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Do health trajectories predict neighborhood outcomes? Evidence of health selection in a diverse sample of U.S. adults

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Abstract

Across the United States, residents of lower income neighborhoods evince poorer health, on average, than residents of more affluent areas. Studies aiming to explain this pattern have focused largely on the effects of neighborhood characteristics on residents' health, often overlooking the possibility that the reverse causal process—that a person's health impacts where they live, or 'health selection into neighborhoods'—also plays a role. We investigated processes of health selection using the Panel Study of Income Dynamics, a longitudinal survey of U.S. households. Using ordinary least squares linear regression, we estimated the effect of householders' self-rated health on their neighborhood socioeconomic status (SES, the Census tract-level family poverty rate) in 2013, adjusting for neighborhood SES and health in 2001 as well as sociodemographic characteristics and residential mobility. Poorer health was associated with residence in higher poverty neighborhoods overall. Stratified models indicated that while health selection was observed across both race/ethnicity and class boundaries, the relationship between poor health and neighborhood poverty was stronger among non-Hispanic Black respondents, those with low income, and respondents who either moved moderate distances or did not move at all during the study period. We conclude with a call for future work exploring the mechanisms leading those in worse health to reside in higher poverty neighborhoods, and for public health policies that seek not only to improve health supporting conditions in economically disadvantaged neighborhoods, but that also support the economic and social needs of residents struggling with health problems.

Keywords

health selection; neighborhoods; socioeconomic status; poverty

INTRODUCTION

Population health varies across places large and small. In the United States, the range of life expectancies between neighborhoods in single cities can exceed 15 years (Dwyer-Lindgren et al. 2017). Not only does health and longevity vary across neighborhoods, this variation is socially patterned, with relatively economically disadvantaged places evincing poorer mental and physical health as well as higher mortality (Diez Roux and Mair 2010; Kawachi and Berkman 2003; Robert 1999).

Variation in health across neighborhoods may be explained by some combination of three processes: contextual–or neighborhood–effects, sociodemographic composition effects, and health selection effects. Much observational and experimental research has been conducted to evaluate support for the neighborhood effects perspective, which is that neighborhood characteristics causally impact residents' health (Diez Roux and Mair 2010; Ludwig et al. 2013; Oakes et al. 2015; Pickett and Pearl 2001; Riva, Gauvin, and Barnett 2007). Neighborhood effects research is motivated by the notion that, if differences in health across communities stem from modifiable characteristics of place, then urban policy and planning interventions can reduce spatial health disparities and improve population health more broadly.

In contrast, composition and selection effects arise from the non-random sorting of more and less healthy residents across neighborhoods (Diez Roux and Mair 2010; Sampson, Morenoff, and Gannon-Rowley 2002). Both composition and selection effects may threaten the validity of causal inference in neighborhood effects research. As such, they are typically viewed as nuisances that must be understood primarily so that they can be controlled (Clampet-Lundquist and Massey 2008; Sampson 2008). We assert, however, that composition and selection effects warrant study in their own right. Evidence that composition or selection underlies spatial variation in health would suggest that investments be directed not only towards neighborhood characteristics, but also towards people themselves and against the social, economic, and health constraints they face - constraints that influence where they end up living. Thus, studies of selection may help identify potentially modifiable mechanisms by which health and social disparities are co-constructed, entrenched, and reproduced.

In this study we define health selection as the dynamic sorting of people into residential contexts on the explicit basis of their health. Both mobility and immobility can contribute to health selection as the likelihood that someone remains in place rather than moves, and the type of place they go upon moving, may be partially driven by their health status. A clear example of health selective mobility would involve people deciding to move closer to medical providers, informal caregivers or loved ones, or other social services due to their health. Health selection can also occur through immobility when residents in poor health hesitate to leave their current home or neighborhood because doing so would take them away from familiar sources of care and other services needed to manage a medical condition. Even if moving decisions are rarely based explicitly on health concerns, health problems that deplete financial resources, alter employment outcomes, change risk tolerance, or constrain people's time and attention (i.e., "bandwidth") in ways that ultimately

affect where people end up living could contribute to subtle but widespread health-based selection into neighborhoods. In the United States in particular, where millions of people lack health insurance and many more are underinsured, health issues have the potential to upend families' economic stability, or at the very least, to delay progress towards financial goals (Himmelstein et al. 2009; Witters 2020). We know from the broader residential mobility literature that socioeconomic resources enable moving for those who are dissatisfied with their existing home or neighborhood, while lack of resources constrains mobility among those who desire to move and prompts it among those who would prefer to stay (Coulter, Ham, and Feijten 2011; Kan 1999). To the extent that poor health drains socioeconomic resources, it should also predict less desirable residential outcomes.

Examining the process of health selection empirically is complicated by the fact that health and neighborhood characteristics are influenced by many of the same factors, including, for example, socioeconomic marginalization and exposure to racism or racial privilege. To isolate the causal effects of health on residential outcomes, some studies have examined rare cases in which health is randomly affected via medical treatment (Arcaya et al. 2017) and where people change neighborhoods because of external circumstances such as Hurricane Katrina rather than for endogenous reasons (Arcaya et al. 2014, 2016). Results from these studies are somewhat mixed in the strength of their support for the existence of health selection.

Observational evidence from the migration literature is generally consistent with the health selection hypothesis, with healthier households tending to move to more advantaged places, reinforcing the spatial concentration of health (Connolly, O'Reilly, and Rosato 2007; Norman and Boyle 2014; Norman, Boyle, and Rees 2005; Riva, Curtis, and Norman 2011; Wilding, Martin, and Moon 2016). Research also suggests that unhealthy people can become "stuck in place", unable to move out of high poverty or socioeconomically declining neighborhoods and further exacerbating geographic health disparities (Cox et al. 2007; Geronimus, Bound, and Ro 2014; Wilding et al. 2016). More stringent control for endogeneity in observational studies, however, has produced null findings. For example, a recent study of young adults found no evidence of selection into neighborhoods based on genetic predictors of weight or mental health, measures that are stable over the life course and thus immune to changing environmental circumstances, including neighborhoods (Belsky et al. 2019). However, these results may obscure selection effects that work in tandem with environmental contexts, those that emerge in later adulthood, and those that are evident primarily among non-European populations, as the study was limited to people of European ancestries. Other conflicting evidence raises questions as to whether patterns of health selection are robust across geopolitical contexts, forms of health, and sociodemographic groups (Curtis, Setia, and Quesnel-Vallee 2009; Dunn et al. 2014; van Lenthe, Martikainen, and Mackenbach 2007).

Our understanding of the scale and scope of health selection in the United States remains particularly limited for two reasons. First, U.S. studies often rely on samples that are disproportionately marginalized or encountering highly unusual circumstances (Arcaya et al. 2014, 2016, 2017). Second, population-based evidence regarding health selection comes primarily from European studies and other non-U.S. contexts (Connolly et al. 2007; Curtis

et al. 2009; van Lenthe et al. 2007; Norman and Boyle 2014; Norman et al. 2005; Riva et al. 2011; Wilding et al. 2016). This is an important gap in the literature as the U.S. is exceptional among countries in many ways, including in its lack of universal healthcare, limited social safety net, vast income and wealth inequalities, and historical and current scourge of systemic racism. We know very little about the effects of health on neighborhood attainment in the U.S. over the course of ordinary life. We know even less about whether such effects differ across key population subgroups. Yet clarifying the role of health selection in the spatial distribution of health is needed to make further progress towards understanding, and potentially intervening on, neighborhood characteristics that causally affect health, and for developing other policies that mitigate the effects of health disadvantage on residential outcomes.

In addition to understanding whether differences in health lead to differences in neighborhood environments, we need to understand how sorting might take place, for example by making it less likely that people will move or by affecting the distance or destination of moves among movers. Prior research on this subject is mixed, with some studies suggesting that moves are more common among those in good health (Norman et al. 2005; Wilding et al. 2016) and others indicating that those in poor health are most likely to move (Dunn et al. 2014; Larson, Bell, and Young 2004; Verheij et al. 1998). Others suggest that patterns depend on additional characteristics such as age (Bentham 1988; Connolly et al. 2007). Because health problems are known to impose physical, social, and/or financial constraints, it may also be that those in poor health move at similar rates compared to their healthier counterparts, but make different move types, for example shorter distance moves, or moves to less desired neighborhoods on average.

To address the population and geography limitations of previous literature, this study examined processes of health selection in a large and heterogenous sample of U.S. adults in the Panel Study of Income Dynamics (PSID). To make progress on issues of reverse causality, we employed a baseline/follow-up empirical strategy and considered movers versus non-movers in some specifications to allow for additional insight into selective mobility and immobility. The baseline/follow-up structure allowed us to ask whether health problems were associated with residence in higher poverty neighborhoods regardless of past health and neighborhood status. Importantly, this question is different from a simple composition question of whether people with poor health reside in higher poverty neighborhoods. This structure enabled us to observe and control for health and neighborhood status at baseline, and then model the relationship between subsequent health and neighborhood outcomes 12 years later. Specifically, we estimated the association between health in 2013 and neighborhood-level socioeconomic status (SES) in 2013 adjusting for both neighborhood SES and health at baseline (2001) within an ordinary least square (OLS) regression framework. Specifications stratified by racial/ethnic identification and family income were explored to examine heterogeneity in associations across social groups.

Our empirical strategy accounted for initial health selection and neighborhood effects; however, it did not account for the potential accrual of neighborhood effects on health over the study period. To limit the role of these effects, we present specifications stratified by

movers and non-movers. We argue that observing PSID respondents that moved during the study period allows for a cleaner interpretation of possible health selection effects given that time in any one neighborhood is short relative to the study period. As summarized by Clampet-Lundquist and Massey (2008), regardless of mechanism, the influence of a neighborhood on its residents requires a non-insignificant passage of time. For non-movers, the observed follow-up relationship between neighborhood SES and health may represent a simultaneous health selection and neighborhood effect. As previously noted, health selection can arise through the inability to leave an economically disadvantaged neighborhood due to health-related barriers, while a negative neighborhood effect may contribute to declining health. Within our framework, and given our data, we are unable to fully disentangle these effects. However, our ability to control for initial health selection and neighborhood effects limits the remaining source of neighborhood effects to fluctuations in neighborhood characteristics that influence health over the study period. Such external environmental changes may include disaster and rebuilding (e.g., New Orleans after Hurricane Katrina, which significantly changed many parts of the city), changes brought by gentrification, and the neighborhood effects of the foreclosure crisis 2006-2008. However, short-term fluctuations in neighborhood SES are uncommon—even when looking across longer periods of time, neighborhood SES is generally stable (Airgood-Obrycki 2019; Malone and Redfearn 2018).

METHODS

Data

Data was collected from the Panel Study of Income Dynamics (PSID). The PSID is a nationally representative longitudinal survey of American families that began in 1968 with a sample of about 18,000 individuals from 5,000 families. Original family members, their descendants, and new spouses and children have since been incorporated into the study, and the study has periodically added members of specific population subgroups to maintain the sample's national representation. Since 1997, respondents have been surveyed biennially.

We drew information from 4,499 heads of household (HOH) ages 20 and above who were surveyed in both 2001 and 2013. To deal with missing data, we used listwise deletion. Our final analytic sample included 4,344 respondents. Males were overrepresented among HOHs and therefore in our sample, as the PSID automatically designated husbands in married heterosexual couples as the HOH; the HOH in households led by single adults could be either male or female. The advantages of using the PSID for this study includes its longitudinal nature and heterogeneous sample, which enabled us to examine patterns of health selection separately across sociodemographic subgroups. Estimating population-average effects of health on neighborhood outcomes was not an intention of our analysis, and we did not include survey weights into our models as a result.

Measures

Neighborhood socioeconomic status (SES)—In all analyses, the dependent variable reflected the SES of a respondent's 2013 neighborhood, as defined by their Census tract. Census tracts are designed by the U.S. Census Bureau to be relatively small, stable, and

homogeneous subdivisions of counties, inhabiting about 4,000 residents on average (Census Bureau 2021). Neighborhood conditions are frequently measured at the Census tract level of geography (Krieger et al. 2003).

Our primary measure of neighborhood SES was tract-level family poverty rate as calculated by the U.S. Census Bureau. The threshold for family poverty used by the Census Bureau is a function of family size and the age of its members, and thresholds are adjusted for inflation each year. Total family income, which is compared to this threshold, includes pre-tax income and excludes non-cash public benefits. We matched respondents' 2013 Census tracts with tract-level family poverty rates in the 2011-2015 American Community Surveys. We created a corresponding measure for respondents' 2001 Census tracts, to be used as a control variable in analyses, by merging with family poverty rates from the 2000 decennial Census. In both years, 2010 Census tract boundaries were used.[1] The resulting variables reflected the proportion of families within the respondent's Census tract that were deemed to be below the poverty threshold in the given year. Neighborhood poverty rates ranged from 0 to 1, with higher values indicating lower neighborhood SES.

Health—Our focal independent variable was self-rated health (SRH) in 2013. SRH is a parsimonious and commonly used measure of overall health; it is strongly correlated with diagnoses, biological measurements, and mortality, and its open-endedness allows people to consider not only diagnoses, but also the severity of their symptoms (including those that have not led to a diagnosis), how well they have adapted to health-related limitations, presence of comorbidities, health-related behaviors, and other potentially relevant information (Idler and Benyamini 1997; Jylhä 2009; Quesnel–Vallée 2007). While some have questioned the suitability of SRH for studying health disparities (Dowd 2012), the current study hinges on health as a predictor rather than an outcome, and its focus is not on health disparities by socioeconomic status or race, but rather neighborhood conditions by health. SRH was assessed with a question asking, "Would you say your health in general is excellent, very good, good, fair, or poor?" We expressed SRH as a five-category variable when conducting analyses on the full sample. In order to comply with PSID data privacy rules for minimum cell sizes, in stratified analyses, we collapsed SRH into three categories: poor or fair; good; and very good or excellent.

To control for baseline health status, we used SRH collected at 2001. In addition, we controlled for a number of diagnosed chronic conditions in 2001 in order to more stringently account for pre-existing health problems that may not have been captured by the categorical SRH question alone. We considered the following nine conditions in the index: arthritis, asthma, high blood pressure, cancer, diabetes, heart attack, heart disease, lung disease, and stroke.

[1]The restricted PSID data we used include Census tract identifiers based on 2010 tract boundaries for all years. Census tract boundaries change over time, and so it is important that longitudinal analyses involving any spatially bound characteristics remain comparable. We therefore used boundary consistent data from the 2000 Census and the 2011-2015 ACS. The National Historic Geographic Information System (NHGIS) provides these data in 2010 boundaries where the original data has been weighted appropriately to account for instances of tracts splitting due to population growth/new development.

Sociodemographic characteristics—We included several sociodemographic covariates, each of which may confound associations between health status and residential considerations. Measures included age in 2001 and age-squared, a binary variable indicating that the respondent was a college graduate, and number of children under 18 in the household in 2001, because presence and number of children predicts both SRH and residential outcomes (Floderus et al. 2008; Denney et al. 2013; Lamidi 2020; Lieber et al. 2020; Lee and Waddell 2010). We adjusted for a binary indicator of male versus female sex/gender, the only two categories included in the data, as gender-based discrimination affects where people can live and harms health (Pennington et al. 2018; Stepanikov et al. 2020). Models also adjusted for, and in some cases were stratified by, racial/ethnic identification (non-Hispanic White, non-Hispanic Black, Hispanic, or other) to account for the fact that racism constrains housing choice and harms health (Williams and Collins 2001; Goosby et al 2018).

We also created and adjusted for a five-category measure of 2001 family income. Respondents were coded as having high income in 2001 if their total family income was above the 90th percentile of the distribution across the full PSID family dataset ($114,000). Low income respondents had incomes below the 90th percentile *and* at least one of the following was true: the family received food stamps the previous year; the family's rent was fully or partially subsidized by the federal, state, or local government; or the housing unit the family lived in was owned by a local housing authority or another public agency. We then created three middle-income categories (low-middle, middle-middle, and high-middle) by dividing into tertiles those whose total family income fell in the bottom 90th percentile of the distribution but did not receive welfare in the form of food stamps or housing subsidies. Note that no respondents in the high income group received social assistance of any kind.

Residential mobility—We created a four-category mobility variable using data from all survey waves between 2001 and 2013 or seven waves of data in all, one in each odd-numbered year. Respondents who reported in all survey waves that they had not moved in the previous two years were coded as having never moved, the reference category. For those who had moved at least once between 2001 and 2013, we calculated the maximum distance between the centroids of their Census tracts, where the PSID bases Census tract location on self-reported residence. We then divided maximum move distance into tertiles which we refer to as "short", "moderate", and "long" moves in text and tables.[2] Rather than a simple binary variable indicating whether a respondent moved or not, we opted for a distance-based measure to capture heterogeneity in move quality that may be associated with distance.

Analysis

We began by estimating descriptive statistics, including means and standard deviations for continuous measures and percentages for categorical variables. Next, we used ordinary least squares (OLS) linear regression to examine the relationship between neighborhood

[2]Within-tract moves were recorded as having a distance of zero kilometers. We cannot verify within-tract move distances but on average this distance is likely quite small.

poverty in 2013 and a respondent's contemporaneous health status in the full sample. Model 1 regressed neighborhood poverty rate in 2013 (Pov_{t+1}) on categories of SRH in 2013 (SRH_{t+1}) for individuals, i, in the analytic sample. Specifically, we compared neighborhood poverty rates for those reporting poor, fair, good, and very good SRH to those with excellent SRH (the reference group). Model 1 controlled for neighborhood poverty in 2001 (Pov_t), SRH in 2001 (SRH_t) (reference: excellent), and number of chronic conditions in 2001 ($Conditions_t$). Model 2 added variables for age and age-squared, male sex, racial/ethnic identification (reference: non-Hispanic White), number of children under 18 in the household, college completion, and family income category (reference: high) as observed in 2001. Income was of particular interest given its potential as a health selection mechanism. Model 3 added the residential mobility variable (reference: did not move) as a covariate to capture the role of mobility as a mechanism for health selection.

$$Pov_{t+1,i} = \alpha + \sum_{j=1}^{4} \beta_j SRH_{t+1,i,j} + \gamma Pov_{t,i} + \sum_{k=1}^{4} \theta_k SRH_{t,i,k} + \delta Conditions_{t,i} + \epsilon_i \quad \text{Model 1}$$

To assess whether effects of health on neighborhood poverty were heterogeneous across key population subgroups, we estimated Model 3 stratified first by race/ethnicity (non-Hispanic White and non-Hispanic Black, the two largest racial/ethnic groups in the sample) and then by 2001 family income category. Three-category measures of SRH (poor/fair, good, and very good/excellent) were used in stratified specifications, rather than the five-category measures, to meet PSID requirements for minimum cell sizes.

To further explore the role of mobility and to make progress towards disentangling health selection from remaining neighborhood effects, we considered models stratified by the residential mobility variable. Three-category measures of SRH (poor/fair, good, and very good/excellent) were used in this specification, rather than the five-category measures, to meet PSID requirements for minimum cell sizes.

RESULTS

Descriptive statistics

Descriptive statistics are provided in Table 1. Respondents were, on average, age 43.71 (standard deviation [SD] = 13.44) in 2001. Approximately three out of four were male (74.40%), a result of limiting the sample to HOHs. Six in ten respondents were non-Hispanic White (59.81%), a third were non-Hispanic Black (31.74%), 5.00% were Hispanic, and 3.50% were some other race/ethnicity. Respondents had just one child (0.97, SD = 1.21) in the home in 2001, on average. About one in four had graduated college (27.20%). About one-quarter of the sample was considered to have low-middle (25.74%), middle-middle (25.53%), and middle-high (25.90%) family income in 2001. An approximately equal proportion was considered low (11.30%) and high (11.53%) income. More than half of respondents moved at least once between 2001 and 2013 (59.00%). Among those who moved, the average maximum distance moved was 278.42 kilometers (km) (SD = 713.19). Move distance was heavily skewed to the right, as the tertiles for the maximum distance moved were as follows: 0 – 7.42km; 7.46 – 34.61km; 34.66 – 7,840km.

Average neighborhood poverty rates increased slightly between 2001 (0.11, SD = 0.10) and 2013 (0.13, SD = 0.12). Meanwhile, health declined. The percent with poor or fair SRH, for example, increased from 11.40% in 2001 to 21.17% in 2013, while the percent claiming excellent health declined from 24.15% to 13.90%. Similarly, the average number of chronic conditions nearly doubled between 2001 (0.64, SD = 1.00) and 2013 (1.25, SD = 1.41). Well over half of respondents reported no diagnoses in 2001 (60.31%), but by 2013, this figure had declined to 37.89%.

Effects of health on neighborhood SES

As shown in Table 2, lower SRH in 2013 was associated with higher contemporaneous neighborhood poverty, as anticipated by the large literature on geographic health disparities. When adjusting only for earlier health status and neighborhood poverty to account for compositional effects (Model 1), reporting poor, fair, and good SRH versus excellent SRH was associated with significantly higher neighborhood poverty rates. Reporting very good SRH was not significantly associated with higher neighborhood poverty compared to excellent SRH, although the coefficient was positive. Fair or good baseline health was associated with higher neighborhood poverty compared to excellent SRH. However, the inclusion of sociodemographic covariates in Model 2 reduced both the magnitude and significance of these health effects. Poor or fair SRH in 2013 remained associated with significantly higher neighborhood poverty relative to excellent SRH. Adjusting for residential mobility in Model 3 did not attenuate these effects, although moving moderate and long distances between 2001 and 2013 was associated with lower 2013 neighborhood poverty.

In sum, even after adjusting for baseline health and neighborhood poverty, sociodemographic characteristics, and residential mobility, 2013 poverty rates were 2.24 (b = 0.0224, 95% confidence interval [CI] = 0.0075, 0.0374) and 1.56 (b = 0.0156, CI = 0.0044, 0.0268) percentage points higher on average, respectively, for those in poor and fair SRH in 2013 as compared to those in excellent SRH in 2013 (Model 3). Earlier measures of health (i.e., SRH and number of chronic conditions in 2001) were not consistently independently associated with neighborhood poverty 12 years later. As expected, neighborhood poverty rates in 2001 and 2013 were significantly related, such that living in places with higher poverty in 2001 was associated with higher neighborhood poverty in 2013. Sociodemographic covariate relationships with neighborhood poverty were in line with previous literature on gender-based, racial/ethnic, and socioeconomic marginalization, with female gender, minority race/ethnicity, lower family income, lower education, and higher number of children, as well as older age, significantly and positively associated with tract-level poverty rates. In general, moderate and long-distance moves were associated with lower neighborhood poverty in 2013. Robustness checks using alternative measures of health and neighborhood socioeconomic status provided qualitatively similar results.

We carried out additional robustness checks to assess whether and how age impacted our results, as age may be an especially important factor related to patterns of residential mobility and the spatial concentration of health, as outlined in the introduction. Removing

age from Model 3 resulted in very little change in the 2013 SRH coefficients. We further stratified Model 3 based on age tertiles and found no significant relationship between 2013 SRH and neighborhood poverty for older respondents (age 50 to 89 in 2001).[3] The relationship between 2013 SRH and neighborhood poverty was qualitatively similar to the main results for the younger tertiles (20 to 37 and 38 to 49).

Variation by race/ethnicity, family income, and residential mobility

Table 3 presents results of analyses stratified by race/ethnicity, allowing us to explore how health selection operated within different levels of racial/ethnic privilege. Among non-Hispanic White respondents, reporting poor/fair SRH was associated with residence in neighborhoods with poverty rates 1.00 percentage point higher than those reporting very good/excellent SRH (b = 0.0096, CI = 0.0013, 0.0180), net of other variables in the model. For non-Hispanic Black respondents, the association was larger in magnitude at 1.80 percentage points (b = 0.0180, CI = −0.0002, 0.0361) but with a p-value just over 0.05. Neither group showed a significant relationship between reporting good versus very good/excellent SRH and 2013 neighborhood poverty. As in main models, baseline health was not significantly associated with 2013 neighborhood poverty after accounting for 2013 health. Also consistent with main models, neighborhood poverty in 2001 was strongly associated with neighborhood poverty in 2013 for both racial/ethnic groups.

Results stratified by categories of family income in 2001, allowing us to explore how health selection operated across levels of household socioeconomic resources, are presented in Table 4. In the low-income group, which includes respondents whose households received government housing assistance or food stamps in 2001, the neighborhood poverty rate was 3.28 percentage points higher on average for respondents with poor/fair 2013 SRH than for respondents with very good/excellent 2013 SRH (b = 0.0328, CI = 0.0024, 0.0632), after accounting for model covariates. The relationship between poor/fair versus very good/excellent 2013 SRH and neighborhood poverty was also statistically significant, and the effect size similar in magnitude, for respondents in the high-middle income category (b = 0.0303, CI = 0.0165, 0.0441). The association between poor/fair SRH and 2013 neighborhood poverty was not statistically significant for any other group, nor was the relationship between good SRH and neighborhood poverty, relative to very good/excellent SRH. One additional result stands out: in the highest-earning group, which comprised the top 10% of the PSID income distribution, the effect of earlier health was large and significant even when controlling for 2013 health, such that compared to very good/excellent SRH in 2001, 2013 poverty rates were 5.40 percentage points higher on average for respondents reporting poor/fair SRH in 2001 (b = 0.0540, CI = 0.0249, 0.0829). Finally, residing in a neighborhood with a higher poverty rate in 2001 was significantly associated with higher poverty rates in 2013 for all income groups, with the magnitude of the association increasing with income.

Stratifying Model 2, which includes income, race/ethnicity, education, and age as covariates, by the residential mobility variable, revealed two important results (Table 5). First, a

[3]Results for robustness checks available upon request.

significant positive relationship between poor/fair SRH and neighborhood poverty in 2013 was present only for non-movers (b = 0.0134, CI = 0.0035, 0.0233) and respondents who moved moderate distances (b = 0.0340, CI = 0.0122, 0.0558). For those moving short and long distances, coefficients were insignificant and smaller in magnitude (b = 0.0078, CI = −0.0125, 0.0281 and b = 0.0088, CI = −0.0094, 0.0270 respectively). These findings reveal a heterogenous selective mobility effect: move distance matters. Second, the magnitude of the effect for the moderate distance movers is more than double that of the non-movers. Under the assumption that it takes time for neighborhood effects to accrue, we interpret the difference in these coefficients as suggestive evidence of a large unproductive selective mobility effect associated with poor/fair SRH for moderate move distances. As discussed, the smaller coefficient for non-movers may represent a simultaneous selection (immobility) effect and a neighborhood effect internalized over the study period.

Longer distance moves may be associated with employment opportunities and/or the presence of socioeconomic resources required to make a long distance move. Moderate distance moves (e.g. across town) may reflect an unwanted relocation if a household's ability to pay for a bundle of neighborhood and housing amenities diminishes over time to the point that relocation is required. To motivate future research on this topic, we explored the demographic and socioeconomic characteristics of respondents in each mobility group.[4] Non-movers and long distance movers tended to be from higher income households (upper middle income and high income groups) while short and moderate distance movers were lower income (lower income and lower middle income groups). Forty percent of both short and moderate distance movers were Black as compared to 28 and 23 percent for non-movers and long distance movers respectively. The vast majority (80 percent) of moderate distance movers were not college educated compared to 66 percent of long distance movers, 70 percent of non-movers, and 78 percent of short distance movers. Lastly, non-movers tended to be older than those who moved, with an average age in 2001 of 49 versus 42, 38, and 39 among those moving short, moderate, and long distances, respectively. Together with the results in Table 5, this is suggestive evidence that health selection may be a channel through which people facing racial/ethnic, gender-based, and socioeconomic marginalization become residentially constrained.

DISCUSSION

The current study examined the effects of health on neighborhood SES, and in particular, whether poorer health is associated with selection into higher poverty U.S. neighborhoods. In a heterogeneous sample of households across the U.S., we found strong evidence that health adversity is associated with residence in higher poverty neighborhoods even after controlling for previous health and neighborhood poverty status. Specifically, the 2013 neighborhood poverty rate was on average 2.24- and 1.56-percentage points higher, respectively, for respondents reporting poor or fair overall health in 2013 as compared to respondents reporting excellent health, adjusting for baseline health and neighborhood poverty in 2001, sociodemographic characteristics, and residential mobility.

[4]Descriptive statistics available upon request. We also ran a simple multinomial model of the four-category residential mobility variable with results mirroring the descriptive observations.

While previous research has explored health selection into neighborhoods and found mixed results (Arcaya et al. 2014, 2016, 2017; Connolly et al. 2007; Curtis et al. 2009; van Lenthe et al. 2007; Norman and Boyle 2014; Norman et al. 2005; Riva et al. 2011; Wilding et al. 2016), extant literature is limited in how it can understand the nature and extent of the health selection problem in the U.S., and therefore, how to respond. This is because previous papers typically focused either on structurally marginalized subsets of the U.S. population under highly unusual circumstances, or on non-U.S. populations, who may have dramatically different access to institutional supports for those facing health and/or economic adversity. Exceptional features of the U.S. context, which we noted in our introduction as including a lack of universal healthcare, limited social safety net, vast income and wealth inequalities, and the historical and current scourge of systemic racism, create the context within which we document poor health leading to residence in higher poverty neighborhoods. To be clear, health need not predict neighborhood SES outcomes, and this relationship could likely be decoupled through policy and planning reforms.

Stratified analyses for race/ethnicity and income suggested that the relationship between health and neighborhood SES was strongest and most robust in relatively marginalized subgroups, although structurally advantaged groups were not entirely untouched by health selection. Three patterns were particularly noteworthy. First, the estimated effect of poorer health on neighborhood poverty among non-Hispanic Black respondents was about double the magnitude of that among White respondents. While the statistical significance of this result was weak—likely due to sample size—it is in line with prior research demonstrating that, in large part owing to structural racism past and present, Black and White Americans with similar income have vastly different resources at their disposal to buffer them in times of hardship, health-related or otherwise (Oliver and Shapiro 2006). Consider that among high-income earners in 2016 (those in the top 10% of all households), the median net worth of White households was more than five times that of Black households (1.79 million versus 0.34 million) (McIntosh et al. 2020). The larger reserves of wealth held by White Americans may provide them more flexibility to stay or move as desired even when faced with health-related and resulting economic challenges.

Second, the estimated effect of poorer health was statistically significant for just two income groups: low-income and high-middle earners. We anticipated an effect among those with low incomes, given research showing that economic resources expand mobility options and improve residential outcomes (Coulter et al. 2011; Kan 1999). This result is also consistent with prior work showing evidence of health selection among low-income populations pushed to move by natural disasters (Arcaya et al. 2014) or policy initiatives (Arcaya et al. 2016). The effect of health on neighborhood poverty among the upper-middle class was more puzzling. We suggest that future studies that are large enough to jointly stratify by family SES and race/ethnicity explore the extent to which upper-middle class health selection is racialized.

Our final set of results provided important nuance to our initial findings. Estimates from the previous specifications represented a composite health selection effect—selective mobility and immobility combined—as these specifications controlled for mobility but did not identify a separate effect for respondents that moved versus did not move during the

study period. Further, controlling for baseline health and neighborhood poverty accounted for initial health selection and neighborhood effects but did not account for the potential accrual of neighborhood effects for respondents that remained in place for the vast majority of the study period. Stratifications by residential mobility highlighted both the mobility and immobility aspects of health selection. Specifically, for both non-movers and moderate distance movers, poorer health in 2013 was significantly associated with higher neighborhood poverty in 2013. The magnitude of the poor health effect for moderate distance movers was more than double that of non-movers. We interpret this result as our clearest evidence of a negative health-based selective mobility effect. While a longer move distance may represent relocation for a job—arguably a beneficial move—a moderate distance move (e.g. across town) may represent changes in a household's willingness and ability to pay for a bundle of neighborhood and housing amenities, for example moving to a larger and more expensive home under good financial conditions and downsizing or otherwise moving to a lower-cost home in response to financial difficulty. We also presented preliminary evidence that residential mobility and types of moves differ by household income, race/ethnicity, education, and age. Future research should explore the reasons for moderate distance moves in people with poor health.

Several limitations to the current study warrant mention. First, it is possible that there are other explanations for our findings that are not associated with health selection. For example, moving itself is a stressful event and can have detrimental effects on health resulting from excitement, anxiety, and loneliness (Oishi and Talhelm 2012). Second, although the PSID has occasionally broadened its sample to reflect the increasing diversity of the U.S. population, the sample we used was not nationally representative. Men are notably overrepresented, as they were automatically designated the head of household in heterosexual married couples by the PSID prior to 2017. Thus, there is an opportunity for future research to evaluate processes of health selection among men and women from different household contexts. To assuage concerns about representativeness, we controlled for many sociodemographic measures that are correlated with both health and neighborhood outcomes, and we stratified our analyses by race/ethnicity and family income. Third, our sample was too small to permit a detailed exploration across all race/ethnicity groups and to consider interactions of race/ethnicity and household income with residential mobility. These are important avenues to consider in subsequent research. In general, the sample size may also have contributed to attenuated significance for key populations.

Health selection has often been overlooked as a potential contributor to spatial health disparities, with prior work devoting much more attention to the effects of neighborhoods on health (Diez Roux and Mair 2010; Ludwig et al. 2013; Oakes et al. 2015; Pickett and Pearl 2001; Riva et al. 2007). We argue that understanding health selection is also crucial, and not only to strengthen causal claims of neighborhood effects. Evidence that spatial health disparities are due in part to health selection—poor health leading people into or constraining them from leaving economically disadvantaged places—also has implications for public policy, suggesting that resources be directed towards residents of economically disadvantaged neighborhoods, and to those in poor health more generally, rather than to neighborhoods' institutions and infrastructure alone. To be clear, working to understand and intervene on health selection in order to promote social and health equity is not to

discount the importance of environment, or to advocate for an atomistic view of individuals. Rather, interrupting health selection processes with people-based supports for health and health-related costs could align with anti-displacement efforts in gentrifying neighborhoods, or in planning for age-friendly communities, among other examples.

The importance of a health and social equity agenda that acknowledges the reciprocal relationship between health and neighborhood attainment has become apparent during the covid-19 pandemic. Data now clearly show how the pandemic was fueled by, and exacerbated, existing geographic, racial/ethnic, and SES-based health and social disparities (Andrasfay and Goldman 2021; Brea, Aronson, and Pescosolido 2021). While the Coronavirus Aid, Relief, and Economic Security (CARES) Act enacted in March 2020 provided a much-needed lifeline to Americans struggling with the pandemic's short-term health and economic fallout, the CARES Act's provisions are largely temporary. Local, state, and federal governments should enact both broad and targeted policies that aim to counteract and repair social inequities exacerbated by the pandemic. These include the expansion of Medicaid, increase in public and private coverage of mental health care, community-controlled, resident-driven recovery plans to support racially diverse and low-income communities that have been disproportionately affected by covid-19, resources to renters and homeowners in arrears on housing payments, and bereavement support for surviving family members who may now face health, economic, and housing challenges in the wake of the pandemic.

To our knowledge, ours is the first study to investigate and document processes of health selection across a heterogeneous U.S sample and over the course of ordinary life. We found evidence of an association between poor health and residence in higher poverty neighborhoods after adjusting for neighborhood SES and health in 2001 as well as sociodemographic characteristics. This relationship was more robust in structurally disadvantaged subgroups, but also appeared in more advantaged groups. Additionally, we found significant evidence of selective mobility and suggestive evidence of selective immobility related to health. We conclude by asserting that health selection appears to be one reason for spatial variation in health in the U.S., alongside composition and neighborhood effects. Future research on health selection should explore the mechanisms underlying the patterns observed here, with a focus on pathways that, if modified, could better support people facing health challenges.

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Table 1.

Descriptive statistics, n = 4,344

	Mean (SD) or %
Age, 2001	43.708 (13.444)
Male	74.4%
Race and ethnicity	
Non-Hispanic White	59.8%
Non-Hispanic Black	31.7%
Hispanic	5.0%
Other	3.5%
Family income, 2001	
Low	11.3%
Low-middle	25.7%
Middle-middle	25.6%
High-middle	25.9%
High	11.5%
College graduate, 2001	27.2%
Number of children in household, 2001	0.966 (1.205)
Moved between 2001 and 2013	
Did not move	41.0%
Short move 0 - 7.4km	19.7%
Moderate move 7.4 - 34.6km	19.7%
Long move 34.6 - 7,840.4km	19.7%
Neighborhood poverty rate, 2001	0.111 (0.103)
Neighborhood poverty rate, 2013	0.133 (0.117)
SRH, 2001	
Poor	2.0%
Fair	9.4%
Good	29.1%
Very good	35.3%
Excellent	24.2%
SRH, 2013	
Poor	5.8%
Fair	15.4%
Good	32.3%
Very good	32.9%
Excellent	13.6%
Number of chronic conditions, 2001	0.636 (0.998)
Number of chronic conditions, 2013	1.254 (1.405)

Notes: SRH = Self-rated health

Table 2.

Effect of SRH on neighborhood poverty rate in 2013

	Model 1 b (SE)	Model 2 b (SE)	Model 3 b (SE)
SRH, 2013 (Ref: Excellent)			
Poor	0.0299 (0.008) ***	0.0213 (0.008) **	0.0224 (0.008) **
Fair	0.0275 (0.006) ***	0.0153 (0.006) **	0.0156 (0.006) **
Good	0.0132 (0.005) **	0.0064 (0.005)	0.00659 (0.005)
Very good	0.0074 (0.005)	0.0041 (0.005)	0.00427 (0.005)
Neighborhood poverty rate, 2001	0.6333 (0.014) ***	0.4520 (0.017) ***	0.451 (0.017) ***
SRH, 2001 (Ref: Excellent)			
Poor	0.0207 (0.011)	0.0039 (0.011)	0.0027 (0.011)
Fair	0.0300 (0.006) ***	0.0146 (0.006) *	0.0141 (0.006) *
Good	0.0153 (0.004) ***	0.0031 (0.004)	0.00268 (0.004)
Very good	0.0041 (0.004)	0.0019 (0.004)	0.0016 (0.004)
Number of chronic conditions, 2001	−0.0038 (0.002) **	−0.0014 (0.002)	−0.00125 (0.002)
Age, 2001	-	0.0019 (0.001) **	0.00142 (0.001) *
Age-squared, 2001	-	−0.00002 (0.000) **	−1.46e-05 (0.000) *
Male	-	−0.0085 (0.004) *	−0.00868 (0.004) *
Race and ethnicity (Ref: Non-Hispanic White)			
Non-Hispanic Black	-	0.0480 (0.004) ***	0.0475 (0.004) ***
Hispanic	-	0.0623 (0.007) ***	0.0611 (0.007) ***
Other	-	0.0027 (0.008)	0.00267 (0.008)
Family income, 2001 (Ref: High)			
Low	-	0.0300 (0.007) ***	0.0309 (0.007) ***
Low-middle	-	0.0252 (0.006) ***	0.0263 (0.006) ***
Middle-middle	-	0.0174 (0.005) **	0.0182 (0.005) ***
High-middle	-	0.0113 (0.005) *	0.0115 (0.005) *
College graduate, 2001	-	−0.0173 (0.003) ***	−0.0170 (0.003) ***
Number of children in household, 2001	-	0.0049 (0.001) ***	0.00440 (0.001) ***
Mobility, 2001 – 2013 (Ref: Did not move)			
Short move	-	-	0.0022 (0.004)
Moderate move	-	-	−0.0145 (0.004) ***
Long move			−0.0129 (0.004) **
Constant	0.0434 (0.004) ***	−0.0011 (0.016)	0.0182 (0.017)
N	4,344	4,344	4,344
R-squared	0.357	0.413	0.416
Adjusted R-squared	0.355	0.410	0.413

Notes: SRH = Self-rated health; Ref. = Reference

*** p < .001

** p < .01

* p < .05

Table 3.

Effect of SRH on neighborhood poverty rate in 2013, by respondent race/ethnicity

	White b (SE)	Black b (SE)
SRH, 2013 (Ref: Excellent)		
Poor or fair	0.00960 (0.004) *	0.018 (0.009)
Good	0.00503 (0.003)	0.00384 (0.008)
Neighborhood poverty rate, 2001	0.484 (0.022) ***	0.397 (0.029) ***
SRH, 2001 (Ref: Excellent)		
Poor or fair	0.00983 (0.006)	0.0149 (0.011)
Good	0.0000946 (0.003)	−0.000163 (0.008)
Number of chronic conditions, 2001	0.000318 (0.002)	−0.00198 (0.004)
Age, 2001	0.00092 (0.001)	0.0029 (0.002)
Age-squared, 2001	−0.0000102 (0)	−0.0000296 (0)
Male	−0.0127 (0.004) **	−0.00678 (0.008)
Family income, 2001 (Ref: High)		
Low	0.0186 (0.008) *	0.0538 (0.021) *
Low-middle	0.0201 (0.005) ***	0.0423 (0.02) *
Middle-middle	0.0131 (0.004) **	0.036 (0.019)
High-middle	0.00838 (0.004) *	0.0261 (0.02)
College graduate, 2001	−0.0171 (0.003) ***	−0.0260 (0.01) *
Number of children in household, 2001	0.00173 (0.001)	0.00587 (0.003) *
Mobility, 2001 – 2013 (Ref: Did not move)		
Short move	0.000811 (0.004)	0.00624 (0.009)
Moderate move	−0.0105 (0.004) **	−0.015 (0.009)
Long move	−0.00363 (0.004)	−0.0343 (0.011) **
Constant	0.0392 (0.015) **	0.0286 (0.042)
Observations	2,598	1,379
R-squared	0.248	0.207
Adj.R2	0.243	0.197

Notes: SRH = Self-rated health; Ref. = Reference

*** p < .001

** p < .01

* p < .05

Table 4.

Effect of SRH on neighborhood poverty rate in 2013, by respondent family income in 2001

	Low income b (SE)	Low-middle b (SE)	Middle-middle b (SE)	High-middle b (SE)	High income b (SE)
SRH, 2013 (Ref: Very good or excellent)					
Poor or fair	0.0328 (0.015) *	−0.00138 (0.009)	0.0151 (0.008)	0.0303 (0.007) ***	−0.00437 (0.011)
Good	0.0163 (0.015)	0.00401 (0.008)	0.00271 (0.006)	0.00177 (0.005)	−0.0108 (0.006)
Neighborhood poverty rate, 2001	0.287 (0.043) ***	0.494 (0.036) ***	0.402 (0.035) ***	0.631 (0.033) ***	0.714 (0.049) ***
SRH, 2001 (Ref: Very good or excellent)					
Poor or fair	0.0255 (0.017)	0.0143 (0.01)	0.000243 (0.011)	−0.00562 (0.01)	0.0539 (0.015) ***
Good	−0.002 (0.014)	0.0144 (0.007) *	−0.000299 (0.006)	−0.00888 (0.005)	−0.00363 (0.007)
Number of chronic conditions, 2001	−0.00182 (0.005)	0.00343 (0.004)	0.000287 (0.004)	−0.0027 (0.003)	−0.00551 (0.004)
Age, 2001	0.00194 (0.002)	0.00195 (0.001)	0.00132 (0.001)	−0.000495 (0.001)	0.000466 (0.002)
Age-squared, 2001	−0.000028 (0)	−0.0000215 (0)	−0.0000158 (0)	0.00000842 (0)	0.00000294 (0)
Male	−0.0345 (0.013) **	−0.00118 (0.007)	−0.000768 (0.007)	−0.0163 (0.008)	−0.0349 (0.018)
Race and ethnicity (Ref: Non-Hispanic White)					
Non-Hispanic Black	0.0588 (0.016) ***	0.0386 (0.008) ***	0.0543 (0.007) ***	0.0428 (0.006) ***	0.0220 (0.009) *
Hispanic	0.0443 (0.028)	0.0656 (0.013) ***	0.0636 (0.013) ***	0.0412 (0.014) **	0.0388 (0.026)
Other	−0.00367 (0.036)	−0.00681 (0.018)	0.00267 (0.015)	0.00344 (0.011)	0.0116 (0.012)
College graduate, 2001	−0.0376 (0.031)	−0.0299 (0.01) **	−0.0130 (0.006) *	−0.0104 (0.004) *	−0.0190 (0.005) ***
Number of children in household, 2001	0.0103 (0.004) *	0.00291 (0.003)	0.00616 (0.003) *	0.00265 (0.002)	0.00111 (0.002)
Mobility, 2001 – 2013 (Ref: Did not move)					
Short move	0.00593 (0.016)	−0.00444 (0.009)	−0.00443 (0.008)	0.0103 (0.006)	−0.00479 (0.008)
Moderate move	−0.028 (0.017)	−0.015 (0.009)	−0.0258 (0.008) ***	−0.00993 (0.007)	−0.0137 (0.008)
Long move	−0.0372 (0.02)	−0.0211 (0.009) *	−0.0176 (0.008) *	−0.00577 (0.006)	0.0101 (0.007)
Constant	0.0777 (0.054)	0.0357 (0.027)	0.0468 (0.03)	0.0640 (0.029) *	0.0494 (0.048)
Observations	491	1,118	1,109	1,125	501
R-squared	0.262	0.331	0.321	0.4	0.417
Adj.R2	0.236	0.32	0.31	0.391	0.397

Notes: SRH = Self-rated health; Ref. = Reference

*** p < .001

** p < .01

* p < .05

Table 5.

Effect of SRH on neighborhood poverty rate in 2013, by residential mobility during 2001-2013

	No Move b (SE)	Short Move b (SE)	Moderate Move b (SE)	Long Move b (SE)
SRH, 2013 (Ref: Very good or excellent)				
Poor or fair	0.0134 (0.005) **	0.00777 (0.01)	0.0340 (0.011) **	0.00882 (0.009)
Good	−0.00276 (0.004)	0.0135 (0.009)	0.000805 (0.009)	0.0153 (0.007) **
Neighborhood poverty rate, 2001	0.793 (0.022) ***	0.442 (0.039) ***	0.240 (0.038) ***	0.127 (0.038) ***
SRH, 2001 (Ref: Very good or excellent)				
Poor or fair	−0.000369 (0.006)	0.0457 (0.013) ***	−0.00986 (0.014)	0.000973 (0.013)
Good	−0.00227 (0.004)	−0.00546 (0.009)	0.0139 (0.009)	0.00608 (0.008)
Number of chronic conditions, 2001	−4.18e-05 (0.002)	−0.00481 (0.004)	0.00192 (0.005)	−0.000938 (0.004)
Age, 2001	0.00127 (0.001)	0.000639 (0.002)	0.00263 (0.002)	0.00155 (0.001)
Age-squared, 2001	−9.15e-06 (0.000)	−1.02e-05 (0.000)	−3.50e-05 (0.000) *	−1.54e-05 (0.000)
Male	−0.00332 (0.005)	−0.0192 (0.009) **	0.00665 (0.009)	−0.0149 (0.008) *
Race and ethnicity (Ref: Non-Hispanic White)				
Non-Hispanic Black	0.0291 (0.004) ***	0.0551 (0.01) ***	0.0647 (0.009) ***	0.0499 (0.009) ***
Hispanic	0.0445 (0.008) ***	0.0480 (0.016) **	0.0355 (0.018) *	0.0940 (0.017) ***
Other	−0.00129 (0.01)	0.0121 (0.017)	0.00796 (0.022)	−0.00743 (0.016)
Family income, 2001 (Ref: High)				
Low	0.0038 (0.009)	0.0292 (0.018) *	0.0454 (0.02) *	0.0458 (0.017) **
Low-middle	0.0137 (0.007) *	0.0217 (0.015)	0.0356 (0.017) *	0.0275 (0.013) *
Middle-middle	0.0139 (0.006) *	0.0189 (0.014)	0.00975 (0.016)	0.0204 (0.012)
High-middle	0.00689 (0.005)	0.0216 (0.014)	0.0107 (0.016)	0.00905 (0.011)
College graduate, 2001	−0.00887 (0.004) *	−0.0231 (0.009) *	−0.0303 (0.01) **	−0.0171 (0.007) *
Number of children in household, 2001	0.00453 (0.002) **	0.00434 (0.003)	0.00328 (0.003)	0.00497 (0.003) *
Constant	−0.00895 (0.025)	0.0536 (0.039)	−0.000315 (0.039)	0.0362 (0.033)
N	1781	855	854	854
R-squared	0.642	0.431	0.305	0.231
Adj. R2	0.639	0.419	0.29	0.214

Notes: SRH = Self-rated health; Ref. = Reference

*** p < .001

** p < .01

* p < .05