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The effects of cumulative natural disaster exposure on adolescent psychological distress

Gabriella Y. Meltzer
New York University School of Global Public Health, gm2477@nyu.edu

Meghan Zacher PhD
Brown University, meghan_zacher@brown.edu

Alexis Merdjanoff PhD
New York University School of Global Public Health, aam258@nyu.edu

Mai P. Do MD DrPH
Tulane University School of Public Health & Tropical Medicine, mdo@tulane.edu

NhuNgoc K. Pham MPH
Tulane University School of Public Health & Tropical Medicine, npham2@tulane.edu

See next page for additional authors

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Authors

Gabriella Y. Meltzer, Meghan Zacher PhD, Alexis Merdjanoff PhD, Mai P. Do MD DrPH, NhuNgoc K. Pham MPH, and David Abramson PhD MPH

INTRODUCTION

Natural disasters are associated with a range of adverse mental health outcomes in children and adolescents, including posttraumatic stress, depression and anxiety, and behavioral problems.[1-3] Disasters are considered adverse childhood experiences whose short- and long-term effects on child and adolescent well-being likely occur through multiple mechanisms.[4] These include direct exposure to physical or emotional trauma and stress from the event itself, such as witnessing the destruction of one's home or the death or injury of a family member, friend, or pet.[5] Disaster-induced displacement may also impact children by disrupting their daily routines, separating them from their peer and support networks, and instigating school transitions.[6,7] Furthermore, disaster-related stressors may strain household dynamics, causing familial conflict and altering parenting practices in a way that ultimately affects children.[6,8] Relatedly, parents' disaster-related psychopathology may heighten child mental health issues by altering parent-child relationships and changing parenting behaviors.[9,10]

A growing body of research has documented both the short- and long-term psychological effects among children and adolescents exposed to natural disasters, particularly Hurricane Katrina. A 2013 study by Lowe et al. showed that Hurricane Katrina-related stressors were associated with maternal psychological distress and school mobility within 1 year of the hurricane, which, in turn, were associated with greater child internalizing and externalizing symptoms.[7] A longitudinal study of children in households either displaced or highly impacted by Hurricane Katrina showed that over 37% of children had received a diagnosis of depression, anxiety, or behavioral disorders following the hurricane.[11] A 2017 review by Lai et al. of children's post-traumatic stress symptom trajectories following disaster exposure found that those children with chronic post-traumatic stress were more likely to have had greater disaster exposure, to have been female, and to have had negative coping and less social support.[5] While these studies demonstrate the short- and long-term consequences of disaster exposure on adolescent mental health, it remains unknown whether cumulative disaster exposure has similar effects on adolescent mental health.

While little is understood about the effects of cumulative disaster exposure on adolescent mental health, there is evidence that among adults, the cumulative impact of exposure to large-scale disruptive events, including natural disasters, is detrimental for psychological well-being. Harville and colleagues showed that exposure to multiple hurricanes among

Gulf Coast residents enhanced risk for subsequent depression and post-traumatic stress disorder.[12,13] Relatedly, Lowe et al. found that Louisianans who were exposed to both Hurricane Katrina and the Deepwater Horizon oil spill had poorer mental health and increased physical symptomology thereafter compared to those exposed to only one of the two events.[14] A qualitative study of 9 mothers in Louisiana who experienced multiple disasters shed further light on the mechanisms through which repeated disaster exposure can harm adult well-being.[15] Several respondents reported that disaster-related social, psychological, and economic losses piled up over time, deterring their chances at sustained recovery. Some respondents demonstrated resilience even after multiple disasters, however, and detailed the usefulness of predisaster resources and individual and institutional support.

Unfortunately, many forms of natural disaster are becoming more frequent and destructive due to climate change. The forms of disaster subject to this trend range from heat waves, droughts, and wildfires, to floods stemming from rising coastlines, hurricanes, tropical storms, and riverine flooding.[16-20] Those living along the Atlantic and Gulf Coasts of the United States are regularly threatened by increasingly intense hurricanes carrying the potential for major winds and floods. Between 2000 and 2020, the state of Florida was struck by 13 hurricanes, Louisiana by 12, and Texas by 9,[21] not to mention the numerous other disasters and near-disasters that threated residents over the same period. 2020 alone had a record-breaking Atlantic hurricane season with 30 named storms, 12 of which made landfall in the continental United States.[22]

If these patterns continue, future generations of children will be more likely than generations past to experience and be negatively impacted by severe disaster not only once but multiple times over the course of their young lives. The impacts of repeated disaster exposure for child well-being are currently unknown. This gap in the literature must be resolved if the potential adverse consequences of repeated exposures for children are to be anticipated and ultimately mitigated.

Critically, the burden of climate change and climate-fueled disasters are not felt equally across the population. This is true globally, as low-income countries will likely bear the brunt of climate change despite their relatively low emissions.[23,24] Within the United States, disaster risk and vulnerability varies demographically, such that Black, Indigenous, and people of color (BIPOC) and the socioeconomically disadvantaged are at heightened risk of experiencing disaster and more vulnerable to related adverse consequences compared to their more resourced, White counterparts.[25,26] These dynamics were especially evident in the context of

Hurricane Katrina, where low-income communities of color were less likely to evacuate before the storm made landfall, experienced greater mortality, spent more time in temporary housing and shelters, and were more likely to be permanently displaced and lose their jobs.[27-29]

The reasons for the heightened vulnerability of ethnoracial minorities and the low-income, while multifaceted, are rooted in racist and classist practices past and present.[30] Such practices involve the de facto segregation of non-Whites and the working class and poor in neighborhoods at heightened environmental risk, and subsequent government neglect of infrastructure that could mitigate risk.[31] The sociodemographic characteristics associated with risk of disaster exposure may also structure risk for repeated disaster exposure. Minorities and those with low incomes may be less able to relocate to climate-resilient neighborhoods and homes in the aftermath of an initial disaster than the white and wealthy. These individuals also may suffer a greater adverse impact of multiple disasters because they have fewer resources to draw on in support of rebuilding and recovery, particularly multiple times.[32,33]

In sum, climate change is putting children at risk of experiencing disaster not just once but potentially several times over the course of their young lives. These patterns may hit minority, low-income, and other marginalized children particularly hard, and may therefore have implications for sociodemographic disparities in child mental health and well-being throughout the life course. As they attempt to cope and rebound from one disaster, they may be unable to fully recover as they continue to be bombarded with subsequent disasters. They may also form the semi-distorted belief that severe storms are everywhere and perpetual, requiring the constant mobilization of coping responses emblematic of chronically overreactive stress responses associated with anxiety disorders.[34-36] On the other hand, studies suggest that most children are resilient or recover quickly post-disaster, especially if they have access to familial and institutional support.[2,3,37] While studies have found that disasters harm adult well-being in a cumulative fashion, this question has not been evaluated in children.

The current study therefore examines the cumulative effects of family disaster exposure on adolescent mental health.[38] Furthermore, to shed light on potential consequences of repeated disaster exposure for adolescent health disparities, we also evaluated variation in the number of disasters adolescents' caregivers were exposed to and their effects on mental health by race, socioeconomic status, and indicators of family resilience and vulnerability. All families in our study experienced Hurricane Katrina, which devastated the US Gulf Coast in 2005, as our data come from 3 longitudinal

cohort studies of adult Katrina survivors from unique subpopulations: low-income mothers in New Orleans; displaced and highly impacted families in Louisiana and Mississippi; and Vietnamese immigrant families in New Orleans. Respondents were asked about their exposure to other environmental disasters in the 13 years following Katrina, at which time they also provided details regarding the emotional, mental, and behavioral health of their adolescent children over the last 30 days. This is the first study that utilizes the combined data from all 3 cohorts to examine the dose-response effects of cumulative familial natural disaster exposure on adolescent psychological distress.

METHODS

DATA COLLECTION

Data for this study come from the Demographic and Health Disparities in Recovery from Hurricane Katrina program, or Katrina@10. Katrina@10 is a multi-institutional collaboration between researchers at Harvard University, New York University School of Global Public Health, and Tulane University School of Public Health and Tropical Medicine to understand the long-term trajectories of recovery from Hurricane Katrina. The Katrina@10 program combines data from 3 separate cohorts: the Resilience in Survivors of Katrina project (RISK), the Gulf Coast Child and Family Health (G-CAFH) study, and the Katrina Impacts on Vietnamese Americans in New Orleans study (KATIVA NOLA). Each of these is a longitudinal observational study of Katrina survivors, although as described below, each has followed a different and unique subpopulation. Our data from each cohort come from the most recent wave of data collection undertaken for the Katrina@10 project in 2018.

RISK study participants were initially enrolled in a 2003 performance-based scholarship intervention for low-income parents at 2 community colleges in New Orleans.[39,40] Eligibility criteria required that students be between the ages of 18 and 34, be parents of at least one dependent child in the household under the age of 19, have a high school diploma or equivalent, and have an annual household income under 200% of the federal poverty line. 1019 participants provided information on their demographics, economic status, physical and mental health, and perceived social support at baseline. Respondents were surveyed a second time about 1 year later, still pre-Katrina; data collection for this survey wave was interrupted by Hurricane Katrina in August 2005. A third survey was conducted approximately 1 year post-Katrina, and a fourth survey about 4

years post-Katrina. The fifth survey wave, undertaken for Katrina@10, took place between 2016 and 2018, or approximately 13 years after Katrina. Only mothers were eligible to participate, and 716 responded.

The G-CAFH cohort consists of households who were either displaced or highly impacted by Hurricane Katrina. In 2006, 1079 households were randomly selected from Federal Emergency Management Agency (FEMA) congregate setting lists (including trailer sites and hotels) in Louisiana and Mississippi, and census blocks determined by FEMA to have incurred moderate, comprehensive, or catastrophic damage in Mississippi. Eligible adult respondents included those who lived at the selected address and were recognized as the primary caregiver, meaning they had knowledge of all household members' health issues. One child in each household was also randomly selected using the Kish sampling strategy and recruited into the longitudinal cohort.[41] Surveys covered topics including adult and pediatric health status; household prevalence of chronic conditions; access to healthcare, health insurance, and social services; children's medical, specialty, and dental needs; children's behavioral conditions and learning disabilities; household social and economic resources; social service needs; household history of post-hurricane displacement; and sociodemographic characteristics. For more information on sampling strategy, please refer to Abramson et al.[42] Three additional waves of data collection were conducted in 2007, 2008, and 2009-2010, followed by the fifth wave in 2017-2018 as part of Katrina@10.[11]

KATIVA NOLA includes first-generation Vietnamese families living in New Orleans at the time of Hurricane Katrina. This representative sample of families was initially recruited just before the hurricane struck as part of an effort to understand this subpopulation's physical and mental health outcomes, socioeconomic status, social support, family structure, acculturation, and past histories. Eligible individuals were between the ages of 20 and 54 at baseline, were born in Vietnam, and had emigrated to the United States between 1975 and 1990 when they were over 5 years old. Researchers sampled households using a May 2005 register of Vietnamese families in New Orleans managed by the Mary Queen of Vietnam Catholic Church and the Mary Queen of Vietnam Community Development Corporation. Given the circumstances posed by Hurricane Katrina, respondents were also asked about their evacuation experiences, pre-storm economic assets, and storm-related losses. Please refer to Vu et al for details on sampling and measurement.[43] Additional waves of data collection occurred 1, 2, and 5 years after Hurricane Katrina, as well as 12 years post-Katrina for Katrina@10.[44]

The Katrina@10 project served as a joint wave of data collection for each of these longitudinal observational cohorts using a unified survey instrument administered online via Qualtrics or by trained interviewers either in person or over the phone. Interviews lasted approximately 1 hour, and all participants provided informed consent. Children who were members of G-CAFH and under the age of 18 continued their participation in the fifth wave of data collection. For all other households, a child between the ages of 10 and 17 was randomly selected using the last-birthday sampling strategy for whom the caregiver respondent provided information.[41] The survey addressed the following themes: housing and mobility history; adult physical and mental health; household social capital and resources; adult risk behaviors, trauma, and exposure history; family dynamics and household constraints; neighborhood conditions; child physical, mental, and behavioral health; child academics; and post-Katrina recovery and life outlook; impacts of Hurricanes Harvey and Irma; climate change beliefs; and sociodemographic characteristics. All procedures were approved by the Harvard University, New York University, and Tulane University Institutional Review Boards. Across the 3 cohorts, 648 respondents provided relevant mental health information for a co-resident child between the ages of 10-17, and thus were eligible for inclusion in our analytic sample. These included 473 respondents from RISK, 145 G-CAFH respondents, and 30 KATIVA NOLA respondents.

MEASURES AND STATISTICAL ANALYSIS

The outcome of interest was adolescent psychological distress. It was based on the adult respondent (ie, parent, grandparent, or other caretaker) reporting that their child had exhibited at least one of the following symptoms in the past month: feeling sad or depressed, having problems sleeping, feeling nervous or afraid, or having problems getting along with other children. Adolescent psychological distress in the past month was treated as a dichotomous variable based on having none or at least one symptom of psychological distress.

The exposure of interest was the number of natural disasters the adult caregiver respondent had experienced since Hurricane Katrina. Respondents were asked, “In your lifetime, have you experienced a natural disaster other than Hurricane Katrina – for example, a flood or hurricane in which you or someone close to you was hurt or your property was damaged?” Those who responded in the affirmative were asked whether they had experienced the following events: Hurricanes Rita (2005), Gustav

(2008), Ike (2008), Irene (2011), Isaac (2012), Sandy (2012), Harvey (2017), Irma (2017), Maria (2017), and any two other disaster events. The number of additional events that the respondent endorsed having experienced in addition to Hurricane Katrina was treated as a continuous variable potentially ranging from 0 to 11.

We used several additional variables in our analyses as covariates. These included sociodemographic variables of race/ethnicity, annual household income, and parental educational attainment reported at the time of Katrina@10. Race/ethnicity was categorized as Non-Hispanic White (reference [ref.]), Non-Hispanic Black, and Vietnamese or Other; poverty threshold based on annual household income was dichotomized as above (ref.) or below $20,000; and parental educational attainment was dichotomized as greater than high school (ref.) or high school or less. In addition, we assessed whether a family had moved away (ref.) or still lived in their pre-Katrina neighborhood at the time of the survey. We treated child age as continuous and dichotomized child sex (male [ref.] vs. female) as additional controls.

Several indicators of familial vulnerability and resilience were also examined, as these constructs have been shown to influence post-disaster recovery.[45] Household financial constraints were based on frequency of difficulty in the past 6 months to afford at least one of the following: rent or mortgage, utilities, transportation, food, and healthcare. Household financial constraints were dichotomized as never or once in a while (ref.) compared to fairly often or very often. Whether the household was currently in stable housing was dichotomized as yes (ref.) or no. Family functioning was determined based on a modified family functioning scale used by Tatsuki and Hayashi,[46] scored and dichotomized into high (ref.) and low family functioning. Parental coping was based on the adult caregiver's response to the question "In general, how well do you feel you are coping with the day-to-day demands of parenting and raising children?" Parental coping was dichotomized as very well (ref.) or somewhat well or not well at all. Caregiver mental health was based on the adult respondent's Mental Component Summary (MCS) of the Medical Outcomes Study Short-Form Version 2 (SF-12) instrument, a widely validated instrument that measures physical functioning, physical and mental well-being, and psychological and emotional functioning.[47] Parental MCS was dichotomized into whether the respondent's score was above or at the threshold (ref.) or below or well below the threshold of poor mental health as compared to the general US population.

We conducted bivariate analyses using Pearson's chi-square, two-sample t-tests, and one-way ANOVA followed by univariate and multivariate

logistic regression with interaction tests to predict the association between the number of additional disasters experienced by the respondent and whether their child exhibited psychological distress in the past month. All analyses were conducted using Stata 15.[48]

RESULTS

Table 1 presents descriptive statistics for the analytic sample, overall and separately according to adolescent psychological distress. Of the 648 respondents in the analytical sample, 112 (17.3%) reported that their child had exhibited one or more symptoms of psychological distress in the past month. Overall, respondents had experienced 0.6 (SD 1.0) natural disasters, on average, in addition to Hurricane Katrina, ranging from 0 to 7. The average number of additional disasters experienced was significantly higher for families of adolescents with psychological distress (0.9, SD 1.3) compared to families of adolescents without psychological distress (0.5, SD 0.9).

The majority of respondents identified as Non-Hispanic Black (75.4%), followed by Non-Hispanic White (16.0%) and Vietnamese or Other (8.6%). Roughly one-quarter (24.6%) of respondents had an annual household income below $20,000, and over 40% had a high school education or less. While the vast majority of respondents reported having stable housing (93.2%), 36.9% reported difficulty affording household expenses fairly or very often. Most families had high family functioning (55.1%) with caregivers who reported coping very well with the demands of parenting (53.0%) and mental component scores above or at the threshold of good mental health (59.5%). The average age of adolescents was 14.1 (SD 2.2) and 52.1% were female. Annual household income, parental education level, household financial constraints, stable housing, family functioning, parental coping, and caregiver mental component score were all significantly associated with prevalence of adolescent psychological distress. Adolescents with psychological distress were more likely to be older, female, live in low-income households, have caregivers with a high school education or less, live in households with financial constraints, live in unstable housing, have low family functioning, and have caregivers with poor parental coping and mental component scores below the threshold.

Table 1. Descriptive Statistics Overall and by Adolescent Psychological Distress in the Past Month, N = 648

	Total	Adolescent Psychological Distress		
		No	Yes	
	N (%) N = 648	n (%) n = 536	n (%) n = 112	*p-value*[1]
Adolescent psychological distress				
No	536 (82.72)	-	-	-
Yes	112 (17.28)			
Number of additional natural disasters (mean, SD)	0.60 (0.98)	0.54 (0.91)	0.88 (1.26)	0.009[2]
Race[3]				
Non-Hispanic White	100 (15.97)	80 (15.38)	20 (18.87)	
Non-Hispanic Black	472 (75.40)	390 (75.00)	82 (77.36)	0.108[4]
Vietnamese or Other	54 (8.63)	50 (9.62)	4 (3.77)	
Annual household income[3]				
Below $20,000	150 (24.63)	114 (22.66)	36 (33.96)	
Above $20,000	459 (75.37)	389 (77.34)	70 (66.04)	0.014
Caregiver education level[3]				
High school or less	260 (40.69)	203 (38.45)	57 (51.35)	
Greater than high school	379 (59.31)	325 (61.55)	54 (48.65)	0.012
Household financial constraints[3]				
Never or once in a while	408 (63.06)	357 (66.73)	51 (45.54)	
Fairly often or very often	239 (36.94)	178 (33.27)	61 (54.46)	<0.001
Stable housing[3]				
No	44 (6.83)	28 (5.25)	16 (14.41)	
Yes	600 (93.17)	505 (94.57)	95 (85.59)	0.001
Family functioning				
Low	291 (44.91)	222 (41.42)	69 (61.61)	
High	357 (55.09)	314 (58.58)	43 (38.39)	<0.001
Parental coping[3]				
Very well	340 (53.04)	308 (58.22)	32 (28.57)	
Somewhat well or not well at all	301 (46.96)	221 (41.78)	80 (71.43)	<0.001
Caregiver Mental Component Score[3]				
At or above threshold	365 (59.45)	330 (65.61)	35 (31.53)	
Below threshold	249 (40.55)	173 (34.39)	76 (68.47)	<0.001
Child age (mean, SD)[3]	14.14 (2.24)	14.04 (2.21)	14.60 (2.29)	0.030[5]
Child sex[3]				
Male	230 (47.92)	192 (49.48)	38 (41.30)	
Female	250 (52.08)	196 (50.52)	54 (58.70)	0.158
Stayed in the neighborhood post-Hurricane Katrina				
No	520 (80.25)	431 (80.41)	89 (79.46)	
Yes	128 (19.75)	105 (19.59)	23 (20.54)	0.819

1. Pearson's χ^2 unless otherwise indicated

2. Two-sample t-test with unequal variances
3. Totals do not add up to N due to missing values
4. Fisher's exact
5. Two-sample t-test with equal variances

Table 2 presents descriptive statistics according to the average number of additional disasters experienced by respondents. None of the sociodemographic, psychological, or housing variables analyzed were significantly associated with number of natural disasters experienced post-Hurricane Katrina.

Table 2. Associations Between Sample Characteristics and Number of Additional Natural Disasters, N = 648

	Number of Additional Natural Disasters (mean, SD)	*p-value*[1]
Adolescent psychological distress		
No	0.54 (0.91)	
Yes	0.88 (1.26)	0.009[2]
Race		
Non-Hispanic White	0.77 (1.14)	
Non-Hispanic Black	0.56 (0.91)	0.148[3]
Vietnamese or Other	0.61 (1.22)	
Annual household income		
Below $20,000	0.51 (0.86)	
Above $20,000	0.63 (1.00)	0.201[2]
Parent education level		
High school or less	0.57 (1.00)	
Greater than high school	0.63 (0.98)	0.394
Household financial constraints		
Never or once in a while	0.61 (1.06)	
Fairly often or very often	0.59 (0.85)	0.722[2]
Stable housing		
No	0.73 (0.95)	
Yes	0.56 (0.99)	0.390
Family functioning		
Low	0.55 (0.86)	
High	0.64 (1.07)	0.214[2]
Parental coping		
Very well	0.55 (0.95)	
Somewhat well or not well at all	0.65 (0.97)	0.187
Caregiver Mental Component Score		
At or above threshold	0.56 (1.00)	
Below threshold	0.69 (0.96)	0.123
Child sex		
Male	0.61 (0.06)	
Female	0.54 (0.06)	0.377
Stayed in the neighborhood post-Hurricane Katrina		
No	0.61 (0.98)	
Yes	0.55 (0.99)	0.545

1. Two-sample t-test with equal variances unless otherwise noted
2. Two-sample t-test with unequal variances

3. One-way ANOVA

Multivariate logistic regression (Table 3) showed that each additional natural disaster experienced by the respondent was associated with 1.41 (95% CI 1.05, 1.88) greater odds of his or her child experiencing psychological distress in the past month, controlling for race/ethnicity, annual household income, parental education level, household financial constraints, stable housing, family functioning, parental coping, parental MCS, child age, and child sex.

Several measures of familial resilience or vulnerability were independently associated with adolescent psychological distress. Those adolescents whose caregivers reported low versus high family functioning (OR 1.81, 95% CI 1.01, 3.23), coping somewhat or well or not well at all versus very well with the demands of parenting (OR 2.85; 95% CI 1.57, 5.19), and whose caregivers' MCS were below or well below the threshold as opposed to above or at the threshold (OR 3.14; 95% CI 1.72, 5.76) reported significantly greater odds of adolescent psychological distress in the past month. In addition, a 1-year increase in child age was associated with 1.19 (95% CI 1.03, 1.36) greater odds of psychological distress, and female children were significantly more likely than males to report psychological distress (OR 1.85, 95% CI 1.04, 3.31). Several additional variables—specifically Vietnamese or Other race/ethnicity, annual household income, parental education level, household financial constraints, and unstable housing—were significantly associated with adolescent psychological distress in crude models, but their associations were attenuated and no longer significant in the multivariate model.

None of the sociodemographic characteristics or indicators of familial resilience or vulnerability analyzed significantly moderated the association between the number of additional natural disasters experienced by respondents and their children's psychological distress.

Table 3. Logistic Regression Predicting Adolescent Psychological Distress, N = 407[1]

	Crude Odds Ratios (95% CI)	Multivariate Odds Ratio (95% CI)
Number of additional natural disasters (mean, SD)	1.33 (1.11, 1.60)**	1.41 (1.05, 1.88)*
Race		
Non-Hispanic White	1.00	1.00
Non-Hispanic Black	0.84 (0.49, 1.45)	0.93 (0.45, 1.91)
Vietnamese or Other	0.32 (0.10, 0.99)*	0.70 (0.15, 3.18)
Annual household income		
Above $20,000	1.00	1.00
Below $20,000	1.75 (1.12, 2.76)*	1.34 (0.71, 2.54)
Parent education level		
Greater than high school	1.00	1.00
High school or less	1.69 (1.12, 2.55)*	1.66 (0.93, 2.96)
Household financial constraints		
Never or once in a while	1.00	1.00
Fairly often or very often	2.40 (1.59, 3.63)***	1.08 (0.59, 1.98)
Stable housing		
Yes	1.00	1.00
No	3.04 (1.58, 5.83)**	2.37 (0.87, 6.45)
Family functioning		
High	1.00	1.00
Low	2.27 (1.49, 3.45)***	1.81 (1.01, 3.23)*
Parental coping		
Very well	1.00	1.00
Somewhat well or not well at all	3.48 (2.23, 5.44)***	2.85 (1.57, 5.19)**
Parental Mental Component Score		
Above or at threshold	1.00	1.00
Below or well below threshold	4.14 (2.67, 6.44)***	3.14 (1.72, 5.76)***
Stayed in the neighborhood post-Hurricane Katrina		
No	1.00	1.00
Yes	1.06 (0.64, 1.76)	1.03 (0.48, 2.22)
Child age	1.13 (1.01, 1.26)*	1.19 (1.03, 1.36)*
Child sex		
Male	1.00	1.00
Female	1.39 (0.88, 2.21)	1.85 (1.04, 3.31)*

*$p < 0.05$ **$p < 0.01$ ***$p < 0.001$

[1]Given that 241 observations were missing information on child age and/or sex, we conducted a sensitivity analysis excluding these two variables from the multivariate model (data not shown). The results were consistent with those of the multivariate logistic regression shown in this table.

DISCUSSION

This is the first study, to our knowledge, that examines the relationship between cumulative natural disaster exposure and adolescents' psychological distress over 10 years after Hurricane Katrina. It is also the first study that utilizes the entire Katrina@10 cohort dataset comprised of individuals from 3 cohort studies of Hurricane Katrina survivors: low-income mothers from New Orleans, families displaced by Hurricane Katrina in Louisiana or from highly affected communities in Mississippi, and Vietnamese immigrants in New Orleans.

Our analyses show that families' experience of repeated disasters in addition to Hurricane Katrina had a significant negative, cumulative impact on co-resident adolescents' psychological well-being while controlling for familial sociodemographic characteristics such as race/ethnicity, annual household income, and caregiver educational attainment. This relationship was not exacerbated or attenuated by factors indicative of familial psychological or material resilience or vulnerability, including family functioning, parental coping, caregivers' mental health status, household financial constraints, or unstable housing. Rather, psychological factors at the immediate family level, as well as adolescents' age and sex, independently predicted adolescent psychological distress in the past month.

In addition, contrary to the literature on social vulnerability to disaster exposure,[49] those who identified as racial/ethnic minorities and/or of lower socioeconomic status were not significantly more likely than Non-Hispanic Whites or those of higher income to have been exposed to additional natural disasters after Hurricane Katrina. This could be due to the fact that after Hurricane Katrina, low-income communities of color were more often permanently displaced and less likely to return to New Orleans and other parts of the Gulf Coast that are susceptible to hurricanes and other natural disasters.[50]

This study's findings on significant independent predictors of adolescent psychological distress in the past month are consistent with those of other research on child mental health in the post-disaster context.[5,9,51] While race/ethnicity and socioeconomic status have been established in the literature to be key social determinants of post-disaster mental health, the effects of these broader structural factors on adolescents' psychological well-being in this analysis were overridden by more micro, family-level processes. A longitudinal, ethnographic study of children affected by Hurricane Katrina by Fothergill and Peek similarly revealed the paramount importance of immediate family functioning and the physical and

emotional presence of supportive adult figures in facilitating post-disaster child and adolescent recovery and resilience.[52]

This study has several limitations. Although respondents were asked about their prior disaster exposure and their co-resident adolescents' psychological distress in the past month, the cross-sectional nature of the Katrina@10 dataset containing all 3 cohorts prevents the ability to make any strong causal inferences. In addition, these 3 distinct cohorts are emblematic of certain subpopulations and their unique experiences, but are not representative of all New Orleans-area or Gulf Coast residents who were affected by Hurricane Katrina. These samples are therefore not well-designed to evaluate patterns of disaster exposure across the broader regional population or across the United States. This study was also subject to proxy response bias in that adolescent psychological distress was determined based on their caregivers' recall. The extent to which adolescents exhibited feelings of sadness or depression, had difficulty sleeping, felt nervous or afraid, or experienced problems getting along with other children may not have been fully captured, as caregivers do not observe their children over a 24-hour period. Adolescent disaster exposure was also not directly observed or collected since the question regarding exposure was posed to the caregiver who reported on his or her own experiences of additional natural disasters; their adolescent children may not necessarily have had the same exposure. In addition, the survey asked respondents to report on their exposure to major natural disasters and excluded exposure to near-disasters, which may cause heightened anxiety and stress even if little damage is incurred.

The results of this analysis suggest that the experience of cumulative climate change-related natural disasters is a collective stressor that has a detrimental impact on adolescent psychological well-being. Projected climate change will create additional disaster-related stressors that demand vigilant coping mechanisms beginning in childhood through adulthood, and inequitable access to supportive resources, relationships, and institutions may exacerbate health disparities. Coastal communities in the Gulf Coast are at particularly elevated risk of the effects of climate change as hurricanes and major flooding events become more frequent and severe.[53] It is therefore imperative that future research evaluates the patterns of cumulative disaster exposure in larger and more representative populations in regions at high risk from climate change to anticipate long-term child and adolescent mental health outcomes and develop strategies to promote individual and family resilience.

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