

ENVIRONMENTAL DETERMINANTS

Intra-Ethnic Disparities in Respiratory Health Problems Among Hispanic Residents Impacted by a Flood

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Objectives. The primary objective of this article is to assess the respiratory health impacts of a flood disaster on Hispanic people residing in the United States, with a focus on intra-ethnic disparities related to age, sex, socioeconomic status, mold exposure, family conflict, English-language proficiency, and a lack of US citizenship. **Methods.** Data were collected in 2010 after a flood disaster (2006) in El Paso County (Texas), which has a Hispanic majority population. A mail-out population-based survey was used retrospectively to assess respiratory health impacts for 363 people residing in 176 self-identified Hispanic households impacted by the flood; logistic regression was utilized to assess intra-ethnic health disparities in flood impacts. **Results.** About 41% of individuals experienced one or more post-flood respiratory health problem. Lower income (OR = 0.532, $p = .002$), mold exposure (OR = 2.267, $p < .001$), increased family conflict (OR = 1.452, $p = .025$), English-language proficiency (OR = 4.023, $p < .001$) and a lack of US citizenship (OR = 13.111, $p = .013$) were significantly associated with higher odds of respiratory health problems in the regression model. **Conclusion.** Statistical findings provide evidence of intra-ethnic disparities in post-flood respiratory health status. Specifically within this Hispanic sample, individuals with lower household incomes, whose homes were covered by larger surface areas of mold, and whose families were characterized by increased tension experienced higher odds of post-flood respiratory health problems. Interestingly, greater English-language proficiency and lacking US citizenship were also risk factors. Given that this is one of the first studies of intra-Hispanic disparities in health following a US-based disaster, the findings underscore the importance of considering diversity within the US Hispanic population when studying environmental and post-disaster respiratory health.

Keywords disaster, respiratory health, language acculturation, El Paso (TX), Hispanic health disparities

INTRODUCTION

Between 27 July and 7 September 2006, El Paso County (Texas, USA) received more than two times its average annual rainfall. An estimated 1500 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 the disaster, the event induced substantial health effects, especially among residents whose homes were damaged (1). This study focuses on intra-ethnic disparities in how post-flood social and physical environmental conditions impacted Hispanic people's respiratory health (e.g., asthma). We describe the adverse respiratory problems that Hispanic people experienced and test the relative importance of age, sex, socioeconomic status, mold exposure, family conflict, language acculturation, and political marginality in predicting post-flood respiratory health problems. In this study, "respiratory health problems" include asthma attacks, coughing and wheezing, or lung/airway irritation or inflammation.

While not focused on determinants of health impacts within Hispanic populations, previous research suggests that young children, the elderly, females, and people of low socioeconomic status are at high risk for health problems post-disaster (2, 3). The focus on respiratory health

is warranted because of its close association with flood impacts (4–6). In terms of physical environmental exposure, flood damage produces conditions conducive to the development of mold and other aeroallergens in homes (7–10). Mold that develops in flood-damaged homes releases mycotoxin-containing spores that can inflame pulmonary tissues and trigger asthma and other respiratory conditions (11). It is well documented that mold and water-damage in buildings is associated with an increased risk of respiratory health problems among occupants (12–16). The trauma and disruption that follows disasters can also contribute to increased family conflict (17–19), which is linked to psychological stress and the worsening of asthma in both children and adults (20, 21). The impact of family conflict on the mental health of household members after disaster is well documented in the literature (2, 22–24), but it has been investigated to a much lesser degree in the physical health impacts literature.

The literature also reveals that racial/ethnic minority groups (e.g., Hispanics) are more prone to adverse post-disaster health impacts as compared to majority groups (e.g., non-Hispanic whites) (2, 25). Scholars have paid very little attention, however, to *intra-racial/ethnic* heterogeneity in post-disaster health impacts, for example, disparities among Hispanic individuals. While investigations of inter-racial/ethnic health disparities are important, such studies typically neglect to examine the role of heterogeneity within ethnic groups in terms of socioeconomic status, age, sex and other documented social determinants

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of health inequalities (26). In one of the only post-disaster studies to examine intra-racial/ethnic group disparities in health problems, Norris and colleagues (27) found that post-Hurricane Katrina post-traumatic stress disorder symptoms were highest among Vietnamese Americans who had low (as opposed to high) levels of US acculturation. No similar study of intra-Hispanic disparities (i.e., within-group differences) in post-disaster health problems has been conducted in the United States. Political marginality among ethnic minority groups (e.g., a lack of US citizenship) has also received surprisingly little attention in the disaster health literature, yet it is a likely risk factor given El Paso County's US–Mexico border location, immigrant gateway status, and predominantly Hispanic population.

Given that by 2050 29% of US population will be Hispanic, considerations of intra-Hispanic diversity are paramount to an expanded understanding of health disparities in the United States. Additionally, Hispanic residents of the US–Mexico border region may be particularly at risk for respiratory exacerbations. A previous study found that while Hispanic children in Texas had lower hospitalization rates for asthma than non-Hispanic children in 2000, their risk of hospitalization was 1.64 times greater if they resided in the border region of the state, as compared to the non-border region (28).

Study Area and Research Questions

According to the US Census 2006 American Community Survey, 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 were 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%), making it an ideal location to examine intra-Hispanic respiratory health disparities (29). 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%) (29).

Unlike most US disasters, the 2006 floods impacted an immigrant gateway (30) at the Mexican border, comprising a highly heterogeneous Hispanic population. This context makes the focus on Hispanics, language acculturation (based on English proficiency for writing and speaking), and political marginality particularly relevant. In 2006, just 24.1% of El Paso County residents spoke only English, while 73.6% spoke Spanish and 17.5% of the county's Spanish speakers did not speak English well or at all (29). Furthermore, 16.4% of county residents were not US citizens.¹ Because Hispanics comprise the largest and fastest growing minority group in the United States, there is a need to advance understanding of Hispanic health disparities in disasters.

The primary research questions addressed in this study are:

- (1) Did the 2006 flood disaster impact the respiratory health of Hispanic people who experienced home damage?
- (2) How are the factors of age, sex, socioeconomic status, mold exposure, family conflict, language acculturation, and political marginality associated with post-flood respiratory health problems for Hispanic people who experienced home damage?

METHODS

Participants

Targeted participants were heads-of-households (over 18) who reported home site damage following the disaster to the City of El Paso and/or the American Red Cross. All targeted participants experienced flood damage to their home that was significant enough to warrant them reporting it to the City and/or Red Cross in response to solicitations offering to link impacted households with recovery resources. Therefore, only those households that reported home site damage following the disaster were included in the sampling frame. After the flood, both the City and the Red Cross collected address information for El Paso County households that reported flood damage. Because the address data were applicable for 2006, 2006 addresses were triangulated to 2010 addresses using reverse directories and phone books.

Data Collection

Using a retrospective survey design, data were collected through a mail survey that was approved by The University of Texas at El Paso's Institutional Review Board (approval number 152171–1). The survey was administered using the tailored design method (31) to obtain the highest achievable response rates by personalizing communication, following-up with non-respondents, and offering incentives. All survey materials were provided to heads of household² in English and Spanish.³ The head of household provided information at three levels: (1) individual (about each member of the household), (2) respondent (about themselves), and (3) household.

Beginning on 26 May 2010, mailings were sent to the flood-impacted 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; and (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. From the 1031 addresses in our initial sampling frame, 247 surveys were returned as undeliverable by the post office due to wrong mailing address information, leaving us with a final sampling frame of 784 households. Of these 784 flood-impacted households, 176 householders completed surveys (28 in Spanish and 148 in English). Because the survey was designed to capture individual-level data for every member of each

household, the 176 surveys yielded data for 475 individuals.

The ethnicity that the head of household self-reported for the entire household was used to select individual cases for analysis. Of the 176 householders who completed surveys, 117 selected “Hispanic or Latino” as the racial/ethnic category that best described the members of their household as opposed to “American Indian/Native American (not of Hispanic origin)”; “White (not of Hispanic origin)”; “Black (not of Hispanic origin)”; “Asian or Pacific Islander (not of Hispanic origin)”; or “Other”. All 363 individuals residing in these 117 “Hispanic” households were included in our analysis. The 112 individuals residing in the 59 households that did not identify as “Hispanic or Latino” were excluded from the analysis.

For the 117 Hispanic households, the mean household size was 3.1 (SD: 1.8; range: 9), while the mean number of children under 18 years old per household was 1.1 (SD: 1.3, range: 6). The mean age of individuals in those households was 33.3 years (SD: 21.4, range: 81). Additionally, 33% of the Hispanic heads of households identified as male while 67% identified as female.

Measures

Survey development was informed by previous disaster health survey research (2, 8). All variables are derived from self-reported measures, recalled by heads of households (see 2, 32–34). A dichotomous respiratory health variable was used as the dependent variable. This variable was created from data collected in response to the question: “Did you or other members of your household experience these health problems during or in the first 4 months after the 2006 floods?” The head of household then marked “Yes” or “No” for the following items for him/herself and for each member of the household: asthma (attacks); more coughing or 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 or wheezing; and lung or airway irritations or inflammation. The dichotomous respiratory health problem variable was coded 1 if the individual (as identified by the head-of-household) had one or more of those problems or symptoms; it was coded 0 if the individual had none of those problems or symptoms.

Seven independent variables, also reported by the head of household, were used in the following domains: age (under 15 years, over 64 years), sex, socioeconomic status (income), mold exposure (surface area in home covered by mold, based on 35),⁴ family conflict (based on 17),⁵ language acculturation, and political marginality (lack of US citizenship) in predicting respiratory impacts post-flood. Table 1 provides details on variable construction and includes descriptive statistics. All continuous variables were standardized before entering them in the regression models.

To address nonresponse bias, the missing values of all analysis variables were multiply imputed (see Table 1).

Multiple imputation (MI) is currently a best practice for addressing missing data in statistical analysis (38–40). MI involves creating multiple sets of values for missing observations using a regression-based approach. It is used to avoid the bias that can occur when missing values are not missing completely at random (MCAR) (42) and is appropriate for self-reported survey data (41). In SPSS,⁶ 20 imputed data sets were specified to increase power and 200 between-imputation iterations were used to ensure that the resulting imputations were independent of each other (42). Using 20 data sets is the current “rule of thumb” in MI as it maximizes power (as opposed to using 3–5 data sets, which used to be the convention) and improves the validity of multi-parameter significance tests (42). Analyzing a single imputed data set would effectively treat the filled-in values as real data, so even the best imputation technique, when used with just one imputed data set may underestimate sampling error. MI techniques appropriately adjust the standard errors for missing data (42). All analysis variables were included in the imputation phase. In order to generate results that we report for the variable means (Table 1), odds ratios and significance levels (Table 2), the SPSS Missing Values add-on ran the statistics 20 times (once per imputed data set) and then pooled the results so that only one mean, one odds ratio and one significance level are provided for each variable.

Data Analysis

The analysis was conducted in three steps. First, to address research question 1, descriptive statistics were calculated for the dichotomous respiratory health problem variable and each of the six respiratory health indicators combined in that dependent variable (see Table 3). To address research question 2, logistic regression was conducted (see Table 2), using the suite of independent variables to predict the dependent variable (1 = one or more respiratory health problems and 0 = none). Before finalizing the regression model, independent variables were tested for multicollinearity. While SPSS does not pool variance inflation factor (VIF) scores, in the models run on the original data set and on all 20 multiply imputed data sets, VIF values were under 2 for each independent variable, indicating the absence of multicollinearity problems.

RESULTS

In reference to research question 1, 41% of the 363 Hispanic individuals in our study experienced at least one respiratory health problem after the flood (based on self-reporting by heads of households). In terms of specific respiratory health problems encountered, the most common were more coughing or wheezing than before the 2006 floods, more coughing in sleep than before the 2006 floods, and asthma (Table 3).

In regards to research question 2, there were five statistically significant regression results ($p < .05$) and relatively

TABLE 1.—Analysis variables: survey question, response level, response values, and descriptive statistics ($n = 363$).

Variable	Survey question	Response level ^a	Response values	Mean ^b	Standard deviation ^c	Range	Percent missing
Respiratory health problems	Did the individual experience any respiratory health problems in the first four months after the flood? ^d	I	0 = No respiratory health problems experienced 1 = Yes, one or more respiratory health problems were experienced	0.413	0.488–0.499	0–1	26
Age under 15 years	Was the individual's age in 2006 under 15?	I	0 = No 1 = Yes	0.283	0.449–0.456	0–1	3
Age over 64 years	Was the individual's age in 2006 over 64?	I	0 = No 1 = Yes	0.070	0.248–0.268	0–1	3
Sex	What is the individual's sex?	I	0 = Male 1 = Female	0.608	0.488–0.490	0–1	<1
Income (socio-economic status)	Which of the following best describes your total household income over the 12 months after the 2006 floods?	H	1 = Less than \$1999 2 = \$2000–\$4999 3 = \$5000–\$9999 4 = \$10,000–\$19,999 5 = \$20,000–\$29,999 6 = \$30,000–\$39,999 7 = \$40,000–\$49,999 8 = \$50,000–\$59,999 9 = \$60,000–\$69,999 10 = \$70,000–\$79,999 11 = \$80,000–\$89,000 12 = \$90,000–\$99,999 13 = \$100,000–\$149,999 14 = \$150,000 or more	6.529	3.139–3.356	1–14	15
Mold exposure	How much surface area in the home was covered by mold?	H	1 = None 2 = Less than about 10 sq. ft. (<a 3' X 3' patch) 3 = Between 10 sq. ft. and 25 sq. ft. (>a 3' X 3' patch, <a 5' X 5' patch) 4 = Between 25 sq. ft. and 100 sq. ft. (>a 5' X 5' patch, <a 10' X 10' patch) 5 = More than 100 sq. ft. (>a 10' X 10' patch)	2.289	1.466–1.525	1–5	5
Family conflict	Comparing the 12 months leading up to the 2006 floods with the 12 months immediately after it, would you say that there was more or less arguing, quarreling, disagreement, or tension between members of your household?	H	1 = Much less after 2 = A little less after 3 = No difference after 4 = A little more after 5 = Much more after	3.503	0.866–0.907	1–5	8
English proficiency (language acculturation)	How well do you speak/write English? ^e	R	2 = Not at all 4 = Not well 6 = Well 8 = Very well	6.649	1.868–1.899	2–8	8
Not a US citizen (political marginality)	Are you a US citizen?	R	1 = No 0 = Yes	0.147	0.343–0.370	0–1	3

Notes: ^aI = variable was collected at the level of the individual; R = variable was collected at the level of the household; H = variable was collected at the level of the household.^bReported means are after data imputation. For all dichotomous variables, which are coded 0–1, the mean is interpretable as the proportion of cases with a value of 1.^cSPSS does not generate pooled results for the standard deviation. Therefore, we report the range of standard deviation statistics for the original data and the 20 multiply imputed data sets.^dRespiratory health problems include: 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.^eEnglish proficiency is the sum of two variables: (a) English speaking proficiency and (b) English writing proficiency.

TABLE 2.—Logistic regression results^a predicting one or more respiratory health problem.

Variable	B	Odds ratio	SE	p-value	95% CI
Female	0.307	1.359	0.302	.310	0.751–2.460
Age under 15 years	0.260	1.297	0.327	.427	0.682–2.467
Age over 64 years	−0.449	0.638	0.669	.502	0.171–2.375
Income	−0.631	0.532	0.196	.002	0.361–0.784
Mold exposure	0.818	2.267	0.188	.000	1.564–3.285
Family conflict	0.373	1.452	0.165	.025	1.048–2.011
English proficiency	1.392	4.023	0.372	.000	1.905–8.495
Not a US citizen	2.573	13.111	1.002	.013	1.748–98.331

Notes: ^aFor model fit, we report the range of Cox & Snell and Nagelkerke R^2 statistics for the original data and the 20 multiply imputed data sets: Cox & Snell R^2 = 0.201–0.347; Nagelkerke R^2 = 0.271–0.465.

TABLE 3.—Post-flood respiratory health problems ($n = 363$).

Respiratory health problem experienced in the 4 months following the flood	% with health problem
More coughing or wheezing than before the 2006 floods	25.8
More coughing in sleep than before the 2006 floods	22.1
Asthma (attacks)	19.8
More asthma attacks than before the 2006 floods	17.5
More missed work/school because of coughing or wheezing	15.5
Lung or airway irritation or inflammation	14.3
One or more of the respiratory health problems	41.3

good model fit (Table 2). Every standard deviation increase in income (approximately 3.5 units on a 14-point scale) was associated with a 47% (95% CI: 22%–64%) decrease in the likelihood of having one or more respiratory health problem after the floods. Standard deviation increases in mold exposure (i.e., approximately 1.5 units on a 5-point scale), family conflict (i.e., approximately 1 unit on a 5-point scale), and English-language proficiency (i.e., approximately 2 units on an 8-point scale) were associated with 127% (95% CI: 56%–229%), 45% (95% CI: 5%–101%), and 302% (95% CI: 91%–750%) increases in the likelihood of having one or more respiratory health problem after the floods, respectively. Additionally, lacking US citizenship was associated with a 1211% (95% CI: 75%–9733%) increase in the likelihood of experiencing a respiratory health problem. Results for the age and sex variables did not approach statistical significance.

DISCUSSION

This study assessed intra-ethnic dimensions of post-disaster respiratory health disparities by focusing specifically on a Hispanic population situated along the US–Mexico border in El Paso County, Texas (where 95% of the Hispanic population is of Mexican-origin (43)). It was notable that nearly half of individuals experienced at least one respiratory health problem after the flood, especially given that people of Mexican-origin in the United States

have relatively low rates of asthma (44). Regression model findings indicate that sex and age were not statistically significant factors influencing post-flood respiratory health problems; in terms of directionality, women (as compared to men) and children (as compared to adults) had increased odds of a respiratory problem, while those over the age of 64 (as compared to adults) had lower odds. Other characteristics of individuals' social and environmental contexts were statistically significantly associated with increased risks. Respiratory health problems were disproportionately experienced by Hispanic individuals with lower socioeconomic status (OR = .532, $p = .002$), by those whose homes contained larger surface areas of mold (OR = 2.267, $p < .001$), and by those whose families experienced relatively greater conflict (OR = 1.452, $p = .025$). Additionally, respiratory health problems were experienced disproportionately by Hispanic people in households with more language acculturated (OR = 4.023, $p < .001$) and/or politically marginalized (OR = 13.111, $p = .013$) decision-makers (i.e., heads of household with greater English proficiency, without US citizenship).

With respect to the association found between lower household income and respiratory health problems, a similar relationship between socioeconomic status and post-disaster health problems has been documented in numerous studies (2, 3, 45, 46). In light of the intra-ethnic focus of this study, however, this finding suggests that lower socioeconomic status within the Hispanic population (which is typically examined as a homogenous group) heightened post-disaster risks for respiratory health problems. Results also indicate that, the greater the residential exposure to mold among Hispanic individuals following the flood, the greater the likelihood that they experienced respiratory problems. This aligns with previous research establishing that mold acts as a trigger of respiratory health problems (11, 47). In terms of family conflict, on average, households were characterized by a slight increase in the amount of quarreling, arguing, and familial tension in the 12 months immediately following the floods than in the 12 months prior to the disaster (Table 1). Our logistic regression model indicates that individuals experiencing increased post-flood family conflict were more susceptible to respiratory health problems. Increased family conflict hypothetically creates a more stressful social environment for individuals who may otherwise lack alternative forms of social support. It may be that the added stress present in households with greater family conflict heightened individuals' likelihood of respiratory health exacerbations (20). While others have documented adverse mental health effects of family conflict following disaster (e.g., 22), our findings reveal statistically significant ($p < .05$) physical health consequences (i.e., increased odds of a respiratory health problem) associated with increased family conflict post-disaster.

Interestingly, study results suggest that English-language proficiency acted as a risk factor in Hispanic individuals' respiratory health problems following the flood disaster. While one may assume that English-

language proficiency among heads of households would be a protective factor in individuals' post-flood respiratory health due to improved cultural competency and resource access (e.g., for remediating flood-damaged homes or receiving respiratory health care), this was not the case. Instead, Hispanic flood victims were better protected from respiratory health problems following the 2006 flood disaster when heads of their households were less language acculturated (in terms of English proficiency). This result contradicts prior research suggesting that lower acculturation among Vietnamese Americans acts as a barrier to positive post-disaster health outcomes (27). Instead, it aligns with research documenting a "Hispanic Health Paradox" (48), which suggests that, among US-based Mexican-origin individuals, those who display low acculturation to US-dominant norms are better protected against adverse health effects, including asthma (49, 50). English-language proficiency also significantly predicted increased odds of mental and physical health problems among residents after this El Paso County flood (1). This English-language finding may appear to be counterintuitive, considering that English-language proficiency could provide Hispanic immigrants or other Spanish-speaking individuals with greater access to information about disaster recovery and healthcare resources (51). Notably, El Paso's location along the US–Mexico border situates residents in a region where many healthcare services are offered in Spanish by Spanish-speaking professionals or by assistants and technicians serving as informal interpreters (52). It may be that less English proficiency was associated with decreased risk for respiratory health problems due to the protective effects of lower levels of acculturation and the high levels of Hispanic cultural competency (specifically, Spanish-language proficiency) exhibited by the region's healthcare providers. Better understanding of this intra-ethnic disparity requires further post-disaster health research with US Hispanic populations in both border and non-border contexts (where Hispanic cultural competency is lower among healthcare providers).

Lastly, results indicate that political marginality was a respiratory health risk factor following the flood disaster. It was also a risk factor for developing mental and physical health problems for El Paso County residents after this flood (1). Lacking US citizenship is linked to constrained resource access (e.g., to healthcare or public assistance). Research has shown that Hispanic people who are non-US citizens are more likely to experience constrained access to health care than those with citizenship status (53), especially since the 1996 passage of welfare reforms (i.e., the Personal Responsibility and Work Opportunity Reconciliation Act [PRWORA]). The PRWORA specified that undocumented immigrants were forbidden from receiving social services, like Medicaid, and that legal immigrants were not entitled to those services for 5 years after arriving in the United States, thus excluding recent immigrants from receiving public healthcare coverage (54, 55). Added to the formal denial of access to public assistance, social isolation and fear may impede individuals from households with non-US-citizen membership from

accessing information and services that could mitigate health impacts (51, 56). Previous qualitative research revealed that El Paso County Hispanic households impacted by the 2006 floods with members lacking US citizenship or legal residency status experienced constrained access to a wide range of resources for coping with the impacts of this disaster (57, 58). Our quantitative results here reveal that Hispanic individuals from households wherein decision makers lacked US citizenship status were placed at disproportionate risk for experiencing post-flood respiratory health problems. This finding suggests that political marginality may represent a barrier to meeting post-disaster health needs within racial/ethnic minority populations with substantial immigrant composition.

LIMITATIONS

The study has several limitations. First, the time between the flood disaster and data collection was relatively long (i.e., nearly 4 years), an issue that was best addressed by using a logistic regression approach, which has been used in prior flood health effects research (59). We believe that using the dichotomous outcome variable (i.e., whether or not each person experienced any respiratory health problem) as opposed to a count variable (i.e., the total number of respiratory health problems experienced by each person) is valid given the nearly 4-year time gap between the disaster and survey administration; using a count variable would assume an unrealistic level of precision in recall among respondents. Second, the individual level health data were reported by heads of households, who may have lacked complete knowledge and had difficulties recalling information about other household members. Third, most heads of households (67%) were female, which could have introduced bias into the analysis, since prior research indicates that women tend to report greater numbers of physical symptoms than men (60). Results of a separate chi-square test, however, reveal that female heads of households did not report greater presence of post-flood respiratory health problems among household members, as compared to male heads of households. Thus, it is not likely that gender differences in reporting substantially affected results. Nonetheless, these three limitations point to the possibility of under- or over-reporting of health problems via the survey, which is an issue for all research relying on self-reported measures (61). Indeed, it can be assumed that an unknown degree of measurement error was introduced in the entire data set through our reliance on self-reported measures. Fourth, over-reporting of US citizenship by heads of households via the survey was possible, due to concerns about confidentiality and fear of deportation among non-US citizens. To minimize the potential for response bias, we inserted a note immediately preceding the survey question reminding respondents about confidentiality, and asked about US citizenship rather than legal US residency status (many non-citizens reside legally in the United States with immigration documents). Fifth, the acculturation variable only measures

language, i.e., English proficiency, and future research should seek to examine acculturation as a complex construct that includes multiple components (e.g., diet, customs, language usage and preferences). Sixth, no formal analysis of non-response bias was conducted due to a lack of information about the socio-demographic characteristics of the population whose homes were damaged by flooding. However, based on our study design, there are three groups who could have incurred home damage due to flooding and who are not represented among survey respondents: people who did not report flood damage to the City of El Paso or American Red Cross, people who relocated outside of El Paso County in the time period between the flood event and survey administration, and people who do not receive mail (either at a street address or post office box) and therefore could not have received the mailed-out survey. Seventh, not all questions were asked for each individual. The US citizenship variable, for example, pertains to heads of households, and it was used to represent the political marginality of all individual members of households. This was justifiable since prior research with Hispanic immigrant households in El Paso County has shown that if any household member lacks legal residency status, all other household members (including those with US citizenship status) may be constrained in accessing health resources (56). Nevertheless, this variable would be improved if it were individual-specific.

CONCLUSION

Findings reveal that Hispanic people in El Paso County were at greater risk to post-flood respiratory health problems when they exhibited lower socioeconomic status, experienced increased family conflict and greater exposure to mold, and lived in households wherein decision-makers were politically marginal and had higher levels of English-language acculturation. Given these findings, it is clear that the provision of support services, in terms of access to affordable health care and medications, counseling, and disaster recovery (e.g., mold remediation), is essential to minimizing respiratory health exacerbations after flood disasters. To reach those most in need, these services need to be provided in a nonthreatening environment in which non-citizens and Spanish-speakers, along with other individuals, feel safe seeking aid. In El Paso County, this did not occur following the 2006 floods (57, 58), which may have contributed to the high incidence of respiratory health problems reported by heads of households after the disaster.

These findings also underscore the need to consider the heterogeneity of Hispanic populations in disaster and environmental health disparities research. Intra-ethnic disaster and environmental health disparities have not received much attention in the literature (for exceptions, see 1, 27, 62, 63), and this is particularly problematic in the case of US Hispanic populations, which are growing larger and becoming increasingly heterogeneous. This study revealed substantial intra-ethnic health disparities

in El Paso, Texas, which is home to a relatively low-diversity Hispanic population (almost exclusively white and of Mexican descent). The need to examine intra-Hispanic health disparities is even more urgent in cities like Los Angeles or Miami, where Hispanic racial and ancestral diversity is far greater, and where intra-ethnic disparities within the Hispanic population may be more powerful influences on post-disaster health problems. Future research is needed in the fields of environmental and disaster health in order to clarify how intra-group social inequalities influence disparate respiratory health impacts among vulnerable ethnic and immigrant populations.

DECLARATION OF INTEREST

The authors report no conflict of interest. The authors alone are responsible for the content and writing of the paper.

This study is based upon work supported by Award Number P20MD002287-05S1 from the National Institute on Minority Health and Health Disparities (NIMHD) at the University of Texas-El Paso. It was also supported by the National Science Foundation (NSF) under Grants No. CMMI-1129984/1130191 at the University of Texas-El Paso and the University of South Florida, Tampa. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the NIMHD or the NSF.

NOTES

1. These characteristics are closely connected to 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), and 95% of the total non-US citizen population (114,363/120,812) (29).
2. All data from the survey were self-reported by heads-of-households.
3. 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.
4. The mold exposure variable was based on Riggs and colleagues' study of mold growth in flood-damaged homes following Hurricane Katrina (35). Similar measures requiring respondents to recall the extent of the physical damages of disasters have been used in prior disaster health impacts research [see 1, 16, 36, 37].
5. The family conflict variable is based on self-reported measures that have been long employed in survey-based disaster health impacts studies (2, 19, 22).
6. We used SPSS version 19 ("IBM SPSS Statistics 19" with the "IBM SPSS Missing Values" add-on module) for our analysis.

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