The Importance of the Neighborhood in the 2014 Ebola Outbreak in the United States: Distress, Worry, and Functioning

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Objective: Ebola media coverage directed public attention to potential disease carriers: residents or travelers from West Africa. We investigated the role of neighborhood population factors (i.e., the concentration of West African foreigners, non–West African foreigners, non-Hispanic Blacks) on individual responses to the Ebola outbreak in the United States. The role of these community-level factors in emotional responses to this public health crisis is poorly understood. *Method:* Demographic factors, mental health, and stressful event history, collected as part of an ongoing longitudinal study of residents from 2 metropolitan communities (New York City and Boston, total $N = 1,346$), were combined with neighborhood data from the U.S. Census. Multilevel models estimated the effects of individual and neighborhood factors on individual psychological distress, functional impairment, and Ebola-related worry. *Results:* Individuals living in neighborhoods with more West African–born foreigners or non–West African foreigners reported more somatization and anxiety symptoms, functioning difficulties, and/or Ebola-related worry than individuals living in neighborhoods with fewer foreign residents ($p < .05$). Individuals residing in neighborhoods with more non-Hispanic Blacks also reported more somatization symptoms than their residential counterparts ($p < .05$). *Conclusion:* Neighborhood demography is important to study during a public health outbreak like Ebola in which media and policy target specific people or regions. Findings suggest research and policies should not only assist at-risk individuals but also at-risk neighborhoods during and after an infectious disease crisis.

Keywords: Ebola, infectious disease, neighborhood, worry, functioning

The first case of Ebola in the United States was confirmed on September 30, 2014. The spread and death toll of the disease (11,315 Ebola-related deaths) made Ebola one of the deadliest epidemics in recent decades (British Broadcasting Corporation, 2016). The vast majority of Ebola cases occurred in West Africa. Nonetheless, Ebola received massive and unprecedented media attention in the United States (Motel, 2014). Sensationalized coverage publicized Ebola as a virus brought into the country by residents or travelers from West Africa, resulting in travel restrictions and quarantines (Bennett, 2014). The unique racial and ethnic nature underscoring the Ebola outbreak provided an ideal opportunity to study the potential impact of neighborhood race and ethnicity on well-being during a public health emergency.

Spatial studies of mental illness in the aftermath of a disaster, once a rarity, are becoming increasingly common. For example, recent work by Gruebner and colleagues (Gruebner, Lowe, Sampson, & Galea, 2015; Gruebner et al., 2016a, 2016b; Lowe, Sampson, Gruebner, & Galea, 2015) has examined the geospatial patterning of fear or sadness in tweets following the 2015 Paris attacks, the spatial clustering of posttraumatic stress symptoms after Hurricane Ike, and community differences in vulnerability and resilience after Hurricane Sandy. These studies, coupled with other studies linking neighborhood populations to mental health or behavior (e.g., Jackson, Browning, Krivo, Kwan, & Washington, 2016; Kessell, Alvidrez, McConnell, & Shumway, 2009; Semyonov, Gorodzeisky, & Glikman, 2012), provide evidence that individual- and community-level resources may operate in tandem to shape postdisaster well-being.

Previous research on response to the Ebola outbreak examined such topics as social media use and distress, including studies documenting that a single news video on Ebola was subsequently linked to approximately 22,000 Google searches and 180 tweets on "Ebola" (Towers et al., 2015), and that Ebola-related tweets included more negative emotion words than flu-related tweets (Fung, Tse, Cheung, Miu, & Fu, 2014). Higher levels of perceived vul-

nerability to Ebola was also associated with greater xenophobia among a representative sample of U.S. residents, an effect that appeared to be moderated by personal and state level individualism or collectivism (Kim, Sherman, & Updegraff, 2016). None of this work, however, addresses the role of neighborhood characteristics in shaping emotional responses to this public health crisis.

In the present study, we examine the associations between neighborhood population characteristics and distress, functioning, and Ebola-related worry among residents of two large U.S. communities. Our study considered the role of both individuals and their surrounding neighborhood demography when seeking to understand responses to the Ebola outbreak. Because psychological responses to collective crises are likely associated with individual-level factors including demographic characteristics, a history of prior mental health difficulties (e.g., Holman, Garfin, & Silver, 2014; Silver, Holman, McIntosh, Poulin, & Gil-Rivas, 2002), and exposure to prior negative life events (e.g., Garfin, Holman, & Silver, 2015; Seery, Holman, & Silver, 2010), these variables were assessed. In addition, the communicable nature and extensive media coverage of Ebola as a West African–borne disease suggested that residents living in neighborhoods with a higher concentration of West African foreigners would report higher levels of psychological distress, more functional impairment, and more Ebola-related worry than residents from communities with different demographic distributions.

Method

Data were collected December 29, 2014 through February 27, 2015 on samples of residents from metropolitan Boston ($n = 642$) and New York City ($n = 704$) areas as part of an ongoing nationally representative longitudinal study that began shortly after the Boston Marathon bombings (Holman et al., 2014). Both communities had suspected or confirmed Ebola patients during the outbreak (Ashkenas et al., 2015; Freyer & Andersen, 2014). Participants came from the GfK KnowledgePanel and were originally recruited to the panel via address-based sampling. Selection into this study was done using a probability-based sampling strategy that ensures each KnowledgePanel participant from the designated geographic area has an equal likelihood of being selected into the study sample. Respondents completed surveys in exchange for Internet access or merchandise credit if households were already web enabled. Participant latitude or longitude data (shifted 100–2,000 ft. for privacy, based on the population density of the Census block) were collected and used to determine Census tract IDs using ArcGIS software. Neighborhood data came from the U.S. Census American Community Survey, 2013 5-year data set (U.S. Census Bureau, 2014). These data include count estimates of foreign-born persons (including details on their place of birth), non-Hispanic Blacks or African Americans, and the total population in a tract. Data were linked by Census tract ID. All procedures for this study, including informed consent requirements, were approved by the Institutional Review Board of the University of California, Irvine.

Measures

Demographics. We assessed age (in years), ethnicity/race (White, Black, Hispanic, other race, and multirace), gender (1, *female*, 0, *male*), marital status (1, *married*, 0, *not married*), household income (1, *less than $24,999*, 2, *$25,000 to $49,999*, 3, *$50,000 to $74,999*, 4, *$75,000 to $99,999*, 5, *$100,000 to $124,999*, 6, *$125,000 to $149,999*, 7, *$150,000 to $174,999*, and 8, *$175,000 or more*), employment status (1, *self-employed or paid employee*, 0, *not employed*), and education status (1, *college graduate or higher*, 0, *less than high school, high school graduate, or some college*).

Mental health history. Prior mental health was measured as a count of physician-diagnosed mental disorders: 0, *no anxiety or depressive disorders*, 1, *an anxiety or depressive disorder*, 2, *both disorders* (see Holman et al., 2014).

Lifetime stressful event history. Stressful event history was measured using a count of total negative life events experienced before January 1, 2015 (possible range: 0–36; see Seery et al., 2010).

Total population. Total population was measured with Census data that captured the estimated number of people within a tract (population of the neighborhood).

Black, foreign-born, and West African populations. Neighborhood-level predictors included Census tract-level population estimates of non-Hispanic Blacks, non–West African–born foreigners, and West African–born foreigners. Estimates were scaled such that a one-unit increase represented an additional 250 non-Hispanic Blacks, non–West African–born foreigners, and West African–born foreigners in the tract.

Anxiety, depression, and somatization symptoms. Subscales of the Brief Symptom Inventory-18 (Derogatis, 2001) were used to measure anxiety, depression, and somatization symptoms in the past week. The Brief Symptom Inventory is a valid and reliable measure of global distress (Derogatis & Savitz, 2000), and the 18-item measure has been used in prior studies of representative samples after a national crisis (Silver et al., 2002). Items are evaluated along a 5-point rating scale ranging from 0 (*not at all*) to 4 (*extremely*).

Functional impairment. Functional impairment was measured with four items drawn from the 36-item Short-Form Health Survey (Ware & Sherbourne, 1992). These items assess the degree to which respondents' physical and emotional health has interfered with social activities or made it difficult to perform work or other regular daily activities in the last week on a scale from 1 (*none of the time*) to 5 (*all of the time*). Items were recoded to 0–4 to give variables a comparable baseline score. The functional impairment measure has good scale reliability (sample $\alpha_{standardized} = 0.87$) and has been used in prior research among a nationally representative sample (e.g., Seery et al., 2010).

Ebola-related worry. Two items assessing worry about the Ebola crisis were adapted from measures used in prior research conducted after 9/11 (Holman et al., 2008; Silver et al., 2002). These items asked how often respondents feared Ebola would affect their community and worried Ebola would affect them or their family in the future on a scale from 1 (*never*) to 5 (*all the time*). Items were again recoded to 0–4 for a comparable baseline score. The measure displayed good internal consistency in the present sample (sample $\alpha_{standardized} = 0.84$).

Data Analysis

To account for a nested design (individuals within tracts), we used multilevel models (MLM). Interclass correlation coefficients estimated from unconditional means models indicated that tract membership explained between 4% and 24% of the variance in our outcome variables—a significant amount. MLM models were es-

timated first on the individual-level covariates and then with tract-level predictors included. The general expression of the MLM equations estimated using xtmixed in STATA 14.1 (Stata Corp, College Station, TX) are below; X represents a matrix of all exogenous predictors:

Level 1: $y_{ij} = b_{0j} + \beta_j(X_{ij}) + r_{ij}$

Level 2: $b_{0j} = \gamma_{00} + u_{0j}$

Results

Of the 1,787 participants enrolled in the longitudinal study, 1,346 participants ($M_{age} = 54.9$; $SD_{age} = 16.1$) completed the Ebola wave of data collection and had valid tract details (Boston metropolitan area: 47.7% of sample; New York City metropolitan area: 52.3% of sample; 17 IDs were dropped because of improbable data after shifting). Census tract population estimates indicate that sampled tracts typically included more than 5,000 people ($M = 5163.39$; $SD = 2015.04$). On average, participants lived in areas with more non–West African–born foreigners ($M = 906.4$; $SD = 801.8$) than non-Hispanic Blacks ($M = 435.5$; $SD = 966.3$) and West African–born foreigners ($M = 21.5$; $SD = 76.5$). Of the Brief Symptom Inventory-18 symptom subscales, on average, depressive symptoms ($M = 2.13$; $SD = 3.58$) were reported more often than anxiety symptoms ($M = 1.81$; $SD = 3.02$) or somati-

zation symptoms ($M = 1.72$; $SD = 2.80$). The mean functional impairment score reported was 1.64 ($SD = 2.84$) and the mean of Ebola-related worry was 0.87 ($SD = 1.32$), suggesting that most people reported *never* or *rarely* being worried about Ebola.

Preliminary models with individual-level covariates indicated that a history of mental disorders, lower household income, and reporting more stressful life events were all associated with poorer outcomes. In addition, minority status was associated with more anxiety symptoms (Hispanic: $b = 0.63$; $SE = 0.23$; $p = .006$; Other race: $b = 0.90$; $SE = 0.35$; $p = .010$), depressive symptoms (Hispanic: $b = 0.70$; $SE = 0.28$; $p = .013$; Multirace: $b = 0.98$; $SE = 0.44$; $p = .027$), functional impairment (Other race: $b = 0.77$; $SE = 0.38$; $p = .043$), and Ebola-related worry (Hispanic: $b = 0.37$; $SE = 0.13$; $p = .003$; Multirace: $b = 0.64$; $SE = 0.20$; $p = .002$; Other race: $b = 0.38$; $SE = 0.19$; $p = .045$). Being a college graduate or higher, being married, or being currently employed were identified as mitigating factors across all models except for anxiety. The final MLM results (including both individual-level and tract-level covariates) are presented in Table 1 and discussed in turn, with reference to our specific neighborhood populations of interest: Black, foreign born, and West African foreign born. All estimates adjust for individual-level and neighborhood-level factors.

Table 1

Multilevel Model Results for Anxiety, Depressive, and Somatization Symptom Scores, Functional Impairment, and Ebola-Related Worry

Variables	Anxiety symptoms (N = 1,279)	Depressive symptoms (N = 1,275)	Somatization symptoms (N = 1,283)	Functional impairment (N = 1,282)	Ebola-related worry (N = 1,286)
Individual-level predictors					
Age (years)	−.01 (.00)**	−.01 (.01)*	−.00 (.00)	−.01 (.00)	−.00 (.00)
Black[a]	−.63 (.27)*	−1.11 (.33)**	−.46 (.28)	−.35 (.29)	.13 (.15)
Hispanic[a]	.44 (.23)	.46 (.29)	.14 (.25)	.21 (.26)	.34 (.13)**
Multirace[a]	.02 (.38)	.71 (.45)	.33 (.39)	.56 (.41)	.65 (.21)**
Other[a]	.75 (.35)*	.57 (.42)	.48 (.36)	.70 (.39)	.34 (.19)
Gender (female = 1)	.20 (.12)	−.14 (.14)	−.08 (.12)	−.13 (.13)	.14 (.06)*
Married	.17 (.13)	−.59 (.16)***	−.06 (.13)	−.25 (.14)	.07 (.07)
Education[b]	.00 (.12)	−.13 (.15)	−.15 (.13)	.03 (.13)	−.29 (.07)***
Employment[c]	−.08 (.13)	−.17 (.16)	−.33 (.13)*	−.50 (.14)***	.05 (.07)
Household income, dollars	−.07 (.03)*	−.13 (.04)**	−.12 (.03)***	−.13 (.04)***	−.02 (.02)
Mental health history[d]	1.13 (.10)***	1.54 (.12)***	.75 (.11)***	1.17 (.11)***	.01 (.06)
Negative life events[e]	.08 (.01)***	.09 (.02)***	.11 (.01)***	.09 (.01)***	.02 (.01)*
Tract-level predictors					
Total population	−.00 (.00)	−.00 (.00)	.00 (.00)	.00 (.00)	−.00 (.00)
Non-Hispanic Black[f]	.01 (.02)	.05 (.03)	.05 (.02)*	.00 (.02)	−.01 (.01)
Foreign born[f,g]	.05 (.02)*	.04 (.03)	.03 (.02)	.02 (.02)	.03 (.01)*
West African foreign born[f]	.45 (.24)	.33 (.30)	.54 (.25)*	.60 (.27)*	−.04 (.13)
Constant	1.40 (.35)***	2.33 (.43)***	1.28 (.36)***	1.87 (.38)***	.69 (.19)***
Variance					
Level 1	3.52	4.79	4.01	4.09	1.21
Level 2	.49	1.20	.35	.78	.04
Log likelihood	−2701.52	−2944.79	−2764.48	−2829.37	−1967.86
Wald χ(df)	294.38 (16)***	401.76 (16)***	282.27 (16)***	311.16 (16)***	75.09 (16)***

Note. Standard errors are presented in parentheses. Models exclude outliers in which standard residuals had absolute values larger than 3.0 (less than 3% of cases). There were no issues of multicollinearity among predictors with all variance inflation factor estimates less than 3.
[a] White race is the reference group. [b] 1, *College graduate or higher*; 0, *less than high school, high school graduate, or some college.* [c] 1, *Self-employed or paid employee*; 0, *not employed.* [d] 0, *No disorders*; 1, *an anxiety or a depressive disorder*; 2, *both disorders.* [e] Lifetime count of total negative life events experienced before January 1, 2015 (possible range: 0–36). [f] Neighborhood counts were scaled such that a one-unit increase is the addition of 250 people (instead of one person) to the tract. [g] Foreign-born total estimate excludes West African foreign-born persons.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Black Population

Increasing the neighborhood population of non-Hispanic Blacks by 250 people was associated with a 0.05 unit increase in resident somatization symptoms ($p < .05$). Additionally, the relationship between neighborhood population of non-Hispanic Blacks and depressive symptoms approached statistical significance ($b = 0.05$; $SE = 0.03$; $p = .058$).

Foreign-Born Population

Anxiety symptoms increase significantly by 0.05 units with a 250-person increase in the number of non–West African–born foreigners in the neighborhood, controlling for all relevant covariates ($p < .05$). Ebola-related worry also increases by 0.03 units for every 250 additional non–West African–born foreigners in the neighborhood ($p < .05$).

West African Foreign-Born Population

The addition of 250 West African–born foreigners in the neighborhood was associated with a 0.54 and 0.60 unit increase in somatization symptom scores and functional impairment (respectively), even after controlling for individual-level factors ($p < .05$). Furthermore, the association between the number of West African foreign born in the neighborhood and anxiety symptoms trended toward significance ($b = 0.45$; $SE = 0.24$; $p = .062$).

Discussion

Disease epidemics in modern society transcend physical boundaries, often attracting global interest. The migration of the Ebola virus into the United States drew attention to the West African community, making it important to consider the broader neighborhood in studies of individual psychological well-being. The Ebola outbreak placed a national spotlight on a disease with potential carriers who came from or traveled to West Africa. Bridging information from individuals to their broader environment, data from two diverse metropolitan areas indicate that above and beyond individual-level predictors, neighborhood demography matters. As the number of West African–born foreigners increased in the neighborhood, residents reported more somatization symptoms and poorer functioning. Similarly, as the number of non–West African–born foreigners increased in the neighborhood, residents reported more anxiety symptoms and Ebola-related worry. An increase in the population of Blacks in the neighborhood also corresponded with an increase in somatization symptoms reported.

The somatization symptomatology and functioning impairments associated with a rise in the neighborhood population of West African–born foreigners and non-Hispanic Blacks is especially informative. It suggests that in the midst of the Ebola outbreak, residents were experiencing mental and physical responses to community members of African descent. The fact that we find an effect for non-Hispanic Blacks, above and beyond the effect of West African–born foreigners, suggests that residents may have been reacting to the phenotypic similarities between West Africans and Blacks, either at a conscious or unconscious level. The notion of phenotype-based reactivity is supported by a recent ethnographic study that found that being African, having black skin, or being from Liberia explained resident experiences with Ebola-

related stigma more than residential proximity to a person infected with Ebola (Smith-Morris, 2017). The heightened Ebola-related worry and anxiety symptoms associated with non–West African–born foreigners in the neighborhood also suggests that residents were especially wary of individuals with international origins.

We suspect that the media rhetoric on Ebola played a contributing factor, although we are unable to determine definitively why living in neighborhoods with more non–West African– and West African–born foreigners was related to resident well-being. However, drawing on insights from Kim and colleagues (2016) and Fung and colleagues (2014), it is possible that the media coverage of Ebola led to greater perceptions of vulnerability to Ebola and alarm, which manifested as xenophobic attitudes toward West African and non–West African foreign-born persons. With the current Zika outbreak, an illness, once again, linked to a particular part of the world (Brazil), our results support the continued examination of the role of neighborhood composition in understanding resident reactions amid a global health crisis.

Contributions, Limitations, and Future Directions

This is the first known study to explore the importance of neighborhood population for individual distress and functioning after a large-scale health crisis, the 2014 Ebola outbreak. The publicity of Ebola as a West African–borne publicly transmittable infectious disease highlighted the need to examine individuals' responses to Ebola in context by including demographic information from their local neighborhood. Residents' psychological response to Ebola was associated with the population of the neighborhood in which they resided. Our analysis clearly demonstrates the important roles of both the individual and his or her neighborhood in understanding reactions to a public health emergency.

Nonetheless, there are limitations to this work that can inform future studies. During the 2014 Ebola crisis, living in an area afflicted with Ebola may have resulted in community fracturing that strained interactions between residents and fueled feelings of grief, distrust in the health care system, and illness stigma (Van Bortel et al., 2016). Ideally, future research will include social network information to investigate the interpersonal dynamics at play in neighborhoods during such a crisis. Moreover, these studies should go beyond our cross-sectional study of generalized distress following the Ebola crisis to examine Ebola-specific reactions (e.g., Ebola-related functional impairment) in a prospective and longitudinal study (i.e., before, during, and after the onset of a public health emergency). Finally, our neighborhood data were measured at the tract level. Future studies would benefit from the added spatial precision of block-level data, allowing for a micro-level analysis of the relationship between both individual and neighborhood immigration status and mental health.

Conclusions

In a public health crisis, research and services are typically directed toward individuals. However, the broader social ecology (including population-level factors) can also inform individual response to a public health threat. This is especially true when the public health threat (like Ebola) is communicable through person-to-person contact and the likelihood of contact varies depending on area. Our study suggests that more attention should be directed to the demographic

and social structure of neighborhoods when seeking to understand individual responses to public health crises. We found that the composition of one's residential neighborhood was associated with individual-level reactions to Ebola that reflect emotional challenge and distress, as well as unexplained physical symptomatology. Public health officials and policymakers should consider examining neighborhoods at risk for negative psychological responses using population characteristics. Indeed, neighborhood population characteristics could be one indicator used to tailor resource allocation most effectively in the aftermath of public health threats. Neighborhood dynamics might also be studied to inform individual and public health responses to highly contagious disease epidemics (e.g., flu). Finally, future efforts should be directed at studying the effect of public health epidemics on neighborhood cohesiveness, networks, and social capital, which may ultimately help to alleviate resident distress and build community cohesion.

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