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ORIGINAL PAPER

The Impacts of Exposure to Environmental Risk on Physical and Mental Health in a Small Geographic Community in Houston, TX

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Abstract Previous research has shown that communities with low average socioeconomic status (SES) and majority minority populations are more likely to be exposed to industrial buildings, waste facilities, and poor infrastructure compared to white communities with higher average SES. While some studies have demonstrated linkages between exposures to specific environmental contaminates within these communities and negative health outcomes, little research has analyzed the effects of environmental contaminants on the mental and physical health of these populations. A cross-sectional survey collected data from residents of Manchester, a small neighborhood in Houston, TX, that is characterized by industrial sites, unimproved infrastructure, nuisance flooding, and poor air quality. Our study (N = 109) utilized the 12 item Short Form Health Survey version 2 (SF12v2) to assess the general mental and physical health of the community. The community as a whole had reduced physical health scores compared to U.S. national averages. The time residents had lived in the neighborhood was also correlated with a reported reduction in physical health scores (r2 = 0.136; p-value < 0.001). The association between time lived in the neighborhood and poorer health scores remained after adjusting for age, race, and gender (coef = −0.27, p-value < 0.001). Mental health scores were within national averages and time spent living in the neighborhood did not appear to negatively impact respondent's mental health scores. These findings point to the need for more research to determine the potential for additive physical and mental health impacts in long-term residents in neighborhoods characterized by environmental justice issues.

Keywords Environmental justice · Health assessment · SF12 · Minority

Introduction

Research in environmental justice communities has conclusively shown that minority populations shoulder an undue burden of exposure to industrial buildings [1], waste facilities [2, 3], and urban pollution [4, 5] compared to majority populations. Further, those with lower socioeconomic status (SES), regardless of race, are more likely to live in areas characterized by poorer environmental conditions [1, 6]. While some studies have demonstrated negative health effects of living in environmentally compromised neighborhoods [1, 4, 7], these studies have tended to focus on social determinants of health, personal habits, or specific exposures, although these only account for a small amount of negative health outcomes [8–10]. More recently, researchers have begun to utilize a multidisciplinary approach to investigate macro-level issues within communities [11]. In an effort to characterize the impact of living for an extended period of time in a community that typifies the problems seen with environmental justice communities, a

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cross sectional study was conducted in the neighborhood of Manchester, a low income, majority minority community in Houston, TX.

Background

Prior research has provided evidence of disparate levels of exposure to environmental risks among low SES and majority minority communities in the U.S [1–4]. These communities experience higher than average levels of air, water, and soil pollution. While efforts to remediate this situation have been slow, linkages between environmentalism, social justice, and civil rights have emerged to support non-white communities organizing for change [12].

According to Evans and Kantrowitz (2002), the main predictors of exposure to poor environmental living conditions are race/ethnicity and low SES [13]. Similarly, a study in Southern California performed by Morello-Frosch et al. (2002) found that race was a strong predictor for the locations of poor air quality and hazardous waste facilities [14]. Differences in the perception of environmental harm also exists. A study by Satterfield et al. (2004) demonstrated differences in perceived risk, as well as acceptance by minority communities that they are exposed to industrial pollutants at higher levels compared to majority communities. When asked if hazardous facilitates are more common in minority communities, 66.5% of nonwhite males and 71.6% on nonwhite females agreed, as compared to only 50.4% of white males [15].

Residents of environmental justice communities have also been shown to have a variety of negative health outcomes [16, 17]. For example, in the Bronx, New York City, Maantay (2007) found that those living near noxious land use were 66% more likely to be hospitalized for asthma related illness [18]. Wendell et al. (2006) found that communities with higher proportions of low SES and racial minority residents have higher obesity rates, more food deserts, and fewer safe and walkable streets [19]. However, little research has looked at the relationship between length of residence in an environmental justice community and overall physical and mental health.

Materials and Methods

Study Location and Population

Manchester, Texas, is a small neighborhood in eastern Houston located on the Houston Ship Channel. Manchester is primarily Non-White Hispanic and has endured numerous issues with flooding [20], air pollution [21], and environmental health concerns [22]. Houston Ship Channel communities are at particularly high risk of impacts from the nexus of exposure to hazardous substances and natural disasters. For example, within one mile of the Manchester neighborhood, there are 21 facilities that report to the EPA's Toxic Release Inventory: 11 large quantity generators of hazardous waste, four facilities that treat, store, or dispose of hazardous wastes, nine major dischargers of air pollution, and eight major storm water discharging facilities [23]. The area is also highly vulnerable to the impacts of natural disasters, both socially and physically. Floodplains along the Sims Bayou have increased by 15% since 1980, due to increases in development and impervious cover like concrete and asphalt, while expected sea-level rise could expose another 35,000 residents in Ship Channel neighborhoods to flooding [24]. The population of the Harrisburg/Manchester Park Super Neighborhood, where Manchester is located, is 98% minority, with a median income that is one-third less than the City of Houston overall. Only 6% of residents have obtained a Bachelor's degree [25, 26].

Based on these identified vulnerabilities, and an existing relationship with local community-based environmental justice and education groups, the Manchester neighborhood was selected as a case study location in which to assess the impact of length of residents on physical and mental health.

Survey Sample

Due to the relatively compact geography of the Manchester neighborhood, a complete census was attempted. Trained survey teams walked every public road and passed every home within the borders of Manchester during two data collection days in December, 2015. Homes that were completely fenced off, abandoned, or were deemed unsafe by the interview team were the only homes not approached during the canvasing.

Community partners that were already engaged with ongoing research assisted with survey data collection to help increase response rates. Specifically, the Green Ambassadors from Houston's Furr High School [27] and the EpiAssist program at the Texas A&M University Health Science Center School of Public Health [28] were chosen to help collect survey data. Logistical coordination, as well as community relations, were managed by Texas Environmental Justice Advocacy Services (TEJAS). Teams were assembled that consisted of two or three individuals, including graduate students from the EpiAssist program, and at least one individual who was fluent in Spanish.

The survey included the 12 item Short Form Health Survey version 2 (SF12v2) that was adapted from the medical outcome study [29]. The SF12v2 has been validated for use in predicting the generic mental and physical health of populations without targeting specific health outcomes and shown to be reliable in both U.S. and international

populations [30, 31]. The SF12v2 has also been applied to ratings of the general mental and physical health of homeless populations [32], those with severe mental health [33], immigrant communities in the U.S. [34], and has been used to evaluate general populations in the U.S. by researchers and state health departments [35, 36]. This survey produces a composite score for mental (MCS) and physical health (PCS) between 0 and 100. A norm based algorithm is used to create these composite scores [37], which allows for comparison between study populations and national averages. The national average score for both mental and physical health is standardized at 50; scores above this represent higher, or healthier, individuals than average. In addition to these items, demographic information (gender, race, and age) and language proficiency (can anyone in the household speak English less than well) was also collected. The survey and accompanying consent materials were approved by the Texas A&M University Institutional Review Board (#15-0648D).

Table 1 Sample characteristics

Characteristics	N
Gender	
Male	54 (49.5%)
Female	55 (50.5%)
Race	
Non-Hispanic white	31 (28.4%)
Hispanic or Latino	68 (62.4%)
African American	9 (8.3%)
Age in years	
Mean (SD)	45 (15.98)
Age in groups	
<35	34 (31.5%)
36–50	28 (25.9%)
51–69	38 (35.2%)
70+	8 (7.4%)
Language	
Spanish	55 (50.5%)
English	54 (49.5%)

Statistical Methods

Descriptive statistics were calculated for each variable, including demographics. Race was coded as either non-Hispanic white or non-white to account for the relatively low number of African American respondents. A two-way scatterplot was created for MCS and PCS and time spent living in the neighborhood. A two tailed t-test was conducted to assess if there were difference between respondents and the national standardized score of 50 for PCS and MCS stratified by gender and race. Multiple linear regression was used to assess the impact of time spent in the neighborhood, age, gender, and racial categories on MCS and PCS. Coefficients of the covariates, along with their corresponding 95% confidence intervals (95% CI) and p-values, were reported. Statistics were calculated using STATA 14 (College Station, TX) and Microsoft Excel (Redmond, Washington).

Results

Between December 19 and December 26, 2015, 109 (N = 109) surveys were collected with an overall response rate of 72.7%. Of the respondents, 28.4% (N = 31) were completed by non-Hispanic white individuals, 62.4% (N = 68) Hispanic or Latino individuals, and 8.3% (N = 9) African American. Approximately half (49.5%; N = 54) were male and (50.5%; N = 55) were female (Table 1).

When comparing the results from this survey to the national mean scores for MCS and PCS, there were statistically significant differences between the two outcome variables (Table 2). Overall, women tended to have the lowest MCS scores. Non-Hispanic White women had mean score of 38.42 (p-value <0.001) showing increased levels of mental stress compared to the national standard. Non-Hispanic White men had a mean score of 43.12, which was not significantly different from the national mean. The PCS produced statistically significant results in every group, showing a consistent impact on physical health from negative exposures in this community. Non-Hispanic White males had the lowest mean score with a value of 34.86 (p-value <0.001), producing responses far lower than expected based on national averages.

Plotting the MCS against years lived in the neighborhood failed to produce a correlation between these two variables, (Fig. 1). Plotting the impact that years spent in the neighborhood on PCS showed a statistically significant (p-value <0.001) score with a weak negative linear relationship ($r^2 = 0.136$), indicating that the longer an individual lived in the neighborhood, the lower their PCS score became (Fig. 2).

In multiple linear regression equations comparing the covariates age, gender, race, and time lived in the neighborhood on MCS and PCS values, non-white respondents scored significantly higher on the mental aspect of the survey compared to Non-Hispanic White respondents (coef = 8.67, 95% CI 3.49–13.85) (Table 3). For the PCS scores, time spent in the neighborhood was the best predictor for decreases in PCS values even after adjusting for the other covariates in the model (coef = −0.27, 95% CI −0.43 to −0.12). This supports the correlation between PCS and time lived in the neighborhood shown in Fig. 2.

Table 2 Two-tailed *t* test of mean values of mental and physical composite scores against national mean values

Outcome and group	*t* value	Mean	95% CI	p-value
Mental composite score				
Male	−0.98	48.24	44.61–51.86	0.33
Female	−2.04	47.13*	43.41–49.95	0.05
Non-Hispanic white male	−2.03	43.12	35.97–50.28	0.06
Non-Hispanic white female	−3.77	38.42*	31.74–45.11	<0.001
Non-white male	0.39	50.79	46.70–54.88	0.69
Non-white female	−0.44	49.24	45.71–52.76	0.67
Physical composite score				
Male	−5.94	40.73*	37.60–43.86	<0.001
Female	−5.85	41.77*	38.95–44.59	<0.001
Non-Hispanic white male	−5.67	34.86*	29.23–40.49	<0.001
Non-Hispanic white female	−3.49	40.49*	34.54–46.43	0.01
Non-white male	−3.62	43.67*	40.11–47.22	<0.001
Non-white female	−4.74	42.18*	38.84–45.51	<0.001

*Statistically significant (p-value <0.05)

Discussion

Mental health, as measured by the SF12v2, of members of this low wealth, majority minority community in Houston, TX, were relatively in-line with national norms, with the exception of female respondents who had values significantly below the national average. However, all racial and gender categories had lower values for physical health when compared to the U.S. as a whole. Contrary to our initial hypothesis, the Non-Hispanic white participants had the lowest values of PCS, with white males showing the greatest reduction in physical health as time lived in the neighborhood increased.

Increased social and cultural cohesion has been shown to mitigate some of the potential negative impacts on mental and physical health [38, 39]. This could account for the relatively higher PCS scores in the non-white participants since Hispanic communities have been shown to exhibit increased social ties and community cohesion [40, 41]. Patel et al. (2003) conducted a study with older Mexican Americans in the southwestern region of the U.S. where individuals who lived in a community with a small population of other Hispanic residents rated their health as poorer than their counterparts who lived in a community with a higher proportion of other Hispanic residents

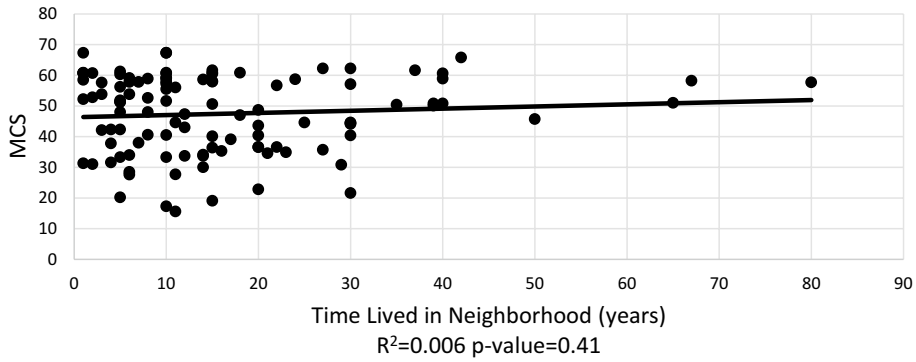

Fig. 1 Mental health composite score by time lived in neighborhood

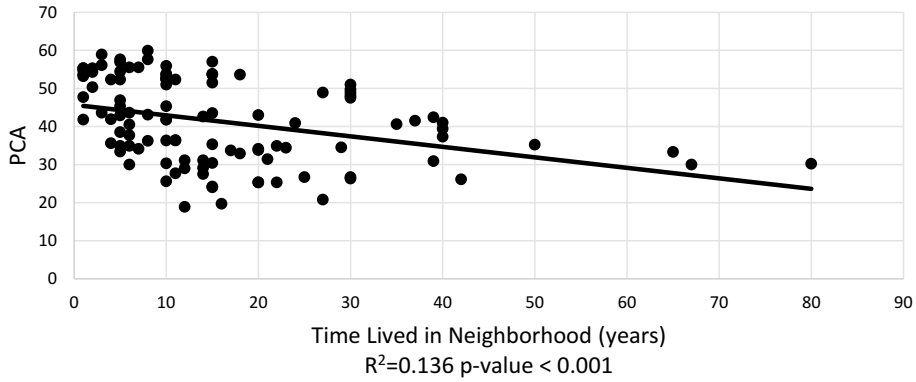

Fig. 2 Physical health composite score by time lived in neighborhood

Table 3 Multiple linear regression comparing the covariates age, gender, race category, and time lived in the neighborhood on MCS and PCS values

Group	*coef*	SE	95% CI	p-value
Mental composite score				
Gender (female)	−2.28	2.36	−6.95 to 2.39	0.34
Race (non-white)*	8.67	2.61	3.49 to 13.85	<0.001
Time in neighborhood	0.11	0.097	−0.08 to 0.31	0.25
Age	−0.14	0.09	−0.31 to 0.04	0.12
Physical composite score				
Gender (female)	−0.87	1.92	−4.67 to 2.93	0.65
Race (non-white)	0.05	0.07	−0.09 to 0.18	0.51
Time in neighborhood*	−0.27	0.07	−0.43 to −0.12	<0.001
Age	−0.07	0.07	−0.20 to 0.08	0.36

[42]. Within the neighborhood of Manchester, Spanish is the preferred language in most homes, restaurants, and convenience stores. Individuals who identify at white may feel more isolated in the community due to this lack of language connection with the rest of the community, as the majority of white respondents preferred English over Spanish, in contrast to the non-white respondents. Since findings of past research have been mixed, future research should target cohesion as a potential factor in ameliorating the effects of poor living conditions on mental health [43].

The time that individuals lived in the community was of particular interest to the research team due to the strength of association with reduced PCS scores, controlling for age, race, and gender. Although our sample was small, adjusted results provide some evidence that those living in conditions characterized by environmental justice issues experience additive negative health impacts the longer they reside there. These findings underscore the need for quick and meaningful environmental remediation and other solutions to assist the most vulnerable populations within the U.S.

There are several important limitations to this study. This was a cross-sectional study; therefore, the direction of causality between environmental exposures and MCS or PCS scores cannot be determined. The survey was interviewer administered, which some research indicates may lead to response bias if respondents rate their overall mental and physical health higher when speaking with an interviewer as compared to self-administered surveys [41, 44]. Despite the relatively high response rate, a small total amount of participants completed the survey, reducing our statistical power and our ability to adjust for potential confounders (N = 109). Non-Hispanic Whites were over-represented in our survey responses as compared to the U.S. Census data on race and ethnicity of Manchester residents [45]. Non-Hispanic Whites were more likely to complete the survey than their Non-White counterparts, which could have caused selection bias within this study.

While more research is needed to tease apart the complex relationships between mental and physical wellbeing and living in an environmental justice community over time,, these findings further illustrate the potential that unjust environmental conditions may impact health. The health impacts may also be additive for those living in these communities for longer periods of time. Therefore, findings from this study support prior recent research in pointing out the importance of swift movement on environmental change.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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