

Hispanic Health Disparities After a Flood Disaster: Results of a Population-Based Survey of Individuals Experiencing Home Site Damage in El Paso (Texas, USA)

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Published online: 21 April 2012
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Abstract In 2006, El Paso County, a predominantly Hispanic urban area, was affected by a flood disaster; 1,500 homes were damaged. We assessed the health impacts of the disaster upon 475 individuals whose homes were flood-damaged using mail survey data and logistic regression. Substantial proportions of individuals had one or more *physical* (43 %) or *mental* (18 %) health problem in the four months following the floods; 28 % had one or more injury or acute effect related to post-flood *cleanup*. Adverse event experiences, older age, and lower socioeconomic status were significantly associated with negative post-flood health outcomes in all three logistic regression models. A lack of access to healthcare, non-US citizenship, and English proficiency were significant predictors of negative outcomes in both the *physical* and *mental* health models, while Hispanic ethnicity (*physical*), native-birth (*mental*), and more serious home damage (*cleanup*) were significant predictors in one model each. The disaster had disproportionate negative health impacts on those who were more exposed, poorer, older, and with constrained resource-access. While a lack of US citizenship and Hispanic ethnicity were associated with higher risks, being less acculturated (i.e., English-deficient, foreign-born) may have protected against health impacts.

Keywords Flood disaster · Physical and mental health · Acculturation · Hispanic · El Paso (TX)

Introduction

Between 27 July and 7 September 2006, El Paso County (USA) received more than two times its average annual rainfall. An estimated 1,500 homes were damaged or destroyed, and dollar losses exceeded US\$200 million. Flood impacts prompted a federal disaster declaration. While no loss of life was attributed to disaster, the event induced substantial health effects, particularly among people whose home sites were damaged. Physical health effects of flood disasters have been known to include injuries, allergies, disease outbreaks, diarrheal diseases, and respiratory conditions [1–10]. Participation in post-flood cleanup, repair and recovery activities can cause accidents, dehydration, heat exhaustion, allergic reactions, and asthma exacerbations [5, 11–13]. Traumatic experiences and post-flood displacement can cause mental health and stress-related disorders [14–18]. In the future, health impacts of floods will almost certainly worsen, as climate change is predicted to increase the occurrence of extreme flood events [19–22].

While the health effects of floods have been well-documented, we lack adequate knowledge of health disparities associated with disasters, particularly in relation to racial/ethnic minority and immigrant groups. The literatures on health disparities [23, 24] and disaster vulnerability [25–27] suggest that the physical and mental health effects of disasters are likely to disproportionately burden groups of people in disadvantaged social positions (e.g., based on age, gender, socioeconomic status, racial/ethnic status, citizenship/immigration status, etc.). The majority of

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existing knowledge of disparities in post-disaster health impacts comes from survey-based research focused primarily on mental health effects. People with more severe event experiences (e.g., fear, evacuation, property damage), women, younger (as opposed to older) adults, the poor, and racial/ethnic minorities are generally more likely to suffer negative mental health effects [16, 28, 29].

Gaps in the disaster health disparities literature include: (1) underdeveloped knowledge of social disparities in physical health effects; (2) neglect of the effect of healthcare access on disaster health outcomes; and (3) limited knowledge of racial/ethnic minority and immigrant populations [16, 29]. To address these gaps, we collected survey data for a population-based sample of those who experienced flood damage at their home sites during the 2006 flood disaster in El Paso County, Texas and we investigated disaster-related health disparities. After describing health impacts, we use logistic regression to assess disaster health disparities in terms of risk and protective factors associated with flood event exposure, age, gender, socioeconomic status, and healthcare access, in addition to variables contextually-relevant to El Paso County's border location, immigrant gateway status, and predominantly Hispanic population (English-language proficiency, nativity, and citizenship status).

Study Area, Research Questions and Hypotheses

El Paso County, Texas comprises a metropolitan area with an estimated 2006 (the disaster year) population of 736,310. In 2006, the vast majority (81 %) of County residents was Hispanic (compared with 15 % for the US and 36 % for TX), while much smaller percentages were non-Hispanic white (14 %) and non-Hispanic black (2 %). El Paso County had a lower median household income (2006 US \$32,111) than the State of Texas (2006 US \$44,922) and the US (2006 US \$48,451) and a poverty rate (28 % in 2006) over two times the national rate (13 %).

Unlike most US disasters, the 2006 floods impacted an immigrant gateway [30] at the Mexican border, comprised of a highly heterogeneous Hispanic population. In this context, English proficiency, nativity and citizenship represent particularly salient dimensions of social inequality. In 2006, just 24.1 % of El Paso County residents spoke only English, while 73.6 % spoke Spanish. Furthermore, 17.5 % of the county's Spanish speakers did not speak English well or at all, 27.5 % of county residents were foreign-born and 16.4 % were not US citizens.¹ Prior research reveals that immigrant

households with members lacking US citizenship or legal residency status—as well as those without English-language proficiency—experienced constrained access to resources for coping with the impacts of this disaster [31, 32].

Because Hispanics comprise the largest and fastest growing minority group in the US, there is a need to advance understanding of Hispanic health disparities in disasters, such as the El Paso County floods. The primary research questions and hypotheses addressed in this study are:

(1) Did the 2006 flood disaster impact the physical and mental health of people who experienced home damage?

- H1: The 2006 floods had measurable negative health impacts on people who experienced home site damage.

(2) How are the factors of event exposure, age, gender, socioeconomic status, healthcare access, and racial/ethnic status associated with health outcomes?

- H2a: Greater severity of event experiences/exposure is associated with negative health outcomes.
- H2b: Younger age is associated with negative health outcomes.
- H2c: Female gender is associated with negative health outcomes.
- H2d: Lower socioeconomic status is associated with negative health outcomes.
- H2e: Lack of access to healthcare is associated with negative health outcomes.
- H2f: Minority racial/ethnic status (i.e., Hispanic) is associated with negative health outcomes.

(3) Are factors contextually-relevant for the Hispanic immigrant population (including citizenship, nativity, and English proficiency) associated with negative health outcomes?

- H3: Immigrant group membership (based on non-US citizenship, foreign-birth, and a lack of English proficiency) is associated with negative health impacts.

Methods

Participants

Participants included heads-of-households that reported home site damage following the disaster to the City of El Paso and/or the American Red Cross; both collected address information for El Paso County households that experienced flood damage. Because the address data were applicable for 2006, we triangulated 2006 addresses to 2010 addresses. We used reverse directories and phone books to triangulate current mailing addresses based on

¹ These characteristics are closely connected with Hispanic ethnicity in El Paso County. In 2006, Hispanics made up 99 % of the county's total Spanish-speaking population that spoke English not well or at all (115,356/116,270), 93 % of the total foreign-born population (187,809/202,516) and 95 % of the total non-US citizen population (114,363/120,812).

victims' home addresses during the year of the disaster. A total of 1,031 households were included in the initial sampling frame.

Data Collection

Data were collected through a mail survey that was approved by our university's Institutional Review Board. We administered the survey using the tailored design method (TDM) [33] to obtain the highest achievable response rates by personalizing communication, following-up with non-respondents, and offering incentives. All survey materials were provided to households in English and Spanish.² Beginning on 26 May 2010, mailings were sent to the households in four phases: (1) surveys were sent with postage-paid self addressed envelopes; (2) one week later, reminder postcards were sent to all non-respondents; (3) ten days later, a second round of surveys was sent to all non-respondents; (4) one week later, a second round of postcards was sent to all non-respondents. In phase 1, incentives of \$10 were offered for completed surveys. In phase 3, a token gift of \$3 was included in outgoing envelopes. In total, 247 surveys were returned, either as undeliverable by the post office due to wrong mailing address information or by households that indicated that they had not experienced home damage in the 2006 floods. This occurred because the standard method we used to update our mailing list led us to inaccurately triangulate current postal addresses for a small subset of households. The final sampling frame was 784 households. 176 surveys were returned for a 22 % response rate. While 176 heads-of-households were surveyed directly, the survey yielded data for 475 individuals who were members of flood-impacted households.

Measures

Survey development was informed by previous disaster health surveys [5, 12, 16, 28]. Three dichotomous dependent variables were analyzed: (1) physical or (2) mental health problems experienced within 4 months of the flood event; and (3) injuries and acute effects related to participation in post-flood cleanup. These variables were constructed based on the literature [5, 11–13, 34–37]. Use of dichotomous (as opposed to continuous) health outcome variables was consistent with prior flood health effects research [e.g., 5] and was warranted due to the three-year time span between the flood event and data collection.

We used ten independent variables, including event exposure (serious home damage, adverse event experiences)

[16], gender, age (in years), socioeconomic status (financial difficulties) [28], access to medical care, Hispanic ethnicity, US citizenship status, and acculturation (foreign-birth, a lack of English-speaking proficiency). Table 1 provides details on variable construction for all variables and includes descriptive statistics and information about the level at which the variables were collected (i.e., respondent [head-of-household], household, or individual level). All continuous variables were standardized before entering them in the regression models.

We multiply imputed the missing values of all analysis variables (see Table 1) to address nonresponse bias. Multiple imputation (MI) involves creating multiple sets of values for missing observations using a regression-based approach [38, 39]. It is used to avoid the bias that can occur when missing values are not missing completely at random (MCAR) [40], and is appropriate for self-reported survey data [39, 41]. In SPSS, we specified 20 imputations to increase power with 200 between-imputation iterations to eliminate dependencies between the imputed datasets [41]. All analysis variables were included in the imputation phase. In order to report results for the variable means (Table 1), correlations (Table 3), odds ratios and significance levels (Table 4), we used SPSS to analyze each of the 20 imputed datasets and pool the results.

Data Analysis

Analyses were conducted in three steps. First, we calculated descriptive statistics for specific health conditions, the three dependent variables, and all independent variables (to address research question 1). To address research questions 2 and 3, we ran bi-variate correlations between the dependent and independent variables and we conducted logistic regression, using the suite of independent variables to predict each dependent variable. The first two multivariate models utilize all cases ($n = 475$); for the third model, we selected only individuals age 10 years and over with the assumption that children under 10 did not participate in post-flood cleanup ($n = 401$). Before finalizing the three models, we tested the independent variables for multicollinearity. While SPSS does not pool variance inflation factor (VIF) scores, in models run on the original dataset and on all 20 multiply imputed datasets, VIF values were under 2 for each independent variable, indicating the absence of multicollinearity problems.

Results

In reference to research question 1, 43 % of individuals had one or more physical health problem and 18 % had one or

² An expert translated the survey from English into Spanish; then the survey was reviewed by multiple bilingual English–Spanish graduate students, and revised to ensure clarity and comparability.

Table 1 Analysis variables: survey question, level, metric, and descriptive statistics

Variable	Survey question	Level ^a	Metric	Mean ^b	Range	Percent missing
Physical health problems	Did you or other members of your household experience the following health problems during or in the first four months after the 2006 flood? ^c	I	0 = No health problems experienced 1 = Yes, one or more health problems was experienced	0.430	0–1	12.0
Mental health problems	Did you or other members of your household experience the following health problems during or in the first four months after the 2006 flood? ^d	I	0 = No health problems experienced 1 = Yes, one or more health problems was experienced	0.183	0–1	12.0
Cleanup injuries and acute effects	Did you or other members of your household experience the following problems after the 2006 floods while cleaning or repairing flooded homes? ^e	I	0 = No injuries or acute effects were reported 1 = Yes, one or more injuries or acute effects was reported	0.278	0–1	18.3
Adverse event experiences	Which of the following happened to you during or soon after the 2006 flood? ^f	R	Sum of the 13 measures	2.665	0–9	0.0
Serious home damage ^g	What degree of damage did your home experience?	H	0 = Limited damage 1 = Serious damage	0.391	0–1	1.1
Sex	What is the individual's sex?	I	0 = Male 1 = Female	0.607	0–1	0.2
Age	What was the individual's age in 2006?	I	In years	35.675	1–92	2.5
Financial difficulties	How difficult was it for your household to make ends meet financially the year after the 2006 floods?	H	1 = Not at all difficult 2 = Slightly difficult 3 = Somewhat difficult 4 = Very difficult 5 = Extremely difficult	2.332	1–5	5.5
Access to medical care	Do you have a regular doctor or a clinic where you can go to for your routine medical care?	R	0 = No 1 = Yes	0.820	0–1	5.7
Hispanic ethnicity	Does the Hispanic racial/ethnic category best describe the people in your household?	H	0 = No 1 = Yes	0.772	0–1	5.3
Not a US citizen	Are you a US citizen?	R	0 = Yes 1 = No	0.112	0–1	2.5
Foreign-born	Were any members of your household born outside the US?	H	0 = No 1 = Yes	0.362	0–1	0.0

Table 1 continued

Variable	Survey question	Level ^a	Metric	Mean ^b	Range	Percent missing
Lack of English proficiency	How well do you speak English?	R	0 = Well or very well 1 = Not well or not at all	0.181	0–1	2.5

^a I = variable was collected at the level of the individual; R = variable was collected at the level of the respondent (i.e., head-of-household); H = variable was collected at the level of the household

^b Reported means are after data imputation

^c The physical health problems were: skin irritation, rashes or hives; nose irritation or sneezing fits, bloody noses, runny or congested sinuses; eye irritation, including burning, watering, itching, or redness; throat irritation or dry/hacking cough; allergies or hay fever; more allergies or hay fever than before the 2006 floods; asthma; more coughing/wheezing than before the 2006 floods; more coughing in sleep than before the 2006 floods; more asthma attacks than before the 2006 floods; more missed work/school because of coughing/wheezing; lung or airway irritations or inflammation; headaches; blurred vision; nausea; dizziness; gastrointestinal infection (such as shigellosis, cryptosporidiosis, *E. coli*, giardiasis); diarrhea, persistent vomiting; fever; hepatitis A; food poisoning; athlete's foot; or West Nile virus

^d The mental health problems were: depression or post-traumatic stress disorder

^e The cleanup injuries and acute effects were: strained muscles, ligaments, or tendons; injured a bone; got a sprain, bruise, or abrasion; slipped or fell; felt stiffness/soreness; got cut or wounded; got an electric shock; got burned (not by sun); felt very dizzy, light-headed, or nauseated; got poisoned by carbon monoxide; got heat exhaustion/heat stroke; got dehydrated; or got sunburned

^f Respondents' adverse event experiences included: was present when major flooding occurred; fled from home because water started flooding house; saw someone drowning or in danger of drowning; rescued by someone else and taken to a safe place; lost a pet or had to abandon one; feared for life/thought might be injured or killed during the floods; worried about crime; was victim of a crime; worried about family members or close friends living at risk of the floods; performed a dangerous activity; was stranded in an unsafe place during the floods; was separated from children who lived at home; or lost irreplaceable items

^g "Serious home damage" was defined as damage to the household's homes that could only be repaired by a professional contractor

Table 2 Post-flood health problems

Health condition	<i>n</i> with condition	%
<i>Physical, within 4 months of floods (n = 418)</i>		
Allergies or hay fever	93	22.2
More allergies or hay fever than before the 2006 floods	88	21.1
Throat irritation or dry/hacking cough	78	18.7
Headaches	71	17.0
Nose irritation—sneezing fits, bloody noses, runny or congested sinuses	67	16.0
More coughing/wheezing than before the 2006 floods	61	14.6
Eye irritation—burning, watering, itching, redness	57	13.6
Skin irritation—rashes or hives	45	10.8
More coughing in sleep than before the 2006 floods	45	10.8
Blurred vision	39	9.3
Lung or airway irritations or inflammation	36	8.6
Asthma	26	6.2
Dizziness	25	6.0
Diarrhea	21	5.0
More missed work/school because of coughing/wheezing	20	4.8
Athlete's foot	20	4.8
More asthma attacks than before the 2006 floods	19	4.5
Nausea	14	3.3
Fever	11	2.6
Gastrointestinal infection—such as shigellosis, cryptosporidiosis, <i>E. coli</i> , giardiasis	9	2.2
Persistent vomiting	5	1.2
Food poisoning	3	0.7
West Nile Virus	2	0.5
Hepatitis A	0	0.0
<i>Mental, within 4 months of floods (n = 418)</i>		
Depression	73	17.5
Post-traumatic stress	36	8.6
<i>Injuries and acute effects from participation in cleanup (n = 388)</i>		
Felt stiffness/soreness	83	21.4
Strained muscles, ligaments, tendons	64	16.5
Got a sprain, bruise, or abrasion	52	13.4
Slipped or fell	34	8.8
Got cut or wounded	33	8.5
Felt very dizzy, light-headed, or nauseated	32	8.2
Got dehydrated	21	5.4
Got sunburned	21	5.4
Injured a bone	10	2.6
Got heat exhaustion/heat stroke	10	2.6
Got an electric shock	5	1.3
Got burned (not by the sun)	3	0.8
Got poisoned by carbon monoxide	2	0.5

more mental health problem in the 4 months following the floods, while 28 % had one or more injury or acute effect due to participation in home site cleanup (Table 1). In terms of specific physical, mental and cleanup-related effects (Table 2), the most common physical health problems included allergies, throat irritations/coughing/

wheezing (and related exacerbations), headaches, and nose/eye/skin irritations. In terms of mental health, 17.5 % reported experiencing depression and 8.6 % post-traumatic stress. The most common injuries and acute effects related to cleanup were stiffness/soreness, strained muscles, and bruises/sprains/abrasions.

The prevalence rates reported for allergies/hay fever, asthma, depression and post-traumatic stress among El Paso County's flood-impacted population for the four-month period following the floods were higher than prevalence rates in the US population. The rate of allergies/hay fever reported (22.2 %) is substantially higher than the 12-month prevalence rates for the US adult and Hispanic adult populations (7.8 and 5.0 %, respectively), as well as the 12-month prevalence rate for US children aged 17 and under (9.5 %) [42, 43]. In terms of asthma, while the rate reported (6.2 %) is lower than the US prevalence rate (7.7 %) and higher than the US Mexican/Mexican–American-specific rate (5.8 %) [44], notably higher rates of asthma-related symptoms were reported, such as throat irritations (18.7 %), more coughing/wheezing than before the 2006 floods (14.6 %), and more coughing in sleep than before the 2006 floods (10.8 %). The rate of depression reported (17.5 %) is substantially higher than the 12-month prevalence rates for the US adult population (6.7 %) and the US population aged 12–17 years (8.5 %), as well as the lifetime prevalence for adolescents 13–18 years of age (11.2 %) [45–47]. It also exceeds the prevalence of current depression of all types for the US total population (9.1 %) and the US Hispanic population (11.7 %) [48]. Finally, the rate of post-traumatic stress reported (8.6 %) is more than two times higher than the 12-month prevalence rate for the US adult population (3.5 %) and the lifetime prevalence for adolescents 13–18 years old (4.0 %) [45, 46]. Based on these comparisons, it is clear that the prevalence of these health conditions among El Paso's flood-impacted population following the disaster substantially exceeded prevalence rates in the general population.

To address research questions 2 and 3, we ran correlations (Table 3). Then, we used logistic regression to investigate how multiple factors influenced the likelihood of individuals experiencing post-flood health problems, based on analyses of the three dependent variables.³ With

³ To explore interrelationships between independent variables, we ran supplemental subgroup and interaction analyses. Using only Hispanic subjects, results for the physical health problems and mental health problems models were nearly identical to the model results reported in Table 4 for all subjects. The same independent variables were significant in the same directions. For the Hispanic cleanup injuries/acute effects model, two variables became significant (the relationships were in the same direction as in the model using all subjects). Access to medical care was associated with significantly lower odds, and foreign-birth significantly higher odds, of cleanup injuries/acute effects. This foreign-born effect is probably due to increased participation rates in home site cleanup among people from households with foreign-born members, necessitated by their relatively constrained access to cleanup assistance from organizations involved in providing post-disaster aid. Then, using all subjects we explored interactions between Hispanic ethnicity and each of the variables with significant results in the physical health problems, mental health problems and cleanup injuries/acute effects models that

respect to regression findings for physical health problems, there is relatively good model fit, and results reveal seven statistically significant ($P < 0.05$) findings (Table 4). In terms of risk factors, each standard deviation increase in adverse event experiences (i.e., approximately 2 experiences), age (i.e., approximately 22 years) and financial difficulties (i.e., approximately 1 unit on a 5-point scale), respectively, is associated with a 98, 100 and 116 % increase in the likelihood of having one or more physical health problem after the floods. Hispanic ethnicity is associated with a 149 % increase—and non-US-citizenship a 358 % increase—in the likelihood of physical health problems. In terms of protective factors, access to medical care is associated with a 65 % decrease in the likelihood of post-flood physical health problems, while a lack of English-speaking proficiency is associated with a 74 % decrease.

The regression model predicting mental health problems (depression and/or post-traumatic stress) demonstrates relatively good model fit with seven statistically significant predictors (Table 4). In terms of risk factors, each standard deviation increase in adverse event experiences, age and financial difficulties, respectively, predicts a 93, 112 and 207 % increase in the likelihood of having post-flood mental health problems. Non-US-citizenship is associated with a 316 % increase in the likelihood of mental health problems. Results highlight three protective factors: access to medical care is associated with a 70 % decrease in the likelihood of post-flood mental health problems, while foreign-birth and a lack of English-speaking proficiency are associated with 60 and 71 % decreases, respectively.

Results for the regression model predicting cleanup-related injuries and acute effects reveal relatively good model fit and four statistically significant risk factors (Table 4). Each standard deviation increase in adverse event experiences, age and financial difficulties, respectively, predicts a 58, 88 and 93 % increase in the likelihood of having an injury or acute effect due to participation in flood cleanup. Additionally, having serious flood damage to one's home is associated with a 143 % increase in the likelihood of having one or more flood cleanup-related injuries or acute effects.

Footnote 3 continued

we report in Table 4. The only statistically significant interaction term was “Hispanic ethnicity \times adverse event experiences” in both the physical health problems and mental health problems models, demonstrating that Hispanic ethnicity modified the effect of adverse event experiences. Adverse event experiences were more strongly related to physical and mental health problems for Hispanics than for non-Hispanics, but the effects were positive for both subgroups. This highlights the increased health risk for Hispanics who experienced flood-related stressors.

Table 3 Correlations among analysis variables

Variable	A	B	C	D	E	F	G	H	I	J	K	L
<i>(A) Physical health problems</i>												
Corr.	1											
Sig.												
<i>(B) Mental health problems</i>												
Corr.	0.431	1										
Sig.	0.000											
<i>(C) Cleanup injuries and acute effects</i>												
Corr.	0.458	0.313	1									
Sig.	0.000	0.000										
<i>(D) Adverse event experiences</i>												
Corr.	0.350	0.320	0.289	1								
Sig.	0.000	0.000	0.000									
<i>(E) Serious home damage</i>												
Corr.	0.151	0.189	0.314	0.214	1							
Sig.	0.002	0.000	0.000	0.000								
<i>(F) Sex</i>												
Corr.	0.058	0.036	0.029	0.011	0.049	1						
Sig.	0.237	0.448	0.583	0.828	0.292							
<i>(G) Age</i>												
Corr.	0.158	0.157	0.147	-0.055	0.047	0.015	1					
Sig.	0.001	0.001	0.007	0.236	0.318	0.744						
<i>(H) Financial difficulties</i>												
Corr.	0.377	0.377	0.338	0.358	0.198	0.050	-0.092	1				
Sig.	0.000	0.000	0.000	0.000	0.000	0.283	0.049					
<i>(I) Access to medical care</i>												
Corr.	-0.160	-0.177	-0.145	-0.052	-0.236	-0.001	0.077	-0.112	1			
Sig.	0.001	0.000	0.007	0.283	0.000	0.981	0.106	0.023				
<i>(J) Hispanic ethnicity</i>												
Corr.	0.189	0.102	0.190	0.215	-0.031	-0.001	-0.193	0.187	0.009	1		
Sig.	0.000	0.031	0.000	0.000	0.513	0.979	0.000	0.000	0.862			
<i>(K) Not a US Citizen</i>												
Corr.	0.177	0.147	0.179	0.165	-0.050	0.034	-0.105	0.268	-0.028	0.159	1	
Sig.	0.000	0.002	0.000	0.000	0.285	0.460	0.023	0.000	0.545	0.001		
<i>(L) Foreign-born</i>												
Corr.	0.147	-0.013	0.123	0.263	-0.043	-0.076	-0.128	0.211	-0.073	0.284	0.136	1
Sig.	0.003	0.785	0.022	0.000	0.358	0.099	0.006	0.000	0.127	0.000	0.003	
<i>(M) Lack of English proficiency</i>												
Corr.	0.119	0.096	0.115	0.230	-0.114	0.047	-0.088	0.336	-0.089	0.210	0.650	0.216
Sig.	0.013	0.041	0.027	0.000	0.014	0.322	0.060	0.000	0.061	0.000	0.000	0.000

Pearson correlations are reported for multiply imputed data. The total n for all reported variables is 475, except for the “Injuries and other acute effects” variable, which includes individuals more than 9 years of age only ($n = 401$)

Discussion

We found that the disaster had negative health impacts, which were disproportionately experienced depending on event exposure, demographic and socioeconomic characteristics. Findings for adverse event experiences align

with prior mental health studies, and reveal that more severe event exposure influenced negative physical, mental and cleanup-related health outcomes. Controlling for the effects of other variables, serious home damage was a significant predictor of cleanup-related injuries and acute effects only.

Table 4 Logistic regression results: predicting (A) physical health problems, (B) mental health problems, and (C) cleanup injuries and acute effects

Variable	(A) Physical health problems ^a			(B) Mental health problems ^b			(C) Cleanup injuries and acute effects ^c		
	Odds ratio	SE	P value	Odds ratio	SE	P value	Odds ratio	SE	P value
Adverse event experiences	1.98	0.147	0.000	1.93	0.175	0.000	1.58	0.142	0.001
Serious home damage	0.89	0.265	0.664	0.99	0.361	0.980	2.43	0.289	0.002
Sex	1.28	0.248	0.315	1.11	0.325	0.745	1.01	0.275	0.976
Age	2.00	0.135	0.000	2.12	0.170	0.000	1.88	0.139	0.000
Financial difficulties	2.16	0.144	0.000	3.07	0.194	0.000	1.93	0.149	0.000
Access to medical care	0.35	0.333	0.002	0.30	0.386	0.002	0.64	0.334	0.186
Hispanic ethnicity	2.49	0.316	0.004	1.70	0.431	0.218	0.79	0.314	0.448
Not a US citizen	4.58	0.506	0.003	4.16	0.576	0.014	1.54	0.581	0.456
Foreign-born	1.12	0.277	0.694	0.40	0.375	0.015	1.52	0.291	0.148
Lack of English proficiency	0.26	0.471	0.005	0.29	0.588	0.028	0.50	0.493	0.157

For model fit, we report the range of Cox & Snell and Nagelkerke R² statistics for the original data and the 20 multiply imputed datasets

^a Model fit: Cox & Snell R² = 0.269–0.298; Nagelkerke R² = 0.361–0.400

^b Model fit: Cox & Snell R² = 0.243–0.273; Nagelkerke R² = 0.395–0.444

^c Model fit: Cox & Snell R² = 0.189–0.261; Nagelkerke R² = 0.272–0.372

Results for socioeconomic status align with previous studies [5, 16]. Low socioeconomic status emerged as the most robust social predictor of negative post-disaster health outcomes in this study, along with older age. The association found here between older age and negative health outcomes contradicts most prior post-disaster research showing older age to be protective against mental health problems. The apparent resilience of older adults has been explained by the experience and maturity that come with age [49]. However, our results show older age to be associated with worse mental health outcomes, which aligns with several studies following disasters outside of the US [50–52], and physical health outcomes. Theoretically, because adults’ physical capacities deteriorate through time, older age is a risk factor for health impacts in disasters, a hypothesis which our findings empirically support. Additionally, women were not at an increased risk, which diverges from most prior studies, except for a few focused on similar lower-magnitude flood disasters [16].

Despite medical care being a fundamental resource for mitigating negative health impacts, the effect of access to medical care on disaster health outcomes has not been analyzed. We found access to routine medical care to be protective against negative post-disaster physical and mental health effects, which generally corresponds with prior work indicating that having better access to social resources protects mental health in disasters [16].

For racial/ethnic minority and immigrant status, results show that non-US citizenship and English-speaking proficiency significantly predict health problems in two models, while Hispanic ethnicity and native-birth are significant

predictors in one model. These results suggest that certain dimensions of minority and immigrant status are risk factors, while others are protective factors, in the context of disaster in this immigrant gateway community. Hispanic ethnicity and a lack of citizenship emerged as post-disaster risk factors, which can be generally explained by their connections with social vulnerability and constrained resource-access in the US. There are three more proximate explanations for these results. One, minority groups tend to be marginalized in locations where the risks of exposure and disaster-related impacts are greater [27]. For example, Perilla and colleagues [53] found that post-traumatic stress following Hurricane Andrew was higher among Hispanics and blacks than for whites, and that the severity of exposure accounted for much of the minority group members’ heightened distress. Two, minorities and immigrants have relatively insecure livelihoods (as compared to native-born non-Hispanic whites), which amplifies disaster impacts [27]. Notably, we found that Hispanic ethnicity and non-US citizenship have significant bi-variate correlations with more adverse event experiences and greater financial difficulties (i.e., lower socioeconomic status). However, controlling for adverse event experiences and financial difficulties using logistic regression, these variables still emerged as risk factors, which suggests that the combination of greater exposure and social vulnerability amplified health risks for Hispanic and non-US citizen groups. Three, for non-citizen immigrants in particular, they are more likely to lack protective assistance (including healthcare). Aside from the formal denial of access to public assistance experienced by those without legal US residency status, barriers related to language, social isolation and fear may

impede non-citizens from accessing information and services that could mitigate disaster health impacts [53].

A lack of English-speaking proficiency and foreign-birth, two variables closely connected with Hispanic immigrant status in El Paso County, emerged as protective factors when controlling for the effects of other variables. This may reflect the “Hispanic Health Paradox” [54], which refers to the fact that the health of US Hispanics, especially those of Mexican-origin, is favorable relative to other minority groups [55–57]. In terms of why these variables were protective, we propose two explanations. One, there are strong familial, social and economic ties among some migrant groups, including US Hispanics [58], which might be protective in the context of disaster [29]. Two, research on Mexican-origin individuals in the US shows that lower acculturation to dominant US behavioral norms has protective health effects [54]. For example, foreign-born immigrants are healthier than their native-born counterparts upon arrival, but their health advantage declines with time in the US [59]. A lack of English proficiency also reflects lower acculturation. While findings can be explained based on the role of lower acculturation in the “Hispanic health paradox”, they also seem counterintuitive given the fact that English deficiencies may impede immigrants from accessing information and services for self-protection [53]. It is important to note that, in contrast to many US localities, there are high levels of Hispanic cultural competence among El Paso County’s healthcare practitioners and service providers (e.g., many speak Spanish). This raises a question that can only be addressed via disaster health disparities research in other US locations: Is a lack of English proficiency generally protective against disaster health impacts, or is it only protective in contexts where it does not present additional cultural barriers to safety?

Limitations

The study has four primary limitations. First, the time between the flood disaster and data collection was relatively long, an issue that we believe was best addressed by using a logistic regression approach. Second, the individual level health data for household members were reported by heads-of-households, who may have had incomplete knowledge. These two limitations mean that underreporting of health conditions through the survey was possible. It is also possible that some physical and mental health problems experienced within 4 months of the flood disaster (as reported by respondents) were not directly attributable to event exposure. Third, it is important to recognize that depression and PTSD are clinical terms; affirmative responses to having these conditions could have been

prompted by doctors’ diagnoses or respondents’ own assessments. This likely imparts some inaccuracy to these measures, making comparisons of the prevalence of mental health problems between flood victims and general populations imperfect. Fourth, we believe that some households did not report flood damage to the City of El Paso (including people seeking to avoid contact with government workers). We were able to partially address this issue by including separate data for households with flood damage collected by a non-governmental relief organization (the American Red Cross).

Conclusion

In conclusion, this study is among the first to adequately decompose factors influencing physical health disparities among US Hispanics following a disaster. Findings show that the flood disaster had significant negative health impacts, which disproportionately burdened people who were more heavily exposed, poorer, older, and lacking access to resources. Findings also highlight salient racial/ethnic- and immigration-related dimensions of disaster health disparities in the context of a Hispanic immigrant gateway. In this context, processes of social stratification are closely connected to the ability to speak English as well as to the relative advantages conferred by native-birth and US citizenship (and, conversely, by the relative disadvantages associated with foreign-birth and non-US citizenship). Based on the clear social disadvantages associated with Hispanic immigrant status as well as prior research findings [16, 60], it might be expected that Hispanic ethnicity, non-US citizenship, foreign-birth and a lack of English-speaking proficiency would all predict negative post-disaster health outcomes. Interestingly, this was not found. Instead, findings suggest that a lack of acculturation (foreign-birth, a lack of English proficiency) was protective, while a lack of resource entitlement (US citizenship) was a health risk factor, for Hispanic immigrants affected by a flood disaster. To better understand the role of race/ethnicity and immigration in disaster health disparities, more research investigating contextually-relevant indicators, as well as hazard-specific physical and mental health outcomes, is needed.

Acknowledgments Marilú Gamez, from the University of Texas at El Paso (UTEP) Languages and Linguistics Department, provided invaluable expertise with survey translation. UTEP students Lorena Sifuentes and Yolanda McDonald assisted with survey administration and data entry. We acknowledge Bill Hargrove from the Center for Environmental Resource Management at UTEP for providing summer research assistantship funding. This project was supported primarily by Award Number P20MD002287 from the National Institute on Minority Health and Health Disparities (NIMHD). The content is solely the responsibility of the authors and does not necessarily

represent official views of the NIMHD or the National Institutes of Health.

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