview all sample participants resided in the same county as before Katrina. We included a separate measure of whether the respondent moved (within the county) after Katrina as a potential confounder.

Social cohesion was measured using a modified version of the 5-item scale developed by Sampson et al.; the scale has been validated against other measures of community integration and participation [28,29]. Respondents were asked to respond on a 5-point scale how much they agreed that people in their neighborhood after Hurricane Katrina 1) were close-knit or unified, 2) were willing to help their neighbors, 3) generally got along with each other, 4) did not share the same values, and 5) could be trusted. Each respondent’s responses to the 5 items were averaged (item 4 was reverse coded) to give a measure of individually perceived social cohesion (Cronbach’s $\alpha = .75$). The individual social cohesion values for all respondents within each county were averaged to give an estimate of county-level social cohesion, a method analogous to methods used in previous research [28,29]. One consideration is that while our community units of analysis were counties, the questions referred to respondents’ neighborhoods. Our measure of county social cohesion therefore represents an aggregate measure of neighborhood social cohesion: a county with high social cohesion is interpretable as a county whose constituent neighborhoods have high levels of social cohesion. We categorized the social cohesion measure into tertiles at the county level; because the number of participants per county varied, the number of individual participants in each tertile of county social cohesion differs. Figure 1 shows the geographic distribution of counties by social cohesion level.

Depression was measured using a variation of the Patient Health Questionnaire-9 (PHQ-9) [30]. The PHQ-9, whose 9 items correspond to the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) symptoms of major depression, has demonstrated good psychometric properties and construct validity [31]. Respondents described how often they were bothered by each symptom in the time since Hurricane Katrina using a 4-point scale ranging from “not at all” to “nearly every day.” The items were scored 0–3 and then summed to create a score ranging 0–27 (Cronbach’s $\alpha = .89$). In keeping with validity studies and other previous research, a cut-off score of 10, along with the respondent’s report that the symptoms were experienced within the same 2-week period, was used as the case definition for probable depression since Hurricane Katrina in this analysis [30,31]. In validation studies, using a cut-off of 10 the sensitivity and specificity of the PHQ-9 relative to clinician diagnosis of depression were both 88% [30]. As a secondary outcome, we also examined past-month depression, defined as meeting the case definition for depression and reporting having experienced the symptoms within the past month.

Social support was assessed using the 6-item Crisis Support Scale developed by Joseph et al. [32]. Respondents used a 7-point scale to describe how often they received various informal supports (such as sympathy, willingness to listen, and practical help) from others during the 2-month period after Katrina. Each individual’s responses were summed to give a score ranging 6–42 (Cronbach’s $\alpha = .77$). Scores were categorized into tertiles for this analysis.

Potential individual-level confounders included in the analysis were age, gender, race, marital status, educational attainment, and pre-Katrina household annual income. We also included information about four lifetime posttraumatic stress disorder (PTSD) symptoms related to an event other than Katrina: dwelling on or having nightmares about the event, avoiding thinking about the event or situations that reminded the respondent of the event, feeling constantly on guard or easily startled, and feeling numb or detached [33]. Although

depression and PTSD are distinct illnesses, with distinct but overlapping causes, the relatively high rate of comorbidity of these conditions after disasters, along with the monotonic relation between lifetime PTSD symptoms and depression in our sample, suggested that the use of this measure was appropriate in this context to address potential confounding of our results by participants' prior mental health [1,10]. A census-based measure of the percent of residents aged 25 or over with a college degree was also included as a measure of county socioeconomic status (results were nearly identical when this measure was replaced with county-level median household income). The percent of occupied housing units with major or severe damage from Katrina, as classified by the Federal Emergency Management Agency (FEMA), was included as a measure of county-level hurricane exposure [34].

Analysis

All analyses were conducted with SAS software (version 9.2) [35] using SURVEY procedures to account for the study sample design and possible correlations between residents of the same counties induced by the multilevel nature of the data [36]. Analyses alternatively using a general estimating equations (GEE) approach to account for within-county correlations produced nearly identical results [37]. Analyses incorporated weights to account for household and within-household individual sampling probabilities and additionally including a poststratification factor to reflect the age, gender, race/ethnicity, and educational attainment make-up of the study area according to the 2000 U.S. Census. Multiple imputation with 25 imputations was used to impute missing data while accounting for the uncertainty inherent in doing so [38]. At least one variable was imputed for 86 participants (12%); for 81 of these, the only missing information was the measure of household income.

We used unadjusted multinomial regression to examine bivariable associations between the covariates and county social cohesion, and unadjusted logistic regression to examine associations between the covariates and odds of both displacement and depression. We then used logistic regression to examine crude and confounder-adjusted associations of both displacement and county social cohesion with odds of depression. We included interaction (product) terms in our models to investigate joint effects of displacement and social cohesion. Finally, we tested the robustness of our results to additional adjustment for individually perceived social cohesion and social support measures. To the extent that individually perceived social cohesion and social support are influenced by county social cohesion, adjusting for these measures may result in an underestimate of the total effect of county social cohesion on depression. However, given that the county social cohesion variable used in this analysis was constructed by aggregating individual responses, it may be appropriate to view individually perceived social cohesion and social support as confounders in this case. We present results both with and without adjustment for these measures.

RESULTS

Participation rates in the study were comparable to or better than those documented in other population-based studies carried out under similarly difficult conditions: interviews were completed by 50.3% of all eligible sampled households, and only 9.4% of households that were sampled and successfully contacted refused to participate [23,39]. After application of the weights, the study population was sociodemographically representative of the 2000 U.S. Census population in the study area [23]. Out of 810 total participants in the study, 708 met inclusion criteria for this analysis. Sample participants were aged 18–91; after weighting, 52% of the sample was female, 25% was black, 57% was married, 45% had schooling beyond a high school diploma, 50% had an annual household income of at least \$40,000, and 26% had been displaced after Hurricane Katrina (Table 1). The number of participants

in each sample county ranged from 2–168 with a median of 20. The range of county-level social cohesion was relatively limited (range 2.3–3.6, with a possible range 0–4). Mean social cohesion scores for each tertile were 2.62, 3.01, and 3.39 for low-, medium-, and high-cohesion counties, respectively ($F = 50.2$; $p < .0001$). County socioeconomic status and degree of Katrina exposure were more varied (Table 1).

Participants who had been displaced had lower individual social cohesion scores, were more likely to live in counties severely affected by Katrina, and were more likely to meet the case definition for depression (Table 2). Displacement status also varied by individual socioeconomic status and having experienced PTSD symptoms from an event other than Katrina, although not monotonically. Residence in a county with low social cohesion was associated with younger age, lower education, and having experienced PTSD symptoms from an event other than Katrina (Table 2). It was also strongly associated with being displaced or moving after Hurricane Katrina. Higher county social cohesion was strongly associated with higher individually rated social cohesion, which is to be expected not only theoretically but because of the construction of the county measure. County socioeconomic status and hurricane exposure were not related to county social cohesion ($p = 0.87$ and $p = 0.28$, respectively) (Table 2). Table 3 shows coefficients (labeled b) from unadjusted and adjusted logistic regression models of depression. Respondents were more likely to meet the case definition for depression if they were younger, were of black race, had a lower education level or income, or reported low social support or individual social cohesion (Table 3, Model 1).

In models including both medium and high county social cohesion, estimated effects of medium social cohesion did not differ substantively from the null. Therefore, in the final models presented here we combined these two groups into one reference group; doing this did not affect the point estimates for low social cohesion. In unadjusted models, respondents were more likely to meet the case definition for depression since Hurricane Katrina if they had been displaced (Table 3, Model 1; b [coefficient] = 0.94 [95% confidence interval] 0.51–1.43) or lived in a county with low social cohesion ($b = 0.94$ [0.38– 1.51]). After adjustment for individual- and county-level confounders, the estimates were attenuated somewhat (Model 2; $b = 0.72$ [0.15, 1.30] for displacement, $b = 0.58$ [0.04–1.12] for low social cohesion). As we hypothesized, there was evidence of interaction between displacement status and social cohesion (Model 3; interaction $p = 0.04$). Participants exposed only to low social cohesion experienced moderately elevated log-odds of depression, although the confidence interval spanned the null ($b = 0.28$ [–0.35–0.90]) while exposure only to displacement was not independently associated with appreciably different log-odds of depression ($b = 0.04$ [–0.80–0.88]). However, joint exposure to both displacement and low social cohesion was associated with substantially higher log-odds of depression than exposure to neither condition (calculated from Model 3 coefficients; $b = 1.34$ [0.86–1.83]).

The final models do not include marital status or whether the participant moved (within the county) after Katrina; these variables were not associated with either the exposure or the outcome in the bivariable analysis and their exclusion from the multivariable models did not affect the results for social cohesion. Similarly, because results were nearly identical when models included individual education, individual income, or both measures, we present models including only individual education. Figure 2(a) shows predicted probabilities of depression from Model 3, by social cohesion and displacement status.

Table 3 also shows results from models additionally adjusted for individually perceived social cohesion (Model 4), social support (Model 5), and both individually perceived social

cohesion and social support (Model 6). These additional adjustments did not appreciably affect the estimates for displacement, county social cohesion, or their statistical interaction.

Ninety-one participants (weighted 15%) reported experiencing past-month depression. Results from models using past-month depression as the outcome were consistent with those for any depression since Katrina, although less precise (Table 4 and Figure 2[b]). Displacement and low social cohesion were both independently associated with higher odds of past-month depression after adjustment (Model 2; $b = 1.26$ [0.68–1.84] and $b = 0.66$ [0.09–1.24], respectively); compared to the models of depression since Hurricane Katrina, the main-effect point estimate for displacement was larger in magnitude while the estimate for low social cohesion was smaller. Just as with the models of any depression, there was evidence of interaction (interaction $p = 0.02$) such that joint exposure to both displacement and low social cohesion was related to substantially higher odds of past-month depression (calculated from Model 3 coefficients; $b = 1.83$ [1.37–2.30]) and main-effect estimates for both exposures were minimal in the interaction model ($b = 0.17$ [–0.99–1.33] and $b = 0.12$ [–0.55–0.78], respectively). Also consistent with models of depression since Katrina, the estimates were not substantially changed by additional adjustment for individually perceived social cohesion and social support (Models 4–6).

DISCUSSION

In a population-based sample of residents of the state of Mississippi 18–24 months after Hurricane Katrina, we found that joint exposure to post-Katrina displacement and low county-level

social cohesion was associated with a much greater likelihood of depression while exposure to just one of the risk factors was associated with only slightly higher odds of depression. The associations were evident after taking into account individual- and county-level covariates, including county-level Katrina exposure, and robust to additional adjustment for individually perceived social cohesion and social support.

Our results were consistent with existing evidence relating displacement to poorer mental health, as well as with past studies linking depression with the community social environment [6,21]. More generally, we addressed a previously identified gap in the epidemiology literature by applying the question of community social environmental influence on mental health to a postdisaster context [40]. Although the importance of social ties to postdisaster mental health has been widely acknowledged and empirically supported [3,14,41], research in this field has focused almost exclusively on aspects of the smaller-scale social environment, such as individual social ties and social support, rather than on the broader community-scale social environment. In one study that considered the broader social environment, Wind et al. [42] found in a flood-affected community in England that individually perceived social capital was inversely associated with depression 11 months after the flood. In another, Ahern and Galea [43] hypothesized that associations between higher neighborhood-level income inequality and higher odds of depression among low-income residents six months after a terrorist attack might be explained in part by differences in social interactions between residents of neighborhoods with different inequality levels.

The strong interaction we observed between displacement and community social cohesion may help explain inconsistencies across previous studies in associations between displacement and depression [6,7]. Furthermore, our results suggest a need for further research into how different social and individual conditions interact to shape longer-term mental health after a traumatic event. Joint exposure to risks at the individual, interpersonal, and community levels may result in vulnerabilities that are not evident when each of the

risks is considered separately. For example, in a study of Katrina survivors displaced to Colorado, Wadsworth et al. [44] found that different patterns of coping were predictive of different trajectories of depression; these patterns may in turn be differentially influenced by the community social environment.

In addition to consideration to the joint influence of post-trauma experiences, further research that more explicitly accounts for time will be important for fully characterizing how displacement and social cohesion relate to depression after a disaster. In our analysis, estimates for the main-effect association of displacement and the joint association of displacement and low social cohesion were larger for past-month depression than for any depression since Hurricane Katrina while the main-effect estimate for low social cohesion was smaller for past-month depression. Although care should be taken in interpreting these differences given the substantial overlap in confidence intervals for the two outcomes, they suggest that ongoing stressors related to displacement may confer risk for depression that either endures over the longer term or has a relatively late onset relative to the time of the traumatic event, and that this longer-term risk can be compounded by the community environment. In addition, there is already evidence that disasters such as Hurricane Katrina themselves affect the social environment [17]. Therefore, it will be important to understand how social cohesion levels before a disaster are affected by the disaster itself and, in turn, how pre- and postdisaster social cohesion may act in concert to affect the mental health of community members. Research is also needed to examine the effects on mental health of the multiple social environments to which displaced populations are exposed as they relocate in the period after a disaster. Finally, research is needed that addresses permanently relocated populations, among whom the potential benefits of a cohesive community must be balanced against the stresses of adapting to a new community [6].

Because of the cross-sectional nature of this study we cannot rule out the possibility that the onset of depression preceded exposure to a given level of social cohesion or that depressed residents were more likely to leave their homes following the disaster, precluding a causal interpretation of our results. Similarly, we cannot rule out the possible selection of individuals predisposed to depression into counties with low social cohesion. This is a particularly important consideration with respect to the construction of our social cohesion measure, as it is possible that individuals' mental health may influence their reports of social cohesion. That said, the robustness of our results to adjustment for individual psychological characteristics and perceptions (social cohesion, social support, and prior PTSD symptoms) suggest that further research into a potential causal link between social cohesion and postdisaster depression among populations grappling with disaster-related stressors is warranted. Inherent to this analysis is also the assumption that the average of individually reported social cohesion levels represents a valid estimate of the true level of social cohesion in each county. This is a substantial assumption, but it is supported by our population-based sample design and is in keeping with previous research of the area-level social environment and depression [21]. Finally, our estimates are imprecise, likely due in part to the relatively small number of counties and their limited range of social cohesion.

Our results highlight the importance of addressing the multiple, simultaneous disruptions that are a hallmark of mass traumatic events in order to identify vulnerable populations and understand the psychological ramifications of these events. They also demonstrate the utility of applying a socioecological model of mental health to post-event contexts. Just as mass traumatic events affect entire communities, community-level characteristics and processes may help minimize their initial damaging effects on individual members and promote recovery in the longer term. It is our hope that future research will identify attributes of communities that are beneficial to their members' mental health after a traumatic event and elucidate the mechanisms through which these attributes operate.

Acknowledgments

Funding: This study was supported by grant MH 078152 from the National Institutes of Health. The NIH had no further role in study design; in the collection, analysis and interpretation of data; in the writing of the report; or in the decision to submit the paper for publication.

REFERENCES

1. Davidson JR, McFarlane AC. The extent and impact of mental health problems after disaster. *J Clin Psychiatry*. 2006; 67(Suppl 2):9–14. [PubMed: 16602810]
2. Fullilove MT. Psychiatric implications of displacement: contributions from the psychology of place. *Am J Psychiatry*. 1996; 153(12):1516–1523. [PubMed: 8942445]
3. Norris FH, Friedman MJ, Watson PJ, Byrne CM, Diaz E, Kaniasty K. 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. *Psychiatry*. 2002; 65(3):207–239. [PubMed: 12405079]
4. Internal Displacement Monitoring Centre/Norwegian Refugee Council. Global estimates 2011: People displaced by natural hazard-induced disasters. Geneva, Switzerland: Internal Displacement Monitoring Centre; 2012.
5. Internal Displacement Monitoring Centre/Norwegian Refugee Council. Global overview 2011: People internally displaced by conflict and violence. Geneva, Switzerland: Internal Displacement Monitoring Centre; 2012.
6. Porter M, Haslam N. Predisplacement and postdisplacement factors associated with mental health of refugees and internally displaced persons: a meta-analysis. *JAMA*. 2005; 294(5):602–612. [PubMed: 16077055]
7. Uscher-Pines L. Health effects of relocation following disaster: a systematic review of the literature. *Disasters*. 2009; 33(1):1–22. [PubMed: 18498372]
8. Radanovic-Grguric L, Barkic J, Filakovic P, Koic O, Laufer D, Petek A, Mandic N. The impact of displacement on the expression of depressive disorder and social functioning among the war refugees. *Psychiatria Danubina*. 2009; 21(4):474–482. [PubMed: 19935480]
9. Person C, Tracy M, Galea S. Risk factors for depression after a disaster. *J Nerv Ment Dis*. 2006; 194(9):659–666. 00005053-200609000-00005 [pii]. [PubMed: 16971817]
10. Tracy M, Norris FH, Galea S. Differences in the determinants of posttraumatic stress disorder and depression after a mass traumatic event. *Depress Anxiety*. 2011; 28(8):666–675. [PubMed: 21618672]
11. Kendler KS, Karkowski LM, Prescott CA. Causal relationship between stressful life events and the onset of major depression. *Am J Psychiatry*. 1999; 156(6):837–841. [PubMed: 10360120]
12. Kessler RC. The effects of stressful life events on depression. *Annu Rev Psychol*. 1997; 48:191–214. [PubMed: 9046559]
13. Kaplan GA. What is the role of the social environment in understanding inequalities in health? *Ann N Y Acad Sci*. 1999; 896:116–119. [PubMed: 10681892]
14. Ajdukovic D. Social contexts of trauma and healing. *Med Confl Surviv*. 2004; 20(2):120–135. [PubMed: 15260176]
15. Galea S, Hadley C, Rudenstine S. Social context and the health consequences of disasters. *Am J Disaster Med*. 2006; 1(1):37–47. [PubMed: 18274042]
16. Kawachi I, Subramanian SV. Measuring and modeling the social and geographic context of trauma: a multilevel modeling approach. *J Trauma Stress*. 2006; 19(2):195–203. [PubMed: 16612828]
17. Norris FH, Stevens SP, Pfefferbaum B, Wyche KF, Pfefferbaum RL. Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *Am J Community Psychol*. 2008; 41(1–2):127–150. [PubMed: 18157631]
18. Council of Europe. Concerted development of social cohesion indicators: Methodological guide. France: Council of Europe, Strasbourg; 2005.

19. Johns LE, Aiello AE, Cheng C, Galea S, Koenen KC, Uddin M. Neighborhood social cohesion and posttraumatic stress disorder in a community-based sample: findings from the Detroit Neighborhood Health Study. *Soc Psychiatry Psychiatr Epidemiol.* 2012
20. Kawachi I, Berkman LF. Social ties and mental health. *J Urban Health.* 2001; 78(3):458–467. [PubMed: 11564849]
21. Mair C, Diez Roux AV, Galea S. Are neighbourhood characteristics associated with depressive symptoms? A review of evidence. *J Epidemiol Community Health.* 2008; 62(11):940–954. [PubMed: 18775943]
22. Cohen S, Wills TA. Stress, social support, and the buffering hypothesis. *Psychol Bull.* 1985; 98(2): 310–357. [PubMed: 3901065]
23. Galea S, Tracy M, Norris F, Coffey SF. Financial and social circumstances and the incidence and course of PTSD in Mississippi during the first two years after Hurricane Katrina. *J Trauma Stress.* 2008; 21(4):357–368. [PubMed: 18720399]
24. Jia H, Moriarty DG, Kanarek N. County-level social environment determinants of health-related quality of life among US adults: a multilevel analysis. *J Community Health.* 2009; 34(5):430–439. [PubMed: 19554435]
25. Koenen KC, Aiello AE, Bakshis E, Amstadter AB, Ruggiero KJ, Acierno R, Kilpatrick DG, Gelernter J, Galea S. Modification of the association between serotonin transporter genotype and risk of posttraumatic stress disorder in adults by county-level social environment. *Am J Epidemiol.* 2009; 169(6):704–711.
26. Muntaner C, Li Y, Xue X, Thompson T, O'Campo P, Chung H, Eaton WW. County level socioeconomic position, work organization and depression disorder: a repeated measures cross-classified multilevel analysis of low-income nursing home workers. *Health Place.* 2006; 12(4): 688–700. [PubMed: 16318920]
27. Congdon P. Spatial path models with multiple indicators and multiple causes: mental health in US counties. *Spat Spatiotemporal Epidemiol.* 2011; 2(2):103–116. [PubMed: 22749588]
28. Lochner K, Kawachi I, Kennedy BP. Social capital: a guide to its measurement. *Health Place.* 1999; 5(4):259–270. [PubMed: 10984580]
29. Sampson RJ, Raudenbush SW, Earls F. Neighborhoods and violent crime: a multilevel study of collective efficacy. *Science.* 1997; 277(5328):918–924. [PubMed: 9252316]
30. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med.* 2001; 16(9):606–613. [PubMed: 11556941]
31. Kroenke K, Spitzer RL, Williams JB, Lowe B. The Patient Health Questionnaire Somatic, Anxiety, and Depressive Symptom Scales: a systematic review. *Gen Hosp Psychiatry.* 2010; 32(4):345–359. [PubMed: 20633738]
32. Joseph S, Andrews B, Williams R, Yule W. Crisis support and psychiatric symptomatology in adult survivors of the Jupiter cruise ship disaster. *Br J Clin Psychol.* 1992; 31(Pt 1):63–73. [PubMed: 1559118]
33. Prins A, Ouimette P. The primary care PTSD screen (PC-PTSD): Development and operating characteristics. *Primary Care Psychiatry.* 2004; 9(4):151–134.
34. U.S. Department of Housing and Urban Development. Current Housing Unit Damage Estimates: Hurricanes Katrina, Rita, and Wilma. 2006
35. SAS Institute Inc. SAS software, version 9.2. Cary, NC: SAS Institute Inc; 2002.
36. SAS Institute Inc. SAS/STAT 9.2 User's Guide. Cary, NC: SAS Institute Inc; 2008. Introduction to survey sampling and analysis procedures.
37. Hanley JA, Negassa A, deB. Edwardes MD, Forrester JE. Statistical analysis of correlated data using generalized estimating equations (GEE): an orientation. *Am J Epidemiol.* 2003; 157:364–375. [PubMed: 12578807]
38. Raghunathan TE. What do we do with missing data? Some options for analysis of incomplete data. *Annu Rev Public Health.* 2004; 25:99–117. [PubMed: 15015914]
39. Galea S, Tracy M. Participation rates in epidemiologic studies. *Ann Epidemiol.* 2007; 17(9):643–653. [PubMed: 17553702]
40. Nakagawa Y, Shaw R. Social capital: A missing link to disaster recovery. *Int J Mass Emerg Disasters.* 2004; 22(1):5–34.

41. Brewin CR, Andrews B, Valentine JD. Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *J Consult Clin Psychol.* 2000; 68(5):748–766. [PubMed: 11068961]
42. Wind TR, Fordham M, Komproe IH. Social capital and post-disaster mental health. *Glob Health Action* 4. 2011
43. Ahern J, Galea S. Social context and depression after a disaster: the role of income inequality. *J Epidemiol Community Health.* 9; 60:766–770. [PubMed: 16905720]
44. Wadsworth ME, Santiago CD, Einhorn L. Coping with displacement from Hurricane Katrina: predictors of one-year post-traumatic stress and depression symptom trajectories. *Anxiety Stress Coping:*1–20. 2009

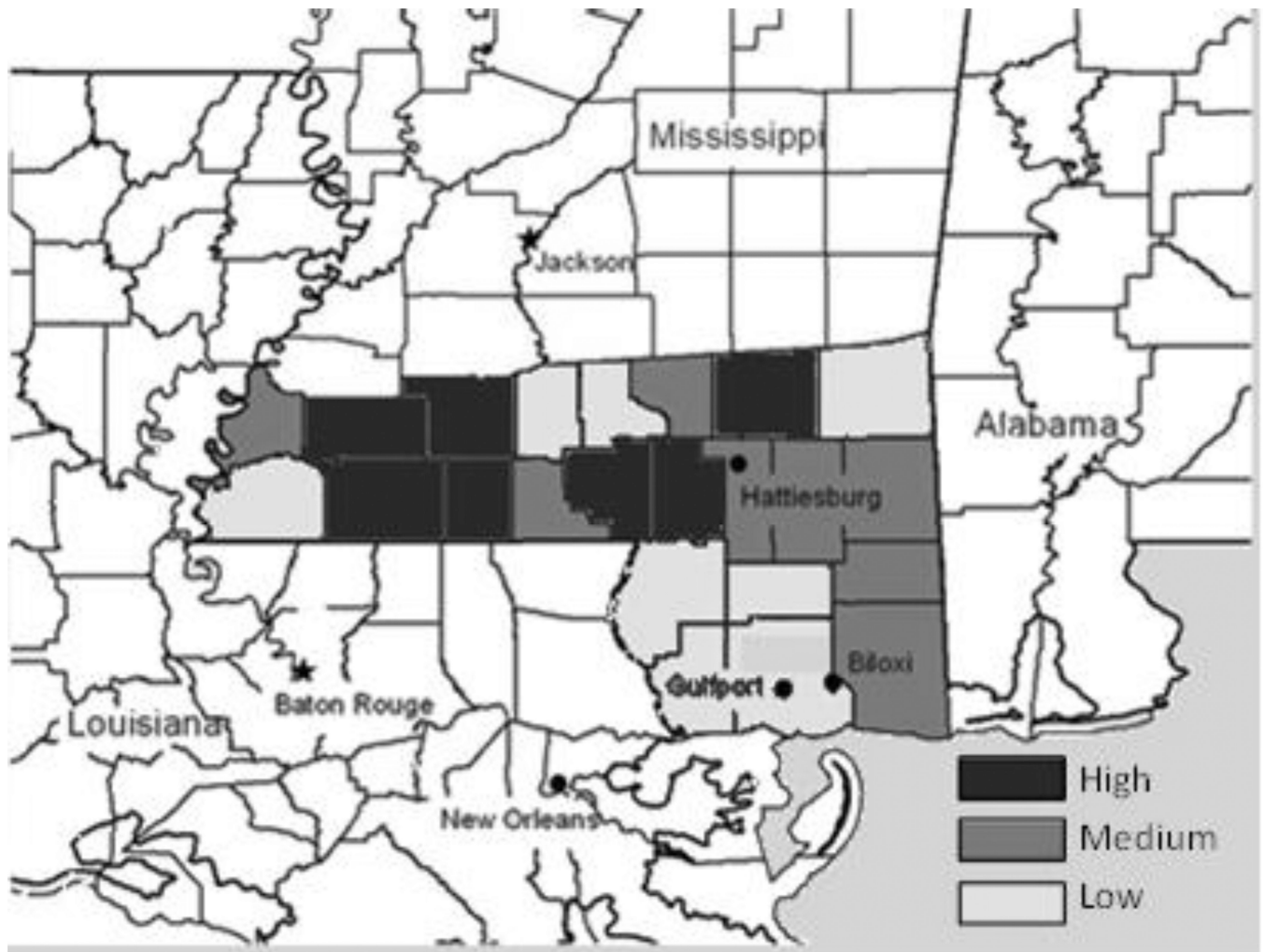


Figure 1.

Map of Mississippi counties included in the study area, by tertile of social cohesion. Black, medium gray, and light gray areas show sample counties with high, medium, and low social cohesion, respectively. White area shows surrounding counties in the states of Mississippi, Louisiana, and Alabama.

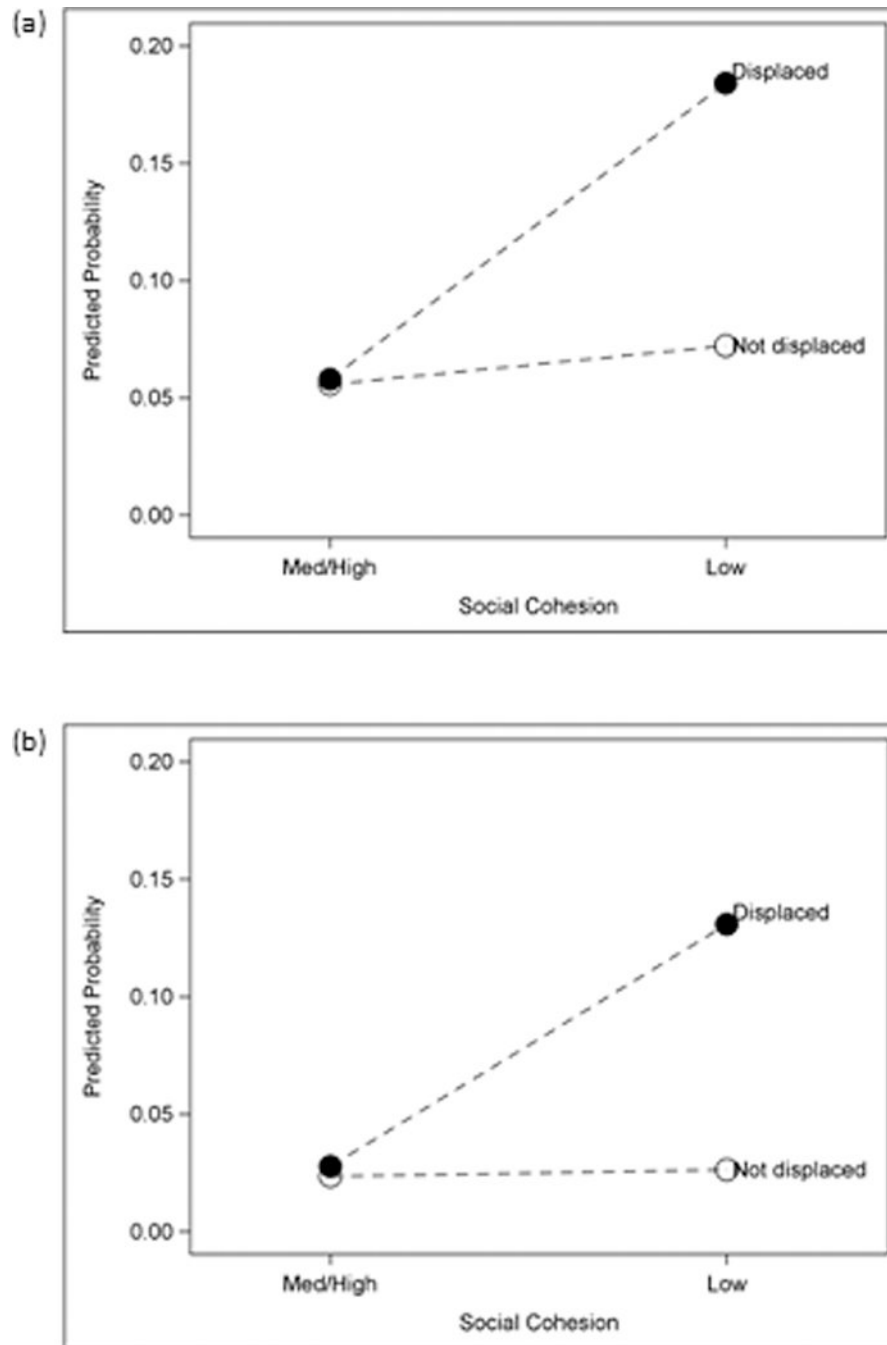


Figure 2. Predicted probabilities of (a) depression since Hurricane Katrina and (b) past-month depression, by county social cohesion and displacement status. Probabilities calculated from Table 3, Model 3 and Table 4, Model 3, respectively. Models adjusted for gender, age, race, education, lifetime PTSD symptoms, county education level, and county exposure to Hurricane Katrina. Probabilities calculated for a White, 54-year-old (population mean) male with a high school degree, no lifetime PTSD symptoms, mean county education level, and median county Katrina exposure.

Table 1
Sociodemographic characteristics of sample population and sample area, Mississippi Community Study, 2007^a

Frequencies and weighted percents of the sample population by category of individual sociodemographic characteristics, as well as medians and ranges of the sample counties by category of county-level characteristics.

Characteristic	Individual		County	
	<i>N</i>	<i>Weighted %^b</i>	<i>Median</i>	<i>Range</i>
Gender				
Female	443	52		
Male	265	48		
Age				
18–34	110	28		
35–64	411	53		
65–91	187	19		
Race				
Black	148	25		
White	560	75		
Marital status ^c				
Married/living with partner	390	57		
Divorced/separated/widowed	226	21		
Never married	90	22		
Missing	2	<1		
Educational attainment ^c				
Less than high school	99	24		
High school/GED	233	32		
Some college	199	31		
College graduate	176	13		
Missing	1	<1		
Annual household income before Katrina ^c				
<\$20,000	151	27		
\$20,000-\$39,999	193	31		
\$40,000-\$59,999	111	15		
\$60,000	170	27		
Missing	83	12		
Displacement after Katrina				
No	499	74		
Yes	208	26		
Moved (within county) after Katrina				
No	652	92		
Yes	56	8		

Characteristic	Individual		County	
	<i>N</i>	<i>Weighted %^b</i>	<i>Median</i>	<i>Range</i>
Lifetime PTSD symptoms				
0	328	48		
1–2	220	28		
3–4	160	24		
Individual social cohesion score				
0–2 (Low)	82	16		
2.1–3	189	24		
3.1–4 (High)	437	60		
Missing	0	0		
Social support tertile ^c				
Low	189	28		
Medium	234	32		
High	284	39		
Missing	1	<1		
Social cohesion (possible range 0–4; higher score indicates higher social cohesion)			2.9	2.3–3.6
% population aged 25+ with at least a BA			7.5	4.7–16.4
Median annual household income 2000			\$2.7K	\$1.9K–\$3.9K
% occupied housing units with major or severe damage from Hurricane Katrina			3.4	0.2–69.8

^a Sample limited to respondents who reported being of non-Hispanic black or white race and who did not change their county of residence after Hurricane Katrina (N = 708). Sample area includes 23 counties.

^b May not add to 100% because of rounding.

	Displacement ^b					Social Cohesion ^b					p	
	No	Yes	No	Yes	X ²	High	Med	Low	High	Med		Low
\$40,000-\$59,999	102	49	67	34		30	45	76	22	29	48	
\$60,000	124	48	80	20		40	60	72	32	31	37	
Experienced a Katrina-related traumatic event					5.9							2.4
No	374	126	77	22		105	162	233	25	30	45	
Yes	125	83	64	36		26	47	135	19	22	59	
Displacement after Katrina												24.0
No	--	--	--	--	--	107	164	228	28	29	43	
Yes	--	--	--	--	--	24	45	140	11	23	65	
Moved (within county) after Katrina					3.6							3.1
No	475	177	76	24		123	197	332	23	29	48	
Yes	24	32	53	47		8	12	36	24	16	60	
Number of lifetime PTSD symptoms					28.1							19.3
0	246	82	81	19		74	96	158	29	29	42	
1	73	37	71	29		14	35	61	16	25	59	
2	74	36	62	38		16	33	61	20	23	57	
3	59	30	66	34		13	27	49	14	39	47	
4	47	24	68	32		14	18	39	21	19	60	
Individual social cohesion score					14.4							144.2
0-1.9 (Low)	50	31	59	41		5	20	57	7	20	73	
2-2.9	129	60	72	28		21	65	103	13	31	56	
3-4 (High)	319	118	78	22		105	124	208	32	28	40	
Social support tertile					1.8							3.0
Low	140	49	75	25		36	57	96	21	27	52	
Medium	155	80	69	31		36	67	132	22	24	54	
High	204	80	76	24		59	85	140	26	31	43	
Depression					17.3							10.8
Yes	68	50	57	43		14	26	78	15	18	67	
No	431	159	78	22		117	183	290	26	30	44	

County characteristics	Displacement ^b				Social Cohesion ^b				p		
	No	Yes	No	Yes	High	Med	Low	High			
Median household annual income (\$10,000 units) ^c	2.9	3.5	3.9	3.9	2.6	2.7	2.9	3.8	2.3-3.6	0.2	0.89
County % population aged 25+ with at least a BA ^c	8.9	10.4	16.4	16.4	7.8	6.7	7.6	6.2-16.4	4.7-13.1	0.3	0.87
County % occupied housing with major/severe damage from Katrina	4.1	34.2	69.8	69.8	1.0	4.0	5.4	0.2-5.2	0.3-34.2	2.5	0.28

^aSample limited to respondents who reported being of non-Hispanic black or white race and who did not change their county of residence after Hurricane Katrina. Information incorporates imputed values and percents are weighted.

^bFor displacement the population is individual respondents and p-values are from unadjusted logistic regression. For social cohesion, the population is individual respondents (N = 708) for individual characteristics and counties (N = 23) for the county characteristics; p-values are from unadjusted multinomial logistic regression.

^cData from 2000 U.S. Census.

Table 3
Coefficients from logistic regression models of depression since Hurricane Katrina, Mississippi Community Study, 2007^a

Coefficients and 95% confidence intervals from logistic regression models of depression since Hurricane Katrina. Coefficients in Model 1 are not adjusted for other variables. Model 2 adjusted for displacement, low county social cohesion, Black race, sex, age, educational attainment, number of lifetime PTSD symptoms, county percent population aged 25+ with at least a bachelor's degree, and county percent occupied housing units with major or severe damage from Hurricane Katrina. Model 3 = Model 2 + displacement x low county social cohesion interaction. Model 4 = Model 3 + individual perceived social cohesion score. Model 5 = Model 3 + social support tertile. Model 6 = Model 3 + individual perceived social cohesion score and social support tertile.

	Unadjusted			Adjusted								
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6						
-2 Log Likelihood^b		588.91	584.63	584.41	578.47	578.30						
Covariate	b	95% CI	b	95% CI	b	95% CI						
Displaced after Katrina	0.97	(0.51, 1.43)***	0.72	(0.15, 1.30)*	0.04	(-0.80, 0.88)	0.03	(-0.79, 0.85)	0.00	(-0.85, 0.85)	0.01	(-0.84, 0.86)
Low social cohesion	0.94	(0.38, 1.51)**	0.58	(0.04, 1.12)*	0.28	(-0.35, 0.90)	0.25	(-0.43, 0.93)	0.23	(-0.39, 0.86)	0.26	(-0.42, 0.93)
Low social cohesion x displaced			1.02	(0.05, 2.00)*	1.03	(0.06, 1.99)*	1.03	(0.06, 1.99)*	1.11	(0.15, 2.08)*	1.11	(0.14, 2.09)*
Black race (vs. White)	0.98	(0.01, 1.95)*	0.62	(-0.26, 1.50)	0.71	(-0.18, 1.61)	0.69	(-0.22, 1.61)	0.67	(-0.27, 1.61)	0.69	(-0.24, 1.62)
Female gender	0.12	(-0.24, 0.49)	0.08	(-0.32, 0.48)	0.11	(-0.30, 0.52)	0.11	(-0.31, 0.54)	0.10	(-0.33, 0.53)	0.10	(-0.34, 0.54)
Age (per 5 years)	-0.09	(-0.17, 0.00)*	-0.06	(-0.15, 0.02)	-0.06	(-0.15, 0.02)	-0.06	(-0.15, 0.02)	-0.06	(-0.15, 0.02)	-0.07	(-0.15, 0.02)
Educational attainment (vs. <high school)												
High school/GED	-1.05	(-1.85, -0.24)*	-0.68	(-1.53, 0.17)	-0.62	(-1.50, 0.27)	-0.59	(-1.38, 0.20)	-0.60	(-1.51, 0.31)	-0.62	(-1.43, 0.18)
Some college	-1.23	(-2.14, -0.32)**	-0.99	(-1.80, -0.18)*	-0.95	(-1.80, -0.11)*	-0.92	(-1.69, -0.15)*	-0.92	(-1.76, -0.07)*	-0.95	(-1.72, -0.17)*
College graduate	-1.89	(-2.77, -1.02)***	-1.54	(-2.34, -0.75)***	-1.40	(-2.23, -0.57)**	-1.35	(-2.09, -0.62)***	-1.31	(-2.17, -0.44)**	-1.34	(-2.10, -0.58)***
Number of lifetime PTSD symptoms	0.55	(0.34, 0.75)***	0.49	(0.24, 0.73)***	0.49	(0.25, 0.73)***	0.49	(0.26, 0.72)***	0.45	(0.21, 0.70)***	0.46	(0.22, 0.70)***
County % population aged 25+ with a BA ^c	-0.11	(-0.26, 0.04)	-0.05	(-0.19, 0.10)	-0.05	(-0.19, 0.08)	-0.05	(-0.19, 0.09)	-0.05	(-0.19, 0.09)	-0.05	(-0.19, 0.09)
County % occupied housing units with major/severe damage from Katrina (per 5%)	-0.01	(-0.11, 0.09)	-0.01	(-0.11, 0.08)	-0.01	(-0.09, 0.08)	-0.01	(-0.09, 0.08)	-0.01	(-0.10, 0.08)	-0.01	(-0.10, 0.08)

	Unadjusted			Adjusted		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
-2 Log Likelihood^b		588.91	584.63	584.41	578.47	578.30
Covariate	b	b	b	b	b	b
Individual social cohesion score ^d	-0.67 (-1.09, -0.22)**			-0.06 (-0.42, 0.31)		0.05 (-0.34, 0.44)
Social support (vs. T3: High)						
T2: Medium	0.89 (0.12, 1.66)*				0.27 (-0.57, 1.11)	0.28 (-0.55, 1.11)
T1: Low	1.28 (0.41, 2.14)**				0.66 (-0.30, 1.63)	0.71 (-0.27, 1.68)

^a Sample limited to respondents who reported being of non-Hispanic black or white race and who did not change their county of residence after Hurricane Katrina. N=708; weighted N=1533.

^b Average value over 25 imputations; -2 log likelihood for intercept-only model = 743.42; -2 log likelihood for model including only social cohesion, displacement, and their interaction = 698.30.

^c Data from 2000 U.S. Census.

^d Range 0–4. Higher represents higher social cohesion.

* p < 0.10;

** p < 0.01;

*** p < 0.001

Table 4
Coefficients from logistic regression models of past-month depression, Mississippi Community Study, 2007^a

Coefficients and 95% confidence intervals from logistic regression models of past-month depression. Coefficients in Model 1 are not adjusted for other variables. Model 2 adjusted for displacement, low county social cohesion, Black race, sex, age, educational attainment, number of lifetime PTSD symptoms, county percent population aged 25+ with at least a bachelor's degree, and county percent occupied housing units with major or severe damage from Hurricane Katrina. Model 3 = Model 2 + displacement x low county social cohesion interaction. Model 4 = Model 3 + individual perceived social cohesion score. Model 5 = Model 3 + social support tertile. Model 6 = Model 3 + individual perceived social cohesion score and social support tertile.

	Unadjusted			Adjusted								
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 5	Model 6				
-2 Log Likelihood^b		471.67	464.13	462.55	447.92	447.92	447.92	447.92				
Covariate	b	95% CI	b	95% CI	b	95% CI	b	95% CI				
Displaced after Katrina	1.40	(0.85, 1.95)***	1.26	(0.68, 1.84)***	0.17	(-0.99, 1.33)	0.14	(-1.00, 1.27)	0.13	(-1.11, 1.36)	0.13	(-1.09, 1.35)
Low social cohesion	1.18	(0.61, 1.76)***	0.66	(0.09, 1.24)*	0.12	(-0.55, 0.78)	0.04	(-0.70, 0.77)	0.01	(-0.63, 0.65)	0.01	(-0.69, 0.72)
Low social cohesion x displaced			1.55	(0.20, 2.90)*	1.57	(0.25, 2.90)*	1.71	(0.30, 3.12)*	1.71	(0.30, 3.12)*	1.71	(0.30, 3.12)*
Black race (vs. White)	0.50	(-0.60, 1.60)	-0.14	(-0.92, 0.64)	0.03	(-0.75, 0.82)	-0.03	(-0.83, 0.77)	-0.09	(-0.94, 0.76)	-0.09	(-0.93, 0.76)
Female gender	0.28	(-0.27, 0.83)	0.42	(-0.02, 0.86)*	0.48	(0.07, 0.89)*	0.50	(0.05, 0.95)*	0.50	(0.07, 0.93)*	0.50	(0.05, 0.95)*
Age (per 5 years)	-0.11	(-0.22, 0.01)*	-0.09	(-0.20, 0.02)	-0.09	(-0.20, 0.02)	-0.09	(-0.20, 0.03)	-0.09	(-0.20, 0.02)	-0.09	(-0.20, 0.02)
Educational attainment (vs. < high school)												
High school/GED	-1.15	(-2.05, -0.24)*	-0.72	(-1.63, 0.19)	-0.64	(-1.59, 0.31)	-0.54	(-1.48, 0.39)	-0.58	(-1.60, 0.44)	-0.59	(-1.56, 0.39)
Some college	-1.09	(-2.10, -0.09)*	-0.83	(-1.73, 0.07)*	-0.79	(-1.76, 0.18)	-0.68	(-1.59, 0.24)	-0.64	(-1.64, 0.35)	-0.65	(-1.60, 0.30)
College graduate	-1.59	(-2.49, -0.69)***	-1.31	(-2.05, -0.56)***	-1.08	(-2.01, -0.16)*	-0.94	(-1.75, -0.12)*	-0.86	(-1.94, 0.21)	-0.87	(-1.84, 0.10)*
Number of lifetime PTSD symptoms	0.60	(0.39, 0.82)***	0.53	(0.27, 0.78)***	0.54	(0.29, 0.79)***	0.52	(0.28, 0.76)***	0.48	(0.22, 0.73)***	0.48	(0.23, 0.72)***
County % population aged 25+ with at least a BA ^c	-0.10	(-0.26, 0.07)	-0.13	(-0.23, -0.02)*	-0.13	(-0.23, -0.03)*	-0.13	(-0.24, -0.02)*	-0.14	(-0.26, -0.01)*	-0.14	(-0.26, -0.02)*
County percent occupied housing units with major/severe damage from (per 5%)	0.02	(-0.09, 0.14)	0.03	(-0.08, 0.13)	0.04	(-0.05, 0.13)	0.03	(-0.06, 0.13)	0.04	(-0.06, 0.14)	0.04	(-0.06, 0.14)

	Unadjusted			Adjusted		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
-2 Log Likelihood^b		471.67	464.13	462.55	447.92	447.92
Covariate	b	95% CI	b	95% CI	b	95% CI
Individual social cohesion score ^d	-0.78	(-1.25, -0.30)***	-0.17	(-0.51, 0.17)	0.01	(-0.37, 0.39)
Social support (vs. T3: High)						
T2: Medium	1.36	(0.47, 2.25)**			0.81	(-0.04, 1.66)*
T1: Low	1.77	(0.89, 2.66)***			1.34	(0.39, 2.30)**

^a Sample limited to respondents who reported being of non-Hispanic black or white race and who did not change their county of residence after Hurricane Katrina. N=708; weighted N=1533.

^b Average value over 25 imputations; -2 log likelihood for intercept-only model = 622.12; -2 log likelihood for model including only social cohesion, displacement, and their interaction = 554.86.

^c Data from 2000 U.S. Census.

^d Range 0-4. Higher represents higher social cohesion.

* p < 0.10;

** p < 0.01;

*** p < 0.001