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Pre-disaster Health Vulnerabilities Predict Major Depressive Disorder Symptoms Among High-Risk Puerto Rican Adults after Hurricanes Maria and Irma

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Abstract

Objective: Robust research has established that preexisting physical and mental health conditions increase risk for adverse psychiatric outcomes after disasters. However, it is unclear if increased risk is independent of disaster exposure, and most studies have relied on retrospective reports of pre-disaster functioning.

Methods: In a pre-post sample of high-risk Puerto Rican adults (N = 361) who experienced Hurricanes Irma and Maria, we assessed: 1) whether indicators of pre-disaster depression and physical health conditions were associated with posttraumatic stress disorder (PTSD) and major depressive disorder (MDD) symptoms; and 2) whether the effects of pre-disaster depression and physical health conditions on PTSD and MDD symptoms were indirect via disaster exposure or had exacerbated the effects of disaster exposure on PTSD and MDD symptoms.

Results: Pre-disaster depression and physical health problems were significantly associated with higher post-disaster MDD symptoms (B = 1.50, SE = 0.36, p < .001, and B = 0.21; SE = 0.09, P = 0.016), but not PTSD symptoms. Indirect effects of pre-disaster depression and physical health symptoms via disaster exposure were non-significant, and neither moderated the association of disaster exposure on PTSD and MDD symptoms.

Conclusions: Research is needed to understand other pathways through which pre-disaster health conditions predict post-disaster mental health.

Brief Report

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A robust body of literature indicates that exposure to disasters is associated with increased risk for a range of mental health problems, including PTSD and MDD.[1] Although the disaster mental health literature is substantial, a key limitation is a lack of pre-disaster data, precluding examination of the role of preexisting factors in shaping risk and resilience without retrospective bias.[2] The few studies that have included pre-disaster data have shown that pre-disaster mental health symptoms are among the strongest predictors of post-disaster psychiatric outcomes.[3,4] In contrast, findings regarding pre-disaster physical health are mixed, with some studies showing physical health symptoms to be associated with heightened risk for mental health symptoms and others finding no significant relationships.[5,6]

Whereas the main effects of pre-disaster health indices on post-disaster symptoms have been repeatedly examined, no studies to our knowledge have investigated whether this effect is indirect via higher disaster exposure. That is, it is possible that suffering from pre-disaster mental and physical health symptoms increase risk for more severe disaster exposure, which in turn heightens risk for post-disaster mental health symptoms. This possibility is supported by a longitudinal study of Hurricane Katrina survivors, wherein pre-disaster psychological distress (PD) was associated with disaster-related stressors, which were then predictive of post-disaster PTSD symptoms.[4] However, the investigators did not examine whether the indirect effect of pre-disaster PD on post-disaster PTSD symptoms via disaster-related stressors was statistically significant. Alternatively, pre-disaster health indices could exacerbate the mental health risks associated with disaster exposure. In this vein, a study of youth disaster survivors found that those with preexisting chronic physical health conditions were more likely than those without them to experience post-disaster psychological symptoms, with the authors suggesting that the impact of exposure might have been enhanced by their health-specific needs and vulnerabilities.[7]

Current Study

The current study therefore first sought to assess whether indicators of pre-disaster depression and physical health conditions were associated with post-disaster PTSD and MDD symptoms in a pre-post study of high-risk Puerto Rican adults who experienced Hurricanes Irma and Maria in 2017. Second, we aimed to examine whether pre-disaster health indices were indirectly associated with post-disaster PTSD and MDD via higher disaster exposure, and whether pre-disaster health indices exacerbated the effect of disaster exposure on post-disaster PTSD and MDD symptoms. This is the first study to our knowledge on mental health after Hurricanes Irma/Maria that includes pre-disaster data to shed light the relationships between pre-disaster health, disaster exposure, and post-disaster psychological functioning.

Method

Participants and Procedures

Participants were originally part of the San Juan Overweight Adults Longitudinal Study (SOALS). The baseline SOALS sample included 1206 Hispanic adults, ages 40 to 65, who were recruited through mass media. All eligible participants met criteria for being overweight or had obesity and had not been previously diagnosed with diabetes mellitus (DM). Baseline data were collected between 2011 and 2013. Of the 1206 SOALS participants, 1028 completed a follow-up visit between 2014 to 2016 (3 years after baseline; 1-3 years prior to the hurricanes), which comprised the pre-disaster data for the current study. The primary goal of SOALS was to evaluate the association between periodontitis, insulin resistance, and pre-diabetes. Information on other chronic health conditions and depression were also ascertained through interviews and questionnaires. All measures were administered in Spanish.

Post-disaster data were then collected after 2 hurricanes that affected Puerto Rico. First, Hurricane Irma passed by Puerto Rico on September 6, 2017, with Category 5 winds that caused significant damage to infrastructure through flooding, loss of power, and disruptions in water supply[8] (Crunch, 2019). Shortly after, on September 20, 2017, a second storm (Category 4), Hurricane Maria, made landfall and caused severe flooding, damage to property, mudslides, and additional infrastructure damage that led to water disruption, widespread power loss and the loss of as many as 2975 lives.[9] (Cangialosi et al., 2018).

In the aftermath of the hurricanes, the Preparedness to Reduce Exposures and diseases Post-hurricanes and Augment Resilience (PREPARE) study was initiated, in part to follow up with a subset of participants from the SOALS study.[10] PREPARE evaluated the preparedness, resilience, and impact of the hurricanes. Other PREPARE participants included adults with confirmed diabetes diagnoses who were recruited from federally qualifying health centers; however, given that these participants had not provided pre-disaster data, they were excluded from the current analysis.

Of the 1028 SOALS participants who completed the pre-disaster assessment, 869 were deemed eligible for PREPARE (22 were excluded for missing data, 125 had DM detected at baseline, 3 were deceased, and 9 refused to be contacted for future studies), and the research team aimed to survey 375 participants. Post-disaster data collection began in May 2019 (20 months post-disaster) and ended due to COVID-19 lockdowns in March 2020 (34 months post-disaster). At that point, the team was just short of its recruitment goal, having surveyed 364 SOALS participants. Of these, 3 participants were dropped in the current analysis due to missing data, yielding a final sample of 361. The study was approved by the Institutional Review Board at the University of Puerto Rico, and participants provided informed consent at each time point.

Measures

Pre-disaster health conditions

Participants responded to dichotomous items assessing whether they had ever been diagnosed with 18 different physical health conditions (e.g., asthma, hypertension, diabetes, cancer). A total count of pre-disaster diagnosed physical health conditions was computed.

Pre-disaster depression diagnosis

Participants were asked whether they had ever been diagnosed with depression. Responses to this item were used to classify pre-disaster depression diagnosis (1 = *yes*, 0 = *no*).

Post-disaster mental health symptoms

Post-disaster major depression disorder symptoms. The Patient Health Questionnaire-9 (PHQ-9) is a 9-item questionnaire for depression screening, using a 4-point Likert-type scale (0 = *not at all* to 3 = *nearly every day*). Total scores range from 0 to 27, with higher scores indicating higher symptom severity of depression. Cronbach's α in the current study was .84.

Post-disaster posttraumatic stress disorder symptoms. Symptoms of PTSD were assessed with the Posttraumatic Checklist for DSM-5 (PCL-5). The PCL-5 is a 20-item screening measure of PTSD Criterion B (re-experiencing), Criterion C (avoidance), Criterion D (negative cognitions and mood), and Criterion E (hyperarousal) symptoms. Participants reported PTSD symptoms in reference to their experience of the hurricanes, and rated how much they are bothered by each PTSD symptom in the past month (0 = *not at all* to 4 = *extremely*). Scores range from 17 to 85, with higher scores indicating greater symptom severity. Cronbach's α in the current study was .90.

Disaster exposure

A total of 13 dichotomous items were used to assess 2 categories of disaster exposures: health-related (e.g., direct injury, impact on personal health, impact on family member's health) and non-health-related (e.g., damage to home, financial impact, loss access to food). Items were then summed with higher scores indicating greater disaster exposure. Development of these items was informed by prior disaster mental health studies.

Demographic covariates

Demographic covariates were included based on their association with post-disaster mental health symptoms in prior research.[1] Age was included as a continuous variable, and sex and race were dummy coded (female = 1, male = 0, and Black = 1 and White = 0, respectively). Level of education was included as 3 dummy coded variables based on highest level of education completed (high school; some college or technical or vocational school; bachelor's degree or higher), with the reference category being a high school education or less. Marital status was dummy coded with 1 = married or cohabitating, and 0 = other. Lastly, participant's annual

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income was dummy coded, with 1 = below $50,000 and 0 = $50,000 or above. All demographic covariates were collected at pre-disaster, except for marital status and income, which were collected at both pre- and post-disaster timepoints, and race, which was collected post-disaster.

Data Analysis

Data analyses consisted of 4 steps. First, a series of preliminary analyses were conducted, including descriptive statistics and a correlation matrix. To assess missing data, chi-square analyses and independent-samples *t* tests were conducted to examine differences between the 361 participants in the analytic sample and the remaining 667 from the baseline SOALS cohort on all pre-disaster variables. Second, multivariable linear regression models were run, with MDD and PTSD symptoms as dependent variables, and pre-disaster physical health conditions, pre-disaster depression, and demographic covariates entered as predictors. Third, we examined the indirect effects of pre-disaster physical health conditions and pre-disaster depression on the outcomes via disaster exposure, controlling for demographic covariates, using Model 4 of the PROCESS macro. Indirect effects with 95% confidence intervals that did not include zero were considered statistically significant. Lastly, we examined whether pre-disaster physical health conditions and pre-disaster depression moderated the effect of disaster exposure on MDD and PTSD symptoms using PROCESS Model 1.

Results

Preliminary Analyses

Descriptive statistics for the analytic sample are shown in Table 1. The sample was majority female (77.6%, n = 280) with a mean age of 51.07 years (SD = 6.77). A total of 122 participants (15.2%) reported a pre-disaster MDD diagnosis and on average participants had 1.51 pre-disaster physical health conditions (SD = 1.61). Regarding correlations, pre-disaster depression was positively and significantly associated with disaster exposure, post-disaster MDD symptoms, and post-disaster PTSD symptoms. Pre-disaster physical health conditions were positively and significantly associated with post-disaster MDD symptoms, but not significantly associated with disaster exposure or post-disaster PTSD symptoms.

Table 1. Descriptive statistics for participants in the analytic sample (N = 361)

Variable	*M(SD)* or %(*n*)
Demographics	
Age	51.07 (6.77)
Black (%)	17.7% (64)
Female sex (%)	77.6% (280)
Male sex (%)	22.4% (81)
Married or cohabiting pre-disaster (%)	41.8% (151)
Married or cohabiting post-disaster (%)	41.0% (148)
Completed high school	19.7% (71)
Completed some college	32.1% (116)
Completed bachelor's degree or higher	41.6% (150)
Income less than $50,000 pre-disaster	83.4% (301)
Income less than $50,000 post-disaster	83.9% (303)
Pre-disaster depression diagnosis	16.3% (59)
Number of pre-disaster physical health conditions	1.51 (1.61)
Count of disaster exposures	5.51 (2.22)
Post-disaster MDD symptoms	4.80 (4.75)
Post-disaster PTSD symptoms	10.93 (11.27)

Note. MDD = Major depressive disorder; PTSD = Posttraumatic Stress Disorder.

Participants in the analytic sample significantly differed from others in the baseline SOALS sample by gender ($\chi^2[1] = 5.74$, P = 0.017), education ($x^2(3) = 36.05$, P < 0.001), and income ($\chi^2[1] = 12.35$, P < 0.001), with more female participants, higher income participants, and fewer with less than a high school degrees or a high school degree than expected. In addition, participants in the analytic sample had significantly more baseline physical health conditions than their counterparts (t [684.78] = 2.08, P = 0.038, equal variances not assumed).

Main Effects Model

Table 3 shows the results of the multivariable linear regression analyses assessing the main effects of pre-disaster physical health conditions and depression on post-disaster MDD and PTSD symptoms, controlling for disaster exposure and demographic covariates. As shown, having a pre-disaster depression diagnosis (B = 2.86, SE = 0.63, P < 0.001) and more pre-disaster physical health conditions (B = 0.63; SE = 0.15, P < 0001) were significantly associated with higher post-disaster MDD symptoms, as was disaster exposure (B = 0.58; SE = 0.10, P < 0.001). Neither pre-disaster depression nor pre-disaster physical health conditions was significantly associated with post-disaster PTSD symptoms, whereas higher disaster exposure was significantly associated with higher post-disaster PTSD symptoms (B = 1.65, SE = 0.25, P < 0.001).

Indirect Effects Analysis

Neither pre-disaster depression nor pre-disaster physical health conditions had a significant indirect effect on post-disaster MDD symptoms via disaster exposure (Estimate [Est.] = 0.32, SE = 0.22, 95% CI [–0.11, 0.78], and Est. = –0.02, SE = 0.05, 95% CI [–0.12, 0.07], respectively). The indirect effects for the model predicting post-disaster PTSD symptoms were also non-significant (pre-disaster depression: Est. = 0.91, SE = 0.64, 95% CI [–0.32, 2.19]; pre-disaster physical health conditions: Est. = –0.05, SE = 0.13, 95% CI [–0.32, 0.20]).

Moderation Analysis

Neither pre-disaster depression nor pre-disaster physical health symptoms moderated the effect of disaster exposure on post-disaster MDD symptoms (B = 0.47, SE = 0.26, P = 0.071, and B = –0.06, SE = 0.06, P = 0.328, respectively), or the effect of disaster exposure on PTSD symptoms (B = 0.98, SE = 0.64, p = 0.126, and B = 0.08, SE = 0.15, P = 0.588, respectively).

Discussion

The current study examined the role of pre-disaster depression and physical health conditions in predicting MDD and PTSD symptoms following Hurricanes Irma and Maria among high-risk Puerto

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Table 2. Correlations between all study variables (N = 361)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Age	–														
2. Black or African American	−0.04	–													
3. Sex	0.02	0.08	–												
4. Completed high school	−0.10	0.04	0.02	–											
5. Completed some college/tech	−0.07	0.05	−0.06	−0.34**	–										
6. Completed bachelor's degree or higher	0.11*	−0.13*	−0.02	−0.42**	−0.58**	–									
7. Pre-disaster depression diagnosis	0.04	−0.01	0.13*	0.05	−0.02	−0.05	–								
8. Disaster exposure	−0.01	−0.14**	0.02	−0.08	−0.06	0.10	0.10	–							
9. Married or cohabitating pre-disaster	0.03	−0.04	−0.18**	−0.12*	0.02*	0.13*	−0.21**	−0.03	–						
10. Married or cohabitating post-disaster	0.06	−0.02	−0.12*	−0.06	0.02	0.06	−0.11*	−0.02	0.73**	–					
11. Income less than $50,000 pre-disaster	0.02	0.03	0.03	0.17**	0.13*	−0.32**	0.16**	−0.02	−0.32**	−0.23**	–				
12. Income less than $50,000 post-disaster	0.07	0.07	0.09	0.16**	0.01	−0.20**	0.17**	0.04	−0.32**	−0.31**	0.64**	–			
13. Pre-disaster physical health conditions	0.33**	−0.10	0.05	−0.09	−0.01	0.13*	0.24**	0.02	−0.05	−0.01	−0.01	−0.01	–		
14. Post-disaster PTSD sypmtoms	−0.04	0.03	0.13*	0.05	0.05	−0.12*	0.17**	0.33**	−0.16**	−0.11*	0.19**	0.23**	0.04	–	
15. Post-disaster MDD symptoms	−0.06	0.05	0.16**	0.14**	0.01	−0.14**	0.33**	0.28**	−0.16**	−0.11*	0.13*	0.18**	0.20**	0.51**	–

Note. PTSD = Posstraumatic stress disorder; MDD = Major depressive disorder
*$p < .05$
**$p < .01$

Table 3. Results of multivariable regression models (N = 361)

	MDD symptoms B (SE)	PTSD symptoms B (SE)
Constant	3.48 (2.24)	−0.76 (5.58)
Age	−0.09 (0.04)*	−0.08 (0.09)
Black	0.97 (0.59)	1.55 (1.47)
Male sex	0.88 (0.54)	1.73 (1.35)
Completed high school	0.73 (1.00)	0.75 (2.49)
Completed some college/tech	−0.42 (0.96)	1.01 (2.38)
Completed bachelor's degree or higher	−1.37 (0.96)	−1.20 (2.38)
Married or cohabitating pre-disaster	−0.03 (0.68)	−1.23 (1.70)
Married or cohabitating post-disaster	−0.17 (0.66)	0.32 (1.65)
Income less than $50,000 pre-disaster	−0.08 (0.80)	1.67 (1.99)
Income less than $50,000 post-disaster	1.11 (0.80)	3.99 (2.00)*
Pre-disaster depression diagnosis	2.86 (0.63)***	2.21 (1.58)
Pre-disaster physical health conditions	0.63 (0.15)***	0.33 (0.38)
Disaster exposure	0.58 (0.10)***	1.65 (0.25)***

Note: PTSD = Posstraumatic stress disorder; MDD = Major depressive disorder
*$p < .05$
**$p < .01$
***$p < .001$

Rican adults, drawing on data from before and after the hurricanes. We found that having a pre-disaster depression diagnosis as well as more pre-disaster physical health problems were both significantly associated with higher post-disaster MDD symptoms, but not with post-disaster PTSD symptoms. This was the first study to our knowledge to examine the indirect effect of pre-disaster depression and physical health conditions and post-disaster symptoms via disaster exposure, and to evaluate whether the association between disaster exposure and post-disaster symptoms was exacerbated for those with pre-disaster depression or physical health conditions. We found no evidence of indirect or moderating effects.

It is notable that our study did not find pre-disaster depression or pre-disaster physical health conditions to have a significant indirect effect on post-disaster depression or PTSD symptoms. Nor did these conditions moderate post-disaster outcomes. One potential reason for this finding could be our dichotomous depression status, which is not an ideal way to consider the impact of depressive symptoms on post-disaster outcomes. Another reason could be the context of these 2 hurricanes, particularly that they may have been more impactful than previous disasters due to the high death toll, widespread damage, and disruption to infrastructure. Moreover, this paper used a high-risk sample.

Including pre-disaster health indices in these analyses overcomes retrospective bias, a common limitation of disaster mental health research. The significant main effects of pre-disaster depression and physical health conditions on post-disaster MDD are consistent with previous findings that pre-existing mental health vulnerability is predictive of post-disaster mental health symptoms.[3,4] However, the lack of association with post-disaster PTSD is in contrast to these prior studies, which could be due to differences in the disaster context, sample characteristics, or measures utilized. Lastly, this

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finding may indicate that health conditions do not confer as much vulnerability to post-disaster outcomes as previously thought. Overall, the findings are suggestive of underlying risk for mental health problems that persists over time, rather than depression increasing risk via or heightening sensitivity to disaster exposure. The results provide further evidence of the need for consistent care pre- and post-disaster for those suffering from pre-disaster depression. Notably, race was not associated with outcomes, which may be due to a differential conceptualization of racial categories in Puerto Rico compared to the continental U.S.[11]

These data should be considered in light of several limitations. Data were collected from a relatively small sample, limiting statistical power. Although consistent with prior research, pre-disaster conditions were not diagnosed using gold-standard interview instruments. Pre-disaster PTSD was not measured, limiting the conclusions that can be drawn regarding this outcome. This study was limited by the use of a dichotomous variable for the diagnosis of depression. Future research should use measures with continuous variables such as the PHQ-9, as well as a more representative sample with a more variable distribution of pre-disaster health indices. Pre-disaster physical health conditions and depression were measured using dichotomous items, and it is possible that the results would have differed had these assessments provided insight into the severity of symptoms. In a similar vein, pre-disaster data was from 1-3 years prior to the hurricanes and post-disaster from 20-34 months after the hurricanes, and different patterns might have emerged had data been collected within timeframes closer to disaster exposure. All participants in the sample had overweight or obesity at baseline, and although the focus on high-risk adults was a strength, the sample is not representative of the population of Puerto Rico. Finally, systematic differences between the analytic sample and others from the original cohort further limit the study's generalizability.

Despite these limitations, the findings contribute to the limited research on the mental health consequences of disasters that include pre-disaster data and is the first to evaluate indirect and moderating effects for pre-disaster depression and physical health conditions. Notably, participants with health conditions did not experience more negative outcomes post-disaster, indicating a more nuanced conceptualization of pre-disaster vulnerability. Moreover, these data provide additional evidence of the ongoing risk for mental health concerns among individuals already experiencing depression and reinforce the need for consistent mental healthcare from pre- to post-disaster.

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