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Cumulative disaster exposure and hypertension among mothers who survived Hurricane Katrina

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**A thesis submitted in partial fulfillment of the requirements for the degree of
Master of Public Health**

**Yale School of Public Health
Department of Chronic Disease Epidemiology**

May 2022

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Abstract

Introduction: Hurricanes and other weather-related disasters are increasing in frequency and virulence as a result of climate change. While post-disaster mental health outcomes are robustly studied, post-disaster physical health conditions are not, especially in the longer-term aftermath of disasters. Hypertension is of particular concern due to its links with stress and traumatic events. To address this gap in the literature, this study examined the association between cumulative disaster exposure and hypertension over several years.

Methods: Data were from the Resilience in Survivors of Katrina (Project), a longitudinal cohort study of primarily Black mothers. A total of 505 women who had not been diagnosed with hypertension before Hurricane Katrina were studied to find if there were associations between the number of disasters participants had experienced and hypertension. Logistic regression models were used to assess this association.

Results: We found that cumulative disaster exposure was associated with onset of hypertension, particularly in the case of experiencing three or more hurricanes.

Conclusions: These findings provide novel evidence that cumulative disaster exposure is associated with adverse physical health consequences.

Acknowledgements

I would like to thank Dr. Mayur Desai and Dr. Sarah Lowe for their guidance and mentorship throughout this process. You both have been instrumental in my journey at Yale and I would not be where I am today without your help. Additionally, to the members of the RISK Project, thank you for letting me be a part of your incredibly talented team. I have learned so much from each of you.

I would also like to thank my parents, without you I would be neither the woman nor the scholar I am today. Dad, thank you for reading every paper I've ever written (including this one). Mom, thank you for leading me to the path of education and allowing me to follow in your footsteps (even though you will be Dr. Meadows just a few short years before me...).

To my best friend, Sam, thank you for listening to me everyday, you are a bright light in my life. Also, to my roommate Ellie, you and our cats have gotten me through this degree, and I wouldn't have done it without you. And to everyone of my friends, fellow SAYPH board members, and classmates, thank you for supporting and inspiring me daily.

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Introduction

Hurricanes and other weather-related disasters are increasing in frequency and virulence as a result of climate change.¹ The United States' Gulf Coast is geographically vulnerable to weather-related disasters, as evidenced by major historical hurricanes. Two such hurricanes, Katrina in 2005 and Laura in 2020, caused extensive loss of life and \$108 billion and \$19 billion in total damage, respectively.^{2,3} Hurricane Katrina's short- and longer-term impact on residents of the Gulf Coast has been thoroughly studied,⁴⁻⁶ with ample scholarship available on mental health outcomes.^{4,8-9} However, post-disaster physical health conditions are not as robustly studied as post-disaster mental health outcomes, especially in the longer-term aftermath of disasters.¹⁰

In particular, few studies have explored hypertension in groups that have experienced multiple disasters.¹¹⁻¹³ Hypertension, often referred to as high blood pressure, is defined as systolic blood pressure over 140mmHg and diastolic blood pressure over 90mmHg.¹⁴⁻¹⁶ Genetic, environmental, and lifestyle factors also contribute to this 'silent killer', which commonly shows no signs of symptoms and can be difficult to diagnose without regular screening.¹⁶ Additionally, hypertension has been suspected of being a psychosomatic disease, with psychological conditions contributing to development of the disease.¹⁴⁻¹⁶ Ample research suggests that veterans and others who have experienced traumatic events have a higher likelihood of developing hypertension.^{11,15,17}

A relatively small body of literature has shown the impact of weather-related disasters on hypertension outcomes. For example, a systematic review conducted in 2020 identified 13 articles that looked at hypertension after disasters and found that hypertension prevalence was greater among disaster survivors, compared to the general population.¹² However, no study examined whether cumulative disaster exposure is associated with hypertension. In the broader

trauma literature, cumulative exposure to adverse childhood experiences has been linked to a higher risk of cardiovascular disease (CVD).¹⁸ However, no study to our knowledge has looked at cumulative exposure in adults and hypertension specifically.

To address this gap in the literature, this study examined the association between cumulative disaster exposure and hypertension over several years. Using several waves of data from a prospective cohort of primarily Black mothers who all experienced Hurricane Katrina, and some who experienced other hurricanes, we sought to identify relationships between their experiences and physical health.

Methods

Data were from the Resilience in Survivors of Katrina (RISK) project. Initially called the Opening Doors Study, which investigated an intervention to improve retention at community colleges, the RISK project enrolled individuals between the ages of 18 and 34 who were parents and earned less than 200% of the federal poverty line at the time of enrollment (n=1019). This cohort was largely composed of non-Hispanic Black, unmarried mothers, who were surveyed several times since enrollment occurred in 2003.

Participants completed the study's first survey between November 2003 and February 2005, before Hurricane Katrina (Pre-1). Since Katrina, three surveys have been completed: March 2006-March 2007 (Post-1); March 2009-April 2010 (Post-2); and November 2016-December 2018 (Post-3). For each survey, greater than 70% of participants from the original cohort responded. Although men were eligible for participation at baseline, few were recruited, which led to all cohort members re-surveyed identifying as female.

The sample for this study was restricted to 505 women who had not been diagnosed with hypertension before Katrina and who had provided information on hypertension at Post-3. Of the

716 who responded to Post-3, 10 were excluded because they had been diagnosed with hypertension prior to Katrina. Additionally, 18 were removed due to missing hypertension data at Post-3 and 183 were excluded due to missing data for control variables.

Measures

Hypertension

Hypertension data was used from Post-3, the most recent survey. Respondents were asked to self-report whether they had been diagnosed with hypertension by a physician. Hypertension was coded as a binary variable (0=never diagnosed with hypertension; 1=diagnosed with hypertension).

Hurricane Exposure

At each post-Katrina survey wave, participants were asked whether they had experienced hurricanes that had made landfall in the United States or U.S. territories since the previous survey wave. Hurricanes were not limited to those that had affected the initial study area of New Orleans, Louisiana, as several participants have moved from the area since Katrina. Hurricanes included in the total number experienced were Hurricanes Katrina (2005), Rita (2005), Gustav (2008), Ike (2008), Irene (2011), Sandy (2012), Isaac (2012), Harvey (2017), Irma (2017), and Maria (2017). Cumulative exposure was the sum of all affirmative responses to questions asking if the participant had experienced the specific hurricane.

Covariates

Sociodemographic, Katrina-related trauma exposures, psychological outcomes, and clinical characteristic covariates were used for this study. Specifically, the variables used were race, age, marital status, a count of hurricane-related traumas from Katrina, psychological distress (PD), BMI, and self-perceived overall health. Race and marital status were coded as

binary variables (0=other race; 1=Non-Hispanic Black) and (0=not married; 1=married), respectively. Age was assessed continuously. To control for the effects of Katrina, Hurricane Katrina-related traumas were constructed based on previous literature¹⁹ as the sum of affirmative responses to several potentially traumatic experiences that happened during or just after the storm: believed life was in danger, could not access medications, could not access medical care, did not know if child was safe, did not know if another relative was safe, had a relative who could not access medical care, lacked sufficient food, and neighborhood flooded. PD was assessed using the six-item K6 scale at baseline.²⁰ Participants were asked to indicate on a 4-item scale from none of the time to all of the time how often in the previous 30 days they experienced feelings related to PD, such as “hopeless” and “worthless”. In the current sample, Cronbach’s alpha value for internal consistency was 0.75. BMI was split into three categories: healthy, i.e., less than 25 kg/m², overweight, i.e., between 25 kg/m² and 29.9 kg/m², and obese, i.e., 30 kg/m² or higher.²¹ Self-perceived general health at baseline was assessed using a Likert-type scale, excellent, very good, good, fair, and poor. A three-level variable was then created, combining very good and good, and fair and poor answers.²²

Analysis

A description of the sample by hypertension diagnosis was calculated, including means, standard deviations (continuous variables), and percentages (categorical variables). To assess the relationship between hypertension and cumulative hurricane exposure, logistic regression was used. First, unadjusted associations were calculated, followed by adjusted associations using all control variables. Outcomes with $p < 0.05$ were considered statistically significant. All data was analyzed using SAS version 9.4.

Results

Table 1 shows a description of the sample by hypertension diagnosis. Those with hypertension had a mean age of 26.0 years (SD=4.4) and had experienced a mean of 3.0 (SD=2.4) traumas during or immediately post Katrina. Additionally, 30.6% of those who only experienced Katrina, 41.7% of those who experienced two hurricanes, and 45.3% of those who experienced three or more hurricanes reported being diagnosed with hypertension.

Table 1. Sample of characteristics and associations with hypertension

Characteristic	N (%)* Mean ± SD (n=505)	No Hypertension* (n=332)	Hypertension* (n=173)	p†
Hurricanes Experienced, n (%)				0.026
1	356 (70.5)	247 (69.4)	109 (30.6)	
2	96 (19.0)	56 (58.3)	40 (41.7)	
≥ 3	53 (10.5)	29 (54.7)	24 (45.3)	
Race				0.216
Black	430 (85.2)	278 (64.7)	152 (35.4)	
Other	75 (14.9)	54 (72.0)	21 (28.0)	
Age (years), mean ± SD	25.1 ± 4.4	24.6 ± 4.4	26.0 ± 4.4	0.001
Marital status, n (%)				0.314
Married	152 (30.1)	95 (62.5)	57 (37.5)	
Single	353 (69.9)	237 (67.1)	116 (32.9)	
# Katrina Traumas, mean ± SD	2.9 ± 2.3	2.9 ± 2.3	3.0 ± 2.4	0.629
PD ⁻ , mean ± SD	25.1 ± 4.4	4.9 ± 4.1	5.3 ± 4.1	0.353
BMI, n (%)				<0.001
Normal	219 (43.4)	152 (69.4)	67 (30.6)	
Overweight	140 (27.7)	107 (76.4)	33 (23.6)	
Obese	146 (28.9)	73 (50.0)	73 (50.0)	
Self-Rated Health, n (%)				0.160
Excellent	178 (35.3)	120 (67.4)	58 (32.6)	
Very Good-Good	311 (61.6)	205 (65.9)	106 (34.1)	
Fair-Poor	16 (3.2)	7 (43.8)	9 (56.3)	

* Percentages may not sum to 100% due to rounding.

† P-value for analysis of variance t-test (continuous variable) or χ^2 test (categorical variable).

⁻ Psychological Distress, from K6 scale

Results of unadjusted and adjusted logistic regressions are shown in Table 2. In the unadjusted model both experiencing two hurricanes and three or more hurricanes were significantly associated with hypertension (p=0.042 and p=0.035, respectively). In the model adjusting for sociodemographics, clinical characteristics, a count of hurricane-related traumas

from Katrina, and psychological distress, experiencing three or more hurricanes remained significantly associated with hypertension ($p=0.047$). Compared to only experiencing Katrina, participants who experienced three or more hurricanes had 1.87 times the odds of developing hypertension (95% CI: 1.01, 3.47). In the adjusted model, experiencing two hurricanes was marginally associated with hypertension ($p=0.056$). As shown, Black race, marital status, count of Katrina-related traumas, PD, overweight BMI, and self-rated health were not significantly associated with the odds of developing hypertension, whereas older age and higher BMI were associated with increased odds of developing hypertension ($p=0.003$ and $p=0.002$, respectively).

Table 2. Logistic regression analysis of factors associated with hypertension (n=505)

Characteristic	Unadjusted OR (95% CI)	P	Adjusted OR (95% CI)	P
Hurricanes Experienced				
1	1.00		1.00	---
2	1.62 (1.02, 2.58)	0.042	1.61 (1.00, 2.63)	0.056
≥ 3	1.88 (1.04, 3.37)	0.035	1.87 (1.01, 3.47)	0.047
Black Race	1.41 (0.82, 2.42)	0.218	1.52 (0.86, 2.72)	0.152
Age (years)	1.08 (1.03, 1.12)	0.001	1.07 (1.02, 1.12)	0.003
Married	1.23 (0.83, 1.82)	0.314	1.22 (0.80, 1.88)	0.357
# Katrina Traumas	1.02 (0.94, 1.10)	0.629	1.00 (0.91, 1.08)	0.919
PD	1.02 (0.98, 1.07)	0.353	1.02 (0.97, 1.07)	0.513
BMI				
Normal	1.00		1.00	---
Overweight	0.70 (0.43, 1.14)	0.149	0.66 (0.40, 1.08)	0.097
Obese	2.27 (1.47, 3.50)	<0.001	2.02 (1.29, 3.17)	0.002
Self-Rated Health				
Excellent	1.00		1.00	---
Very Good-Good	1.07 (0.72, 1.58)	0.736	1.07 (0.71, 1.63)	0.745
Fair to Poor	2.66 (0.94, 7.50)	0.064	2.57 (0.82, 8.00)	0.104

Discussion

Cumulative disaster exposure and hypertension were assessed in a sample of Hurricane Katrina survivors 12 years post-disaster. In our sample of primarily Black mothers who lived in New Orleans at the time of Katrina, we found that hypertension prevalence increased with the

number of hurricanes experienced. Data showed that 30.6% of participants who had experienced only Katrina reported a hypertension diagnosis, whereas 45.3% of participants who had experienced three or more reported a hypertension diagnosis. Adjusting for sociodemographic factors, clinical measures, potential traumas, and PD, we found that experiencing three or more hurricanes was significantly associated with increased odds of hypertension. Specifically, those who experienced three or more disasters had 1.87 times the odds of developing hypertension as compared to those who had only experienced Katrina, which provides novel evidence that cumulative disaster exposure is associated with adverse physical health conditions.

This finding is consistent with previous studies that show the effects of disaster exposure and cumulative trauma exposure on hypertension,^{11,23,24} but provides a new angle with the focus on cumulative disaster exposure. Prior literature has shown an association between disaster exposure and hypertension onset, which is consistent with the current study's findings.¹² Additionally, results are consistent with the broader trauma literature linking cumulative exposure to adverse physical health outcomes.¹⁸ The link between cumulative disaster exposure and hypertension onset is likely present due to the increased likelihood of chronic stress, which has previously been linked to hypertension.¹⁴⁻¹⁶ As weather-related disasters become more common, it is clear that physical health will be detrimentally affected for those who live in disaster-prone locations and are likely to have multiple exposures to these disasters throughout their lifetime.

Limitations

Multiple limitations exist within this study. First, these findings may not be generalizable to other disaster survivor populations as the sample was entirely female, and mostly Black and single, which is not representative of the general population. However, it is important to note that

disasters typically have larger negative effects on racial and ethnic minorities, women, and those who are socio-economically disadvantaged.²⁵ Second, hypertension prevalence was self-reported, as no medical records were examined. Hypertension is a variable condition that can come and go in a person's lifetime, which may be difficult to track due to the longitudinal nature of this data. It is likely that cases were missed if participants who had hypertension had entered remission at times of data collection. Additionally, persons with hypertension are often asymptomatic, and diagnoses may have been missed.²⁶ Therefore, it is likely that some cases of hypertension are missing from this sample. It is possible that the women in the sample who reported hypertension, relative to those with the condition but who did not report it, were more advantaged in that they had been screened for hypertension, indicating more healthcare utilization.

Conclusion

This study builds on previous research to show the long-term physical impacts of cumulative disaster exposure. It is widely known that single and multiple weather-related disasters are associated with detrimental psychological effects, but no study has linked cumulative disaster exposure to hypertension. Future research should determine if this finding is consistent for other physical conditions in populations who have experienced multiple disasters. Overall, it is clear that weather-related disasters have long-term physical and mental health consequences.

Institutional Review Board Statement

Institutional Review Boards at Harvard University and Princeton University approved the Resilience in Survivors of Katrina Project.

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