

Associations between rat infestations and mental health vary by gender, race, and income in Chicago

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Abstract

Rats are an understudied stressor for people in urban environments around the world but the effects may not be distributed equally among residents. In this study, we examined associations between residential rat sightings and mental health in Chicago, where rat complaints are the highest of any American city. We examined how this relationship varied by frequency of rat sightings, race, ethnicity, income, home ownership, and gender and explored potential psychosocial pathways (e.g. feelings about the home) between rat sightings and mental distress. We conducted a randomized household survey along an income gradient in 2021 and asked about depressive symptoms in the past week (i.e. Center for Epidemiologic Studies Depression scale), frequency of rat sightings in/around the home, perceptions of rats, neighborhood conditions, and socio-demographic characteristics. We used logistic regression to assess relationships among these variables for our entire sample and for specific demographics using stratified models. Respondents (n = 589; 409 complete cases) who saw rats in/around the home daily/almost daily had 5.5 times higher odds of reporting high depressive symptoms relative to respondents who saw rats less frequently after accounting for socio-demographics and neighborhood conditions. This relationship was significant for men and respondents with lower incomes or race or ethnicity other than white. Our results show that rat infestations should be considered a threat to mental health among urban residents. Increased mental health support for residents living in rat-infested housing may improve public health in cities.

Introduction

Living alongside rats creates public health challenges for several reasons. The most well-known rat-associated health risks are zoonotic pathogens, which can cause fatal infections and are transmitted through direct contact (e.g. bites [1]), indirect contact (e.g. urine [2]), or through vectors (e.g. fleas [3]). Several studies have also found associations between rat presence and mental distress, although this relationship is poorly understood [4]. Given that over 10% of the U.S. population experiences some form of mental distress [5] the additional impacts of rats on mental health may have compounding and exacerbating effects.

A growing body of work has demonstrated diverse associations between rat infestations and mental health, although the underlying mechanisms are unclear. For example, individuals who see rats daily are more likely to experience greater depressive symptoms [6]. People living in rat infested areas also report psychological trauma [7], disturbed sleep [8], and stress arising from safety concerns [9, 10]. In fact, rats were the only household pest associated with poorer mental health in an assessment among minority women in group housing [11]. More work is needed to understand the nature of how rat presence impacts mental health, as well as pathways through which these associations operate. For instance, rat sightings may affect mental health through perceptions of powerlessness, neighborhood stigma, fear, and other mechanisms associated with neighborhood disorder [12]. There may be a frequency of rat sightings above which impacts are expected [6] (i.e. a dose-response relationship), suggesting that management which keeps rats below this threshold could help reduce mental health outcomes.

Distress may also be amplified for those with constrained ability to control rat presence. For example, residents with lower socioeconomic status may not have financial resources to hire professionals, time to manage rats themselves, or social capital to advocate for responsive city services. Similarly, renters may lack power to make household structural changes or rely on landlords for pest control. Existing literature has primarily focused on specific populations rather than the general population; for example, people with histories of drug use [6], low-income communities [8], or those in slum communities in the global south [7,13]. Understanding how rats impact residents' mental health across socioeconomic lines will improve support for diverse communities.

Rat infestations are particularly concerning in Chicago, Illinois, the city with the most rat complaints in America for eight consecutive years [14]. Chicago also has some of the highest rates of economic inequity among American cities, largely driven by socioeconomic and racial segregation across neighborhoods [15]. This pattern reflects legacies of structural racism resulting in lower financial investment and higher environmental health burdens in communities of color [16] that create conditions conducive to rat population growth. The mental health implications of household rat exposure may thus be amplified in marginalized communities already experiencing poorer neighborhood conditions.

In this study, we examined how living with rats may impact urban residents' mental health in Chicago. First, we identified sociodemographic and psychosocial correlates of rat sightings in a large and diverse residential sample in a major city with high rat prevalence. Second, we examined relationships between rat sightings and mental distress and determined thresholds at which rat sightings in the home, and on one's block, are more likely to be associated with mental distress. Third, we assessed the extent to which associations between rat sightings and mental distress vary by race, ethnicity, income, home ownership, and gender. Specifically, we tested the hypothesis that the association between rats and mental distress would be heightened among urban residents with lower incomes, renters, and individuals of minority race or ethnicity, due to systemic disinvestment. Last, we explored a set of hypothesized psychosocial factors as potential pathways between rat sightings and mental distress: feeling negatively about the home, thinking about rats when they are not present, and less perceived control with respect to rats. The results of this study will broaden the public health understanding of rat infestations and associated health disparities to inform targeted rat management in at-risk communities.

Methods

We conducted a randomized household survey in 12 Chicago community areas selected along an income gradient (Figure 1). We mailed survey invitations and reminder cards to sampled households in summer 2021 (June-mid-August), to align with the annual peak in rat complaints in Chicago [17]. Respondents could complete the survey online in English, Spanish, and Mandarin Chinese, participate by phone, request a print copy to submit by mail. We offered a \$10 remuneration for participation.

The survey assessed residents' experiences with rats, knowledge and perceptions of rats, use of rodent control, and health outcomes. Demographic questions were selected to reflect characteristics commonly

associated with underlying inequities in housing or access to services. We asked respondents if they rented or owned their home and their annual income. We asked respondents to select the racial or ethnic heritage categories with which they identify, aligned with those included in the U.S. census [18]. Some racial and ethnic groups were under-represented in our sample in comparison to Chicago population characteristics [19] (Table S1) and sample sizes for many groups were too small to assess individually ($n < 10$), thus, we collapsed these data into “white” and “non-white” categories in our analyses but included summary statistics for all racial and ethnicity categories in the Supplemental Material (Table S2). We also asked respondents about their gender identity (woman, man, non-binary, self-describe). Although sample size was too low to include non-binary respondents in analysis ($n = 6$), Supplemental Material shows descriptive statistics for all genders (Table S3).

Rats may be only one aspect of neighborhood conditions that contribute to mental distress. To account for perceived neighborhood disorder, we used a previously-validated five-item three-point scale [6] based on the Block Environmental Inventory [20]. We asked respondents if the following items were “less of a problem,” “about the same,” or a “more of a problem” on their block: vacant housing; trash in the streets; groups of teenagers hanging out on the street; people selling drugs; and people getting robbed or beat up. Higher scores reflected more negative neighborhood perceptions. Scores ranged from 0 to 10 and we considered a score of over five to reflect high neighborhood disorder. Scale Cronbach’s alpha was 0.86.

Rat sightings

We asked about the frequency of rat sightings in or around their home or on the block over the past six months (Never, Rarely (Less than monthly), Sometimes (Monthly), Frequently (Weekly), Daily or almost daily). We asked separately about household and block sightings because we hypothesized that more proximal and personal sightings in the home would be more distressing relative to encounters outdoors. We also asked about direct contact with rats (i.e. touched a rat) over the past six months to assess whether direct contact was particularly associated with mental distress relative to sightings.

Mental distress

We used the 10-item Center for Epidemiological Studies Depression (CES-D) scale to assess and create a binary measure of mental distress [21], which has been previously validated in several populations [22]. The scale includes statements related to depressed mood, feelings of helplessness and hopelessness, and sleep disturbance. Scale scores range from 0 to 30 and a score of 10 or greater indicates the presence of high depressive symptoms.

Psychosocial factors

Because rat infestations are notoriously difficult to control, we hypothesized that rat infestations would create feelings of helplessness for residents that could amplify distress. We asked respondents how much they agreed with the statement “rats are unavoidable”. We also hypothesized a rumination dimension of rat sightings for residents who see rats frequently, so we asked how much respondents

agreed with the statement “I think about rats even when I don’t see them”. For both statements, responses ranged from strongly disagree to strongly agree, which we pooled as “strongly agree/agree” or “other” for statistical analysis. We further hypothesized that rat infestations may more broadly contribute to negative perceptions of their home or community, so we asked whether they agreed with the statement “Do rats affect how you feel about where you live”, with an open-ended response field for explanation. These responses were coded by the lead author for overall tone (positive/neutral/negative) and major theme(s) to increase confidence in the validity of this binary variable.

Statistical analysis

We first assessed the overall association between high vs. low depressive symptoms (outcome) and the frequency of rat sightings in/around the home or on their block using logistic regression. We controlled for neighborhood disorder (high vs. low) and we used a dataset with complete data on rat sightings, CES-D scores, neighborhood disorder scale, and psychosocial factors (n = 589). We completed this analysis with a larger dataset because missing demographic data was biased based on race and income (i.e. the ratio of non-white to white respondents in complete cases was 0.54:1 in complete cases but 0.68:1 in incomplete cases). We then assessed the relationship between rat sightings and high depressive symptoms, while controlling for neighborhood disorder, using stratified models for respondents who identified as women (n=314), men (n=204), white (n=320), non-white (n=175), renters (n=183), and owners (n=381).

We next assessed whether psychosocial factors had a moderating effect on the relationship between rat sightings and high depressive symptoms. We ran logistic regression models with high vs. low depressive symptoms as the outcome and included rat sightings (at home or on block), neighborhood disorder, and each psychosocial factor in turn. We considered a psychosocial factor to have a moderating effect if the coefficient for rat sightings changed by more than 10% [23]. We first ran these models for the overall dataset (n = 589) and then separately for respondents based on gender (women, men), race/ethnicity (white, non-white), and home ownership (renters, owners) using stratified models. We then examined the relationship between rat sightings and depressive symptoms in the presence of all moderating psychosocial factors, neighborhood disorder, and interaction terms for demographic characteristics for which there were significant associations between rat sightings and high depressive symptoms.

Finally, we were interested in identifying demographic correlates for each psychosocial factor because they represent ways in which rats can impact residents’ day to day lives. To explore these associations, we ran global models with each psychosocial factor as the outcome variable and, as explanatory variables, all demographic variables of interest (gender, racial category, income, renting status) as well as daily rat sightings to control for rat exposure.

All statistical analysis was performed in R Studio using R version 4.2.2 [24]. Multicollinearity in the final model was assessed using Variance Inflation Factors using the “car” package with a value of 5 indicating high collinearity [25].

Response rate

We received a total of 589 responses (96.6% English, 3.4% Spanish) for all variables of interest excluding demographics and 409 complete cases (69.6%) due to missing data for race/ethnicity (81%) and income (71%). We had a 14% response rate, which is slightly higher than other postal surveys to randomly-selected households [26]. Of complete cases, survey respondents were more likely to identify as white (n = 255, 62.3%), women (n = 245, 59.9%), and with higher incomes (n = 284, 67.0% over 50K) relative to Chicago census data (Table S1).

Results

Among respondents to all outcomes of interest (n=589), the overall rate of high depressive symptoms was 19.9% (117/589), which was similar for respondents who identified as women (20.5%, 67/327) or men (19.5%, 41/210) but higher for non-white respondents (24.1%, 47/195) relative to white respondents (19.3%, 62/322). In terms of rat sightings, 28.7% (169/589) of respondents saw rats on their block and 21.1% (124/589) saw rats in or around their home daily or almost daily during the study period. In terms of psychosocial factors, 61.5% of respondents agreed that rats affect how they feel about where they live (362), 45.0% agreed that rats are unavoidable (265), and 33.6% (198) agreed that they thought about rats when they did not see them (Table S2 and S3).

Thematic analysis of open-ended responses from those who agreed that rats affected how they felt about where they live (n = 335) showed that 33.7% (113) referred to their property, 6.6% (22) to their block, 28.1% (94) to their neighborhood, and 8.4% (28) to the city of Chicago. Open-ended responses frequently mentioned feeling dirty or unclean (22.0%), avoiding outdoor spaces and activities (17.1%), and wanting to move (8.9%) because of rat issues. All comments were negative in tone using diverse terms such as “fear” (8.3%), “safety” (5.9%), “shame” (3.1%), “neglect” (3.1%), and “disease” (3.1%). The proportions described above were similar in the sample of complete cases (Table S4).

Rat sightings and mental distress

Respondents who reported seeing rats more frequently in or around their home were more likely to have high depressive symptoms (AOR = 1.69 [1.0 - 2.97]). The association was highest for those reporting daily rat sightings (Figure 2). When analyzed as a binary response, respondents who saw rats daily or almost daily in or around their home or on their block were over twice as likely to report high levels of depressive symptoms than respondents who saw rats less often, after accounting for neighborhood disorder (rat sightings in home: AOR = 2.32 [1.45, 3.66], block: AOR = 1.95 [1.27, 2.99]).

This relationship between daily rat sightings and mental distress varied depending on respondent demographics. In stratified models controlling for neighborhood disorder, men (n = 204) who saw rats daily in or around their home were significantly more likely to have high depressive symptoms (AOR = 2.66 [1.17, 5.93]), as were respondents who identified as non-white (n = 175) (AOR = 2.92 [1.36, 6.31]). However, we found no significant relationship for women (n = 314) (AOR = 1.70 [0.87, 3.21]) or white

respondents (n = 320) (AOR = 1.45 [0.68, 2.91]). We found a significant relationship between rat sightings and high depressive symptoms for both renters (n = 183) and owners (n = 381) (renters: AOR = 2.22 [1.07, 4.59], owners: AOR = 2.00 [1.01, 3.83]) but the association was not significant when models were stratified by income. These relationships were generally stronger for rat sightings in the home relative to on the block (Table S5).

Non-white respondents were significantly more likely to come in physical contact with rats relative to white respondents (OR white = 0.50 [0.34, 0.74]) but we found no significant difference based on other demographics of interest.

Moderating effect of psychosocial factors

We found no moderating effect of any of the hypothesized psychosocial factors in the full sample (n = 589). In stratified models, the association between rat sightings and high depressive symptoms was moderated by whether or not rats affected how respondents felt about where they lived, specifically among respondents who identified as women, white, with incomes over 50K, with incomes under 50K, renters, and owners (Table S6).

Our final model for high depressive symptoms included rat sightings at the spatial scale (in/around the home) and frequency (daily) most associated with mental health impacts; the respondent demographics for which there were significant associations between rat sightings and high depressive symptoms as interactions (gender, racial category, property ownership); significant moderators (income and whether or not rats affected how respondents felt about where they live); and controlled for neighborhood disorder. This model showed that respondents who saw rats in their home daily were 5.5 times (95% CI: 1.18 - 9.43) as likely to have high depressive symptoms relative to respondents who saw rats less often (Figure 3, Table S7). The model further showed that depressive symptoms were higher among respondents who were renters (AOR = 1.82 [1.00 - 3.31]) and if they had lower incomes and agreed that rats affect how they feel about where they live as an interaction (AOR = 2.99 [1.03, 8.97]; Figure 4, Table S7).

Demographics associated with psychosocial factors

Relative to women, men were significantly more likely to think about rats when they did not see them (OR women = 0.60 [0.40, 0.91]). We also found that owners and women were more likely to agree that rats affect how they feel about where they live relative to renters and men, respectively (OR renters = 0.62 [0.40, 0.97], OR women = 1.87 [1.24, 2.85]). All other associations were not statistically significant.

Discussion

In this study, we examined relationships between rat sightings and residents' mental distress in a large American city. We found that survey respondents who saw rats in their home daily or almost daily were over five times as likely to report high depressive symptoms relative to respondents who saw rats less frequently. Further, respondents with lower incomes who agreed that rats affect how they feel about

where they live had nearly three times higher odds of reporting high depressive symptoms. We found stronger associations between rat sightings and high depressive symptoms for respondents who identified as men or a race or ethnicity other than white or Euro-American.

Our results align with past studies while broadening the findings and highlighting at-risk groups. For example, German and Latkin [6] also found that daily rat sightings were associated with depressive symptoms, but generalizability was limited to people with histories of drug use. Our results show that rat infestations may affect the mental health of the general population, but that effects are still disproportionately felt by some populations depending on their gender, race, and income. Residents with lower incomes may have been particularly affected by feeling negatively about where they live due to rats (Fig. 4) if they were financially unable to move or hire a pest professional. Women were more likely to agree that rats affect how they feel about where they live relative to men, which may reflect gendered household activities [27]. Conversely, men were more likely to think that rats are unavoidable relative to women. The stronger association between rat sightings and mental distress in men may stem from gendered household roles that result in men feeling more responsible for rodent control [28]. The differences we observed in depressive symptoms and rat sightings between white and non-white respondents are likely due to historic and ongoing oppressive policies wherein communities of color are more likely to live in neighborhoods that have been systematic disenfranchised with other environmental health hazards such as higher heat, poorer air quality, and more contaminants in soil and water [16, 29, 30]. As such, rat infestations can be conceptualized as another environmental health burden disproportionately felt by underserved communities.

Our results also point to potential mechanisms by which rat presence may negatively affect residents' mental health. For example, most respondents indicated that rats affect how they feel about where they live and mentioned feeling unclean, unable to do certain activities around the home such as using outdoor spaces, and wanting to move to a new home. Rats may be perceived as a visible indicator of disorder linked to the undesirability of a property or neighborhood, particularly in marginalized communities for whom neighborhood disorder is perceived to be higher [29]. Future work that elucidates how rats affect residents' perceptions of their home as well as barriers to controlling rats in the home could help identify strategies for mitigating these impacts.

There are several limitations when interpreting our results. Survey responses were biased towards a larger number of white and higher-income respondents, likely reflected in the spatial bias towards respondents from Chicago's North Side (Fig. 1). We also lacked the statistical power to model rat sightings and mental distress for specific racial and ethnic groups. We provide descriptive statistics for all groups in the Supplemental Material, but it will be important for future research to fill this gap. We also relied on self-reported rat sightings as an indicator of rat presence rather than a potentially more objective indicator such as random building inspections. This approach enabled us to focus on rat presence that residents were aware of, which is likely more impactful for mental distress.

Conclusion

Our results suggest that management actions to reduce the likelihood of daily rat sightings in and around the home and on the block should be emphasized to mitigate any negative impacts of rat infestations for resident mental health. Structural challenges can create barriers to household rodent control such as property ownership, relationships with neighbors, affordability of products, and engagement with public services, all of which are influenced by socioeconomic status. Further municipal attention is needed to both support household rodent control and attenuate environmental conditions outside of homes that impact rat prevalence, such as waste management. More broadly, our results highlight rat-associated health impacts beyond the transmission of zoonotic disease. There may also be value in coupling mental health support with rat eradication efforts. Given that most cities around the world are struggling to control rat populations [31], it is important to explore whether and how effective rat control coupled with increasing mental health support for residents experiencing rat infestations could help improve public health in cities.

Declarations

Acknowledgements

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Figures

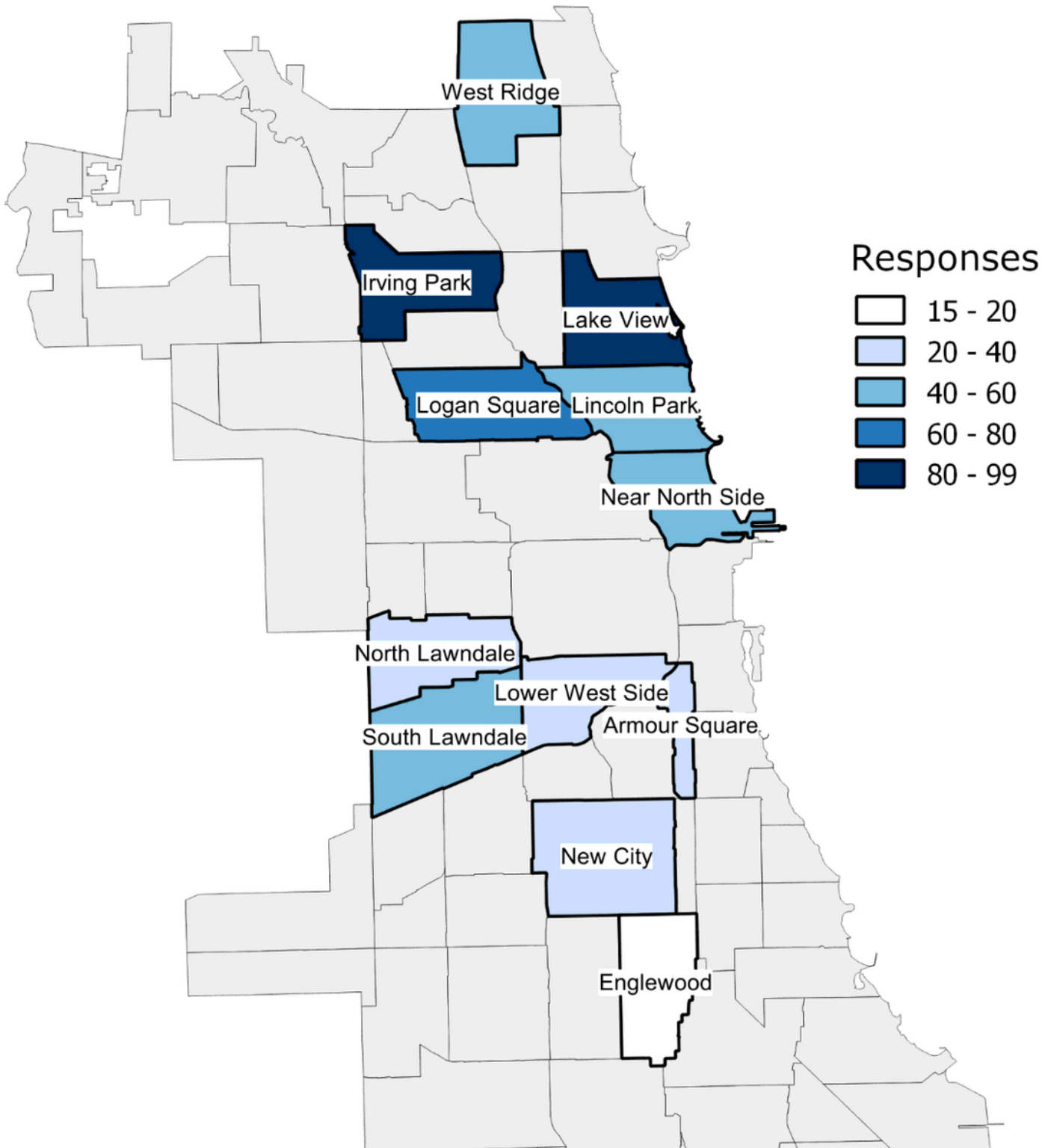


Figure 1

Map highlighting 12 community areas in Chicago where our survey was distributed by mail. Blue shading indicates the number of responses from each community area.

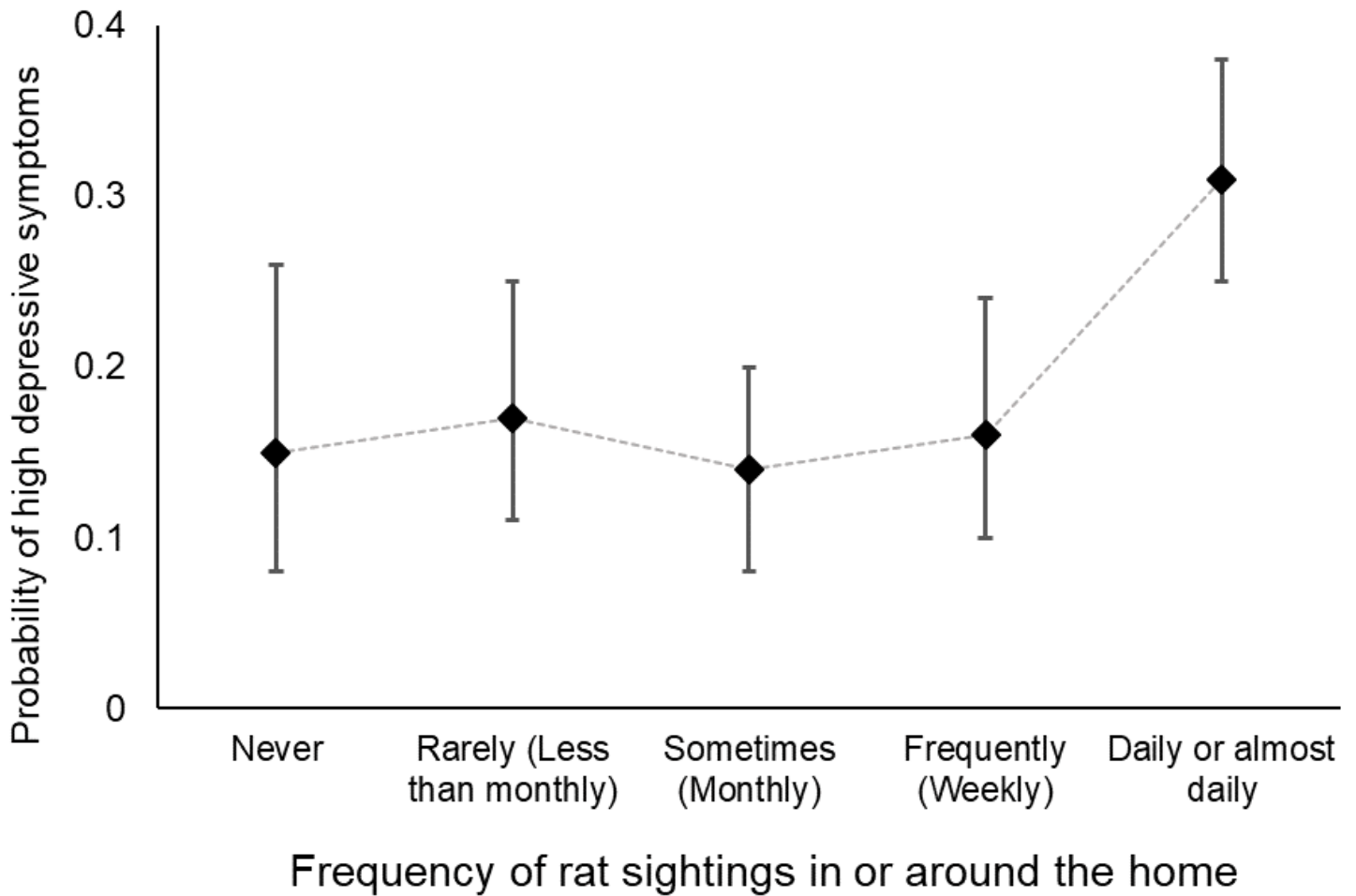


Figure 2

Relationship between the frequency of rat sightings in or around the home and the probability of having high depressive symptoms (i.e. CES-D score of ≥ 10) based on 589 survey respondents in Chicago, IL, USA.

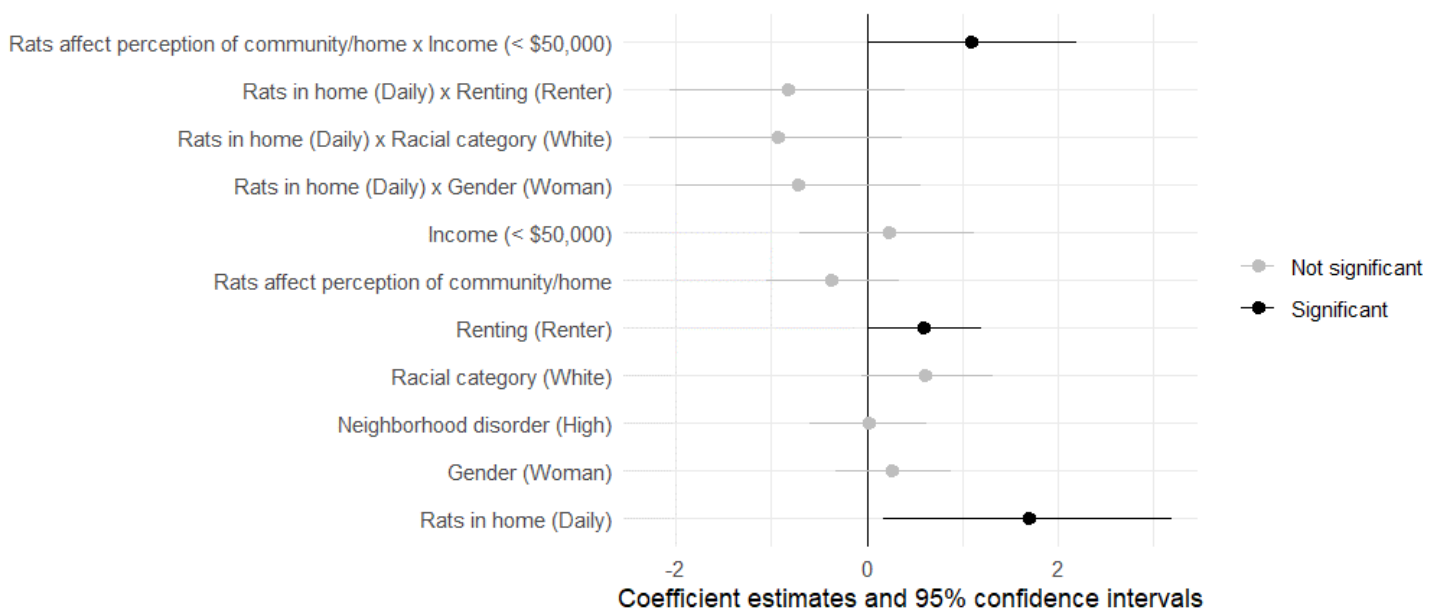


Figure 3

Forest plot showing the coefficient estimates and associated 95% confidence intervals for all explanatory variables included in the final model with high depressive symptoms (i.e. CESD ≥ 10) as the outcome variable (n = 409). Black circles and error bars indicate variables that were statistically significant (p < 0.05).

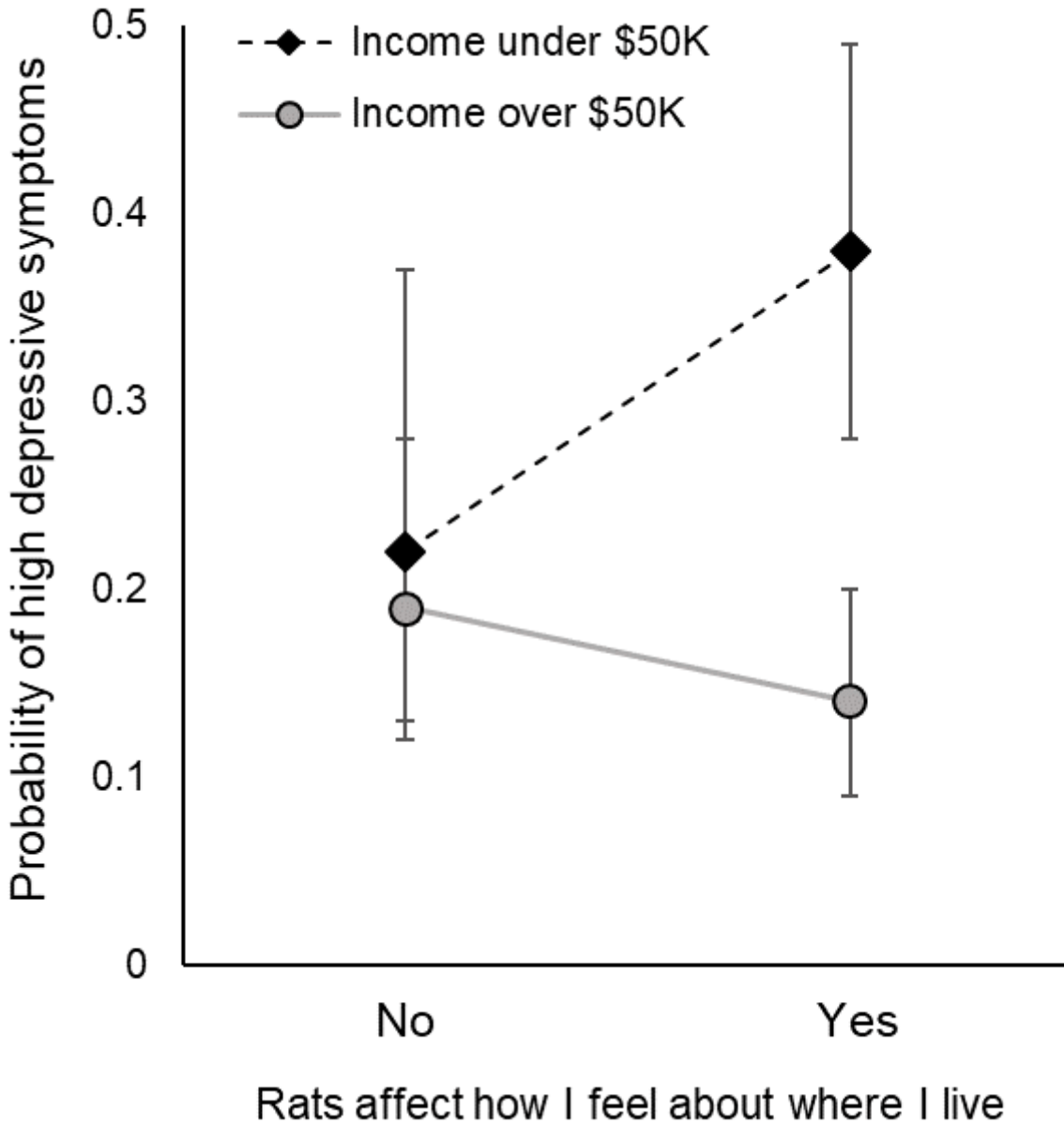


Figure 4

Significant interaction between the probability of a survey respondent reporting high depressive symptoms, rats affecting how they feel about where they live, and if the respondent reported having above (black diamonds) or below (gray circles) an income of \$50,000 USD (n = 409).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Supplementalmaterial10.10.2023.pdf](#)
- [supplementdata58910.16.2023.txt](#)