Neighborhood change, social capital, and health: the case of public housing demolitions in Chicago

Patrick Mayne

Submitted in partial fulfillment of the requirements for the degree of Master of Arts in the Department of Sociology, Brown University

May, 2014

Neighborhood change, social capital, and health: the case of public housing demolitions in Chicago

Patrick Mayne

Contents

1 Introduction

In 1992 the National Commission on Severely Distressed Public Housing estimated that there were 86,000 families in the United States living in public housing units facing "distress, high rates of serious crimes, barriers to managing the environment, and/or physical deterioration of the building" (Green and Lane 1992). In response to that report, Housing Opportunities for People Everywhere (HOPE VI), a U.S. Department of Housing and Urban Development (HUD) program, has awarded grants totaling nearly $6.6 billion since 1993 for the purposes of renovation or demolition of such low-quality public housing stock (HUD 2012b). This program aimed to help public housing residents move into neighborhoods with lower concentrations of disadvantage and to improve that areas previously hosting public housing projects through replacement with mixed-income developments. While previous research has tested the effects of such projects on public housing residents themselves, at this point there has been no study on the effect of such changes for those who remain in the neighborhood after the public housing project has gone.

The present study investigates how the removal of public housing projects affects the health of those who remain in the vicinity of former public housing projects. In doing so, it engages with the sociological and public health literature around the effects of neighborhood composition and social capital on individual and population health. This literature predicts that neighborhoods suffering from concentrated disadvantage will exhibit lower levels of interpersonal trust, collective efficacy, and be less able to enforce community norms of behavior than more affluent neighborhoods. The removal of public housing should lessen the concentrated disadvantage in these neighborhoods thus leading to a long-term improvement in well-being, but the rapid population change may disrupt the beneficial social ties and in the short term cause poorer health outcomes.

This research utilizes data from the Project on Human Development in Chicago

Neighborhoods (PHDCN) to investigate the effects of removal of public housing projects on the self-reported health of individuals living near these demolitions. Data on the timing and location of public housing demolitions between 1994 and 2011 was obtained from the Chicago Housing Authority. The public housing project demolitions in Chicago during this time period coupled with the rich longitudinal data available in the PHDCN provide an opportunity to study the phenomenon of rapid neighborhood change through public housing project removals at both a large scale and in great detail. I find that exposure to public housing demolition has a significant negative effect on child health. This effect is mediated by both large changes in neighborhood composition and decreases in measures of neighborhood social capital and collective efficacy, both of which are significantly associated with nearby public housing demolition.

2 Background

The original motivation for the National Commission on Severely Distressed Public Housing, and later HOPE VI, was twofold: first, that individuals and families living in sub-standard housing is in and of itself a social ill that should be remedied; and second, that the existence of such large concentrations of poverty in neighborhoods presents distinct disadvantages to residents over and above individual- and household-level poverty (Green and Lane 1992). This second line of reasoning determined, to a large extent, the direction of reforms after the 1992 report. Grants have been made with a large emphasis on "reintegrating public housing developments into surrounding communities" while improving the environment for both public housing residents and nearby non-residents through "deconcentration and dispersion, development of mixed-income communities, demolition and/or renovation of current developments, emphasis on family self-sufficiency, and resident management of the properties" (Fosburg et al., 1996, p. v). Through HOPE VI, nearly $400 million have been spent on public housing demolitions alone, with over $6 billion more going towards revitalization grants, which cover both demolition and major rehabilitation, often for the purposes of creating mixed-income housing communities (HUD 2012b).

The Chicago Housing Authority (CHA) has been and remains the second largest public housing agency in the country, directly managing over 40,000 public housing units in 1996. By 2012, the number of directly-managed units had fallen to 21,000. At the same time, Section 8 vouchers for privately-managed subsidized housing had grown from just 15,000 households in 1996 to over 50,000 in 2012 (HUD, 1996, 2012a).[1] While these public housing units were spread across the city of Chicago, as shown in figure 1, demolitions were not, and disproportionately affected the near North, West, and South sides of the city (figure 2). This selective demolition of public housing in Chicago, removing over 22,000 units between 1994 and 2011, led to large, uneven changes to the face of the city, with neighborhoods formerly hosting public housing in some cases being redeveloped on a large scale (in the case of the United Center, near the site of the former Henry Horner Homes), but in other cases simply retaining large empty lots where formerly thousands of residents lived and worked (in the case of Robert Taylor Homes on State Street).

Public housing has been shown to be associated with a number of negative health outcomes, even after controlling for the low socioeconomic status (SES) of those typically resident in public housing projects. In particular, living in public housing has been shown to be associated with an increased risk of exposure to violence (Fertig and Reingold 2007), decreased physical activity among adults (Heinrich et al. 2007; Lewis et al. 1993), and an increased risk of infectious disease (Hota et al. 2007).

[1] The shift from project-based to voucher-based subsidies in Chicago is indicative of a larger shift towards voucher-based housing subsidies in the United States as a whole. In 1996, there were an approximately equal number of Section 8 vouchers and public housing units (1.35 million and 1.33 million respectively). By 2012, public housing units had decreased to 1.15 million while Section 8 vouchers had increased over 70% to 2.34 million (HUD, 1996, 2012a).

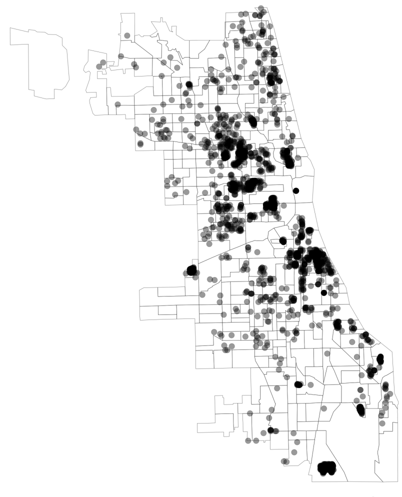

Figure 1: All public housing units managed by the CHA, 1994-2011.

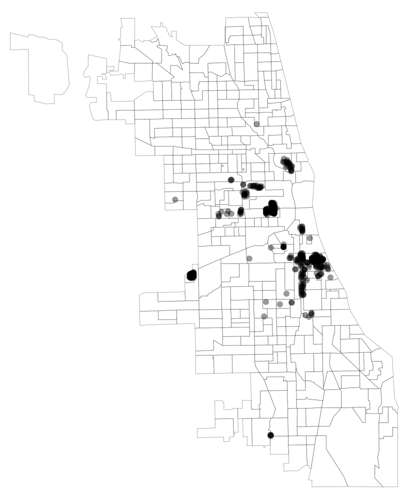

Figure 2: Demolitions of public housing units managed by the CHA, 1994-2011.

These findings may be partly due the concentration of poverty and racial segregation which are associated with public housing projects, and therefore the removal of public housing projects and resettlement of current residents in lower-poverty, less-segregated neighborhoods should bring health benefits to past residents of public housing projects (Fauth et al. 2004; Ludwig et al. 2011), though observed effects have been modest at best in experimental studies (Fauth et al., 2004; Sanders et al., 2003; Ludwig et al., 2011).

The expectation in the current study is that public housing demolition should lead to a deconcentration of disadvantage in the neighborhoods surrounding the former public housing projects, and therefore should benefit the health of those individuals living in those neighborhoods in the long term. In the short term however, the displacement of large proportions of the population should attenuate social capital, and especially the thick ties which are nurtured by similarity and long-standing kinship and neighborhood ties (Kawachi et al., 1997; Kim, 2010; Lochner et al., 2003). By this line of reasoning, the depletion of social capital should lead to relatively worse health outcomes for individuals remaining in the neighborhood.

The current project proposes to add to the extant literature on health in and around public housing projects in two ways. First, it will address the lack of evidence on the health effects of public housing projects on those who do not live in public housing projects themselves but rather live nearby. Second, it will examine changes in neighborhood composition and social capital that are associated with public housing demolitions, and test whether these potential changes mediate the direct effect of public housing demolition on health in a way consistent with the sociological theory described above.

2.1 Neighborhood effects

The deconcentration imperative itself stems from the neighborhood effects literature, which has found large and persistent negative effects of exposure to concentrated poverty and segregation on educational and health outcomes, both in schools and in residential neighborhoods (Chaplin 2002; Hipp 2007; Joseph et al. 2007). More affluent neighborhoods often have better measures of social capital, including interpersonal trust, collective efficacy, and community participation, which are independently associated with improvements in health and well-being (Sampson, 2012), while mixed-income or racially diverse areas provide broader access to public goods and services (Joseph et al. 2007).

William Julius Wilson's influential work, *The Truly Disadvantaged*, showed that disadvantage–poverty, racial segregation, crime, and other social ills–is concentrated spatially and has wide-ranging effects on individuals, directly impacting individual health, exposure to (and participation in) violence, economic outcomes, and even cognitive ability (1987). Later studies have found diverse health effects of neighborhood disadvantage, including increased rates of cardiovascular disease, later staging of cancer at diagnosis, increased rates of domestic violence, and increased rates of mental illness (Caughy et al. 2003; Dekeseredy and Schwartz 2002; Ross and Mirowsky 2001).

The Moving to Opportunity (MTO) study was a prospective experimental study proposed as a solution for the endogeneity issues present in the above observational studies of neighborhood effects (Katz et al., 2001; Sampson, 2008). The inclusion criteria[2] restricted the study to the neediest of families. Families choosing to take place in the study were assigned randomly to one of three study arms: a voucher which may be paid to any private landlord in a tract with less than a 10% poverty rate; a standard Section 8 voucher; or control (no change) (Katz et al., 2001). The

[2]Households with children, living in public or assisted (Section 8) housing, and living in a tract with higher than 40% poverty, and living in one of five pre-selected cities

project suffered from a number of drawbacks that limit its generalizability, especially that the inclusion criteria limit the study population to as little as 5% of the total urban population (Sampson, 2008), and that once a family was placed in a study arm they were under no obligation to actually participate. Nevertheless, moves to lower poverty areas were significantly associated with improvements adult mental health, and adolescent female physical health, mental health, educational attainment, and participation in risky behaviors, while outcomes worsened for adolescent male physical health and delinquency (Katz et al., 2001; Kling et al., 2007; Leventhal and Brooks-Gunn, 2003; Ludwig et al., 2001, 2008; Orr et al., 2003; Sampson, 2008). A more recent study of long-term outcomes among adults in the MTO program found that, after 10-15 years, subjective well-being, physical health, and mental health outcomes were significantly improved for subjects moving to lower-deprivation neighborhoods (Ludwig et al., 2013).

The results of the MTO studies are particularly interesting in the context of the present study, in that they provide insight into the effects of neighborhood deprivation, while also testing, experimentally, the effects of (leaving) public housing. While the effects of living in and leaving public housing are discussed in more detail below, it is important to note here that the neighborhood effects here are extremely particular: they are limited to those individuals who live in public housing and (choose to) leave. Any changes in the neighborhood experienced by individuals are caused by moving residences, rather than *in situ* neighborhood change experienced by individuals remaining in the same location with the neighborhood changing around them. The present study investigates neighborhood changes related to the same processes (residents moving out of public housing projects), but instead seeks to understand the *in situ* effects for households living in the neighborhood of public housing projects, but who are affected by neighborhood changes brought about by the demolition of those projects.

2.2 Social capital

While the deconcentration of disadvantage may have positive effects in the long term, in the short term[3] there is reason to believe that the direction of the effect on health may in fact be negative. Large-scale disruptions to neighborhood structures and larger turnovers of population, of the type presupposed in the above programs, would disrupt the social ties that form the basis of neighborhood social capital, though these ties could be reconstituted over time. Social ties linking individuals to other forms of capital form the basis of social capital (Bourdieu, 1985). Social capital theorists propose that this public good is formed especially in the context of homogeneous communities, and perhaps especially in opposition to a perceived exclusion from broader society (Cattell 2001). Furthermore, various measures of social capital, such as frequency and intensity of social interactions within a neighborhood, have been found to be associated with significantly improved health and employment outcomes, even in conditions of high poverty and other measures of deprivation (Kawachi et al. 1997; Lochner et al. 2003).

The current literature on social capital has recognized and studied two types of social capital. The first type is characterized by strong ("thick") ties between similar, often closely-related individuals is able to provide social, emotional, and often material support (Cattell 2001; Wellman and Wortley 1990). This type may be seen to be at least functionally similar to the Durkheimian conception of mechanical solidarity, whereby similar individuals coalesce to form a highly cohesive community (Durkheim 1997). The opposing type (analogous to Durkheim's concept of organic solidarity),

[3] "Long term" and "short term" are left intentionally undefined, as there has been no research on the temporal dynamics of neighborhood changes in the wake of public housing demolitions. One may, however, assume that the "short term" is the time it takes for social networks disrupted by public housing demolition to re-form. This process would involve the removal of individuals from public housing, the demolition of the buildings themselves, the redevelopment of the public housing site, and the formation of social networks linking new residents of redeveloped public housing sites to residents remaining from before demolition, a process which would likely take between three and ten years

characterized by weaker ("thin") ties between individuals in a heterogeneous community, is able to facilitate the flow of knowledge and resources across a much broader network and between disparate communities in a highly complex society (Durkheim 1997; Granovetter 1973).

These two types of social capital may provide different types of benefits to the individuals holding them. Denser, "thick" social capital networks based on kinship ties, residential proximity, and homophily, for example, may provide greater benefits for those seeking childcare or small interpersonal loans. Additionally, feelings of trust, similarity, and solidarity with others living in close proximity have been found to be associated lower rates of mental illness and lower rates of all-cause mortality and mortality from cardiovascular disease (Kawachi et al. 1997; Kim 2010; Lochner et al. 2003). On the other hand, "thin" social capital present in a neighborhood is more likely to result in greater access to higher quality services and an improved ability to mobilize diverse resources across a society, which may be seen as a primary goal of poverty deconcentration projects (Joseph et al. 2007; Williamson et al. 2009). Research focusing on the effect of social capital on health has, for the most part, focused on "thick" social capital, while, to some extent, the neighborhood effects literature focuses on "thin" social capital in advocating for economically and racially diverse neighborhoods as a boon to individual well-being.

For the present study, (thick) social capital is operationalized along two dimensions: participation in community institutions and governance (community participation) and collective efficacy. Collective efficacy is defined as "social cohesion among neighbors combined with their willingness to intervene on behalf of the common good" (Sampson, 1997, p. 918) and may be seen as a specific application of Bourdieu's definition of social capital, with dense ties supporting specific resources (collective action in the face of threats to neighborhood order). In this definition, collective efficacy is a public, non-excludable good, where benefits accrue not only to those directly embedded in a social network, but also to those living in the vicinity (neighborhood) of the network that facilitates and generates collective efficacy (Sampson, 1997; Sampson and Raudenbush, 1999; Sampson et al., 1999; Sampson, 2012). The concept of collective efficacy also connects social capital with earlier work on neighborhood effects and, especially, the concept of disorder, which was epitomized in the "broken window theory" of Wilson and Kelling (1982). In this sense visible disorder, a "broken window", is a physical sign of low collective efficacy, and physical signs of disorder are predictive of crime precisely because they signal to outside individuals that the neighborhood lacks effective social control, and is therefore to some extent "undefended".

Collective efficacy itself is, theoretically, based on interpersonal trust, expectations, and obligations, which are themselves drawn from co-participation in community structures and social groups (Putnam, 1995), resulting in even greater participation in these groups and higher levels of social cohesion (Coleman, 1988). In this way, community participation can be seen as a necessary but not sufficient precursor to collective efficacy, thus meriting its inclusion in this study as a distinct but related facet of neighborhood social capital.

Literature examining the health effects of inequality hypothesizes that inequality, lack of social capital (thick capital being depleted or prevented from forming in the context of high inequality), and the stress incurred by both may have a direct physiological effect on health. Heightened, and especially chronic, stress leads to increased cortisol production, which over the course of time downregulates the immune system and increases the formation of arterial plaque (Sapolsky, 2004; Shively and Clarkson, 1994). This may be extended to infer that chronic stress from social inequality or negative social interactions may negatively impact health through biological pathways, and thus social capital may benefit health not through its conversion into other forms of capital, but through the physiological benefits of the social interactions that form social capital.

2.3 Neighborhoods and Children's Health

While most of the previous research has focused on adult health outcomes, there is evidence to show that neighborhoods, and chronic stress produced or negated within them, have an equally strong impact on the health of children and adolescents, through many of the same pathways. Within the hospital environment, experimental studies have show that environmental stress is related to physiological responses within children, while increased social and emotional support for children and their families results in reduced recovery periods with fewer negative sequelae (Skipper and Leonard, 1968).

Neighborhood-based studies have further examined this link. Neighborhood disorder, of the type described by Wilson and Kelling (1982) and operationalized as a predictor of adult health by Ross and Mirowsky (2001), has been shown to be predictive of caregiver-rated health in children and adolescents, with this association mediated by depression and anxiety, in turn provoking physiological signs of distress such as dizziness, nausea, and shortness of breath (Hill et al., 2005). The physiological response to stress in children has been further explored and linked to many of the same cortisol-based pathways governing inflammatory processes as chronic stress in adulthood (Evans and Schamberg, 2009; Dulin-Keita et al., 2012; McEwen, 2012). While the pathways may be similar in children and adolescents to that seen in adults, the timing of the exposure to chronic stress and elevated allostatic load in children has been shown to have far-reaching effects on health outcomes across the life course (Evans and Schamberg, 2009; Henderson et al., 2005).

Stress within the neighborhood also indirectly affects children through the home environment. Neighborhood disorder and lack of social cohesion is filtered into the home via adults' perceptions of stress within the neighborhood, affecting family dynamics and adult mental health, and subsequently determining children's well-being (Kohen et al., 2008; Chen and Paterson, 2006). Specifically, increased parental experiences of mental illness and depression, related to experience of stress in the neighborhood, are associated with higher incidences of asthma in children in urban environments (Quinn et al., 2010; Shalowitz et al., 2006). The present study adds to these findings in investigating the association between rapid neighborhood change in the context of public housing demolition, a presumed environmental stressor, on children's health, as mediated by changing social conditions within the neighborhood.

3 Methods

3.1 Data sources

Individual-level data on health and potentially confounding factors are derived from the Project on Human Development in Chicago Neighborhoods (PHDCN), a longitudinal study of children growing up in Chicago neighborhoods, followed in three waves between late 1994 and early 2002.[4] Interviewees were selected from 80 of 343 neighborhood clusters in Chicago. Neighborhood clusters were defined by PHDCN researchers as sets of contiguous census tracts sharing common demographic and socioeconomic characteristics, and thus may be seen as analogous to, though not interchangeable with, the community areas as defined by Chicago school researchers in the early twentieth century. The PHDCN includes interviews from 5,576 individuals in a representative sample of 3,683 Chicago households. These individuals were followed over three waves, with an average time of two years between waves, for a total of 16,381 observations. Individuals were sampled within 7 age cohorts at the first wave (approximately 0, 3, 6, 9, 12, 15 and 18 years of age), with the youngest being three weeks old at the first interview, and the oldest being three months shy of his twentieth birthday.

[4]The first wave was conducted between 1994 and 1997, the second between 1997 and 2000, and the third in 2000 and 2001

In addition to the longitudinal survey, this study also uses a community survey undertaken as part of the PHDCN of 8,872 individuals in all neighborhood clusters at the first wave (in 1994 and 1995). This community survey is used here to calculate neighborhood-level community participation and collective efficacy measures, as described below.

Administrative data on the number of available and occupied public housing units, their dates of demolition, and their locations were obtained from the CHA through a Freedom of Information Act request. Addresses for individual buildings within larger housing projects (for example, there were 28 individual buildings within the Robert Taylor Homes complex) were geocoded using ArcGIS and placed within neighborhood cluster boundaries.

Neighborhood-level measures of racial and ethnic composition and poverty were obtained from the 1990, 2000, and 2010 decennial censuses. These measures were then spatially and temporally interpolated so as to be placed within 1990 census boundaries, which could then be directly related to neighborhood clusters used in the PHDCN at the time of each interview.[5]

The current analysis restricts the full PHDCN sample in three ways, two of which are due to theoretical concerns and one of which is due to practical data limitations. First, the sample is restricted to those individuals in the 6- to 15-year-old cohorts. That is, all children in the sample are roughly school-age throughout observation, and thus engaged somewhat in the neighborhood around their caregivers' home. Second, in order to understand the effect of changes in the built and social environments on residents of neighborhoods which see public housing project demolitions, the sample is restricted only to individuals who have remained in their same neighborhood since the first wave of the survey. Therefore, all observations are included from the first

[5]While linear interpolation introduces a certain amount of error, and especially prevents the actual estimation of the causal effect of public housing demolition on neighborhood change measures, interpolated measures will always have less error than measures fixed at the beginning of the decade under the assumption of monotonicity of change over the course of the decate.

wave, but the third wave observations only include individuals living in the same neighborhood as they were at the first wave. Finally, for some analyses the sample excludes observations from the second wave of the survey because collective efficacy measures were only recorded in the first and third waves of the survey.[6]

3.2 Measures

The outcome of interest for the present study is self-reported health, which has been shown to be a robust and sensitive indicator of overall health status in a variety of settings (Idler and Benyamini, 1997; Miilunpalo et al., 1997; Jylhä, 2009). This measure was recorded across five levels, representing poor, fair, good, very good, or excellent health, and is treated in the analysis as a continuous variable.[7] The primary treatment of interest in this study is proximity to public housing demolition. Individuals were considered exposed to public housing demolition if they were living in a neighborhood cluster or adjacent to a neighborhood cluster in which a public housing project was demolished, at the time of demolition. Exposure to demolition was then considered permanent–there is no waning effect with time. Exposure is a simple dichotomous variable representing any demolition of public housing within one neighborhood cluster of adjacency.[8]

Covariates of particular interest, as potential mediators of the effect of public housing demolition on health, are levels of and changes in measures of neighborhood composition, social capital, and collective efficacy (table 1). For variables derived from the census or CHA data (demolition and neighborhood composition), neighborhoods are defined as the individual neighborhood cluster (from the PHDCN sampling frame) in which the individual lived at the time of the interview and all adjacent neighborhood clusters to that neighborhood cluster. Neighborhood composition is

[6]Community participation was measured at all three waves.
[7]Lower values of this variable denote poorer health, while higher values indicate better health.
[8]See appendix A for a more detailed discussion of the selection of the exposure measure

measured by the percent white and percent black, the percent below the poverty line, and neighborhood entropy[9], all of which were derived from census measures and linearly extrapolated to the date of the survey. Changes in neighborhood composition are measured as the annual percent change in a given measure between censuses.

Community participation and collective efficacy variables were measured at the neighborhood cluster level as the mean of the sum of questions at the individual level (Sampson, 1997; Sampson and Raudenbush, 1999). Community participation was measured at all three waves, with the first-wave values being derived from the community survey. Questions measuring community participation gauged whether individuals attended church, worked collectively with neighbors to address neighborhood issues, worked specifically with government officials or were themselves elected to a body designed to address collective issues, or attended any government or non-governmental hearing or meeting to address neighborhood issues. Collective efficacy questions measured how likely individuals in the neighborhood were to intervene in the following scenarios: children skipping school and hanging out on a street corner; children spray-painting graffiti; a child showing disrespect for an adult; a fight in front of a residence; or a fire station was threatened with closure due to budget cuts.

Collective efficacy variables were only measured in the PHDCN at waves 1 and 3. For this reason, two sets of models were estimated, one set using all three waves and the first three community participation variables, and the other set using only waves 1 and 3 and all collective efficacy and community participation variables.[10]

[9]Entropy is a measure of diversity within a parcel, and is defined as $E_j = -\sum_k p_{jk} \log p_j k$. Here entropy is scaled so as to range from 0 (least diverse) to 100 (most diverse)

[10]Community participation and collective efficacy variables, while incorporated as neighborhood-level measures in this model, are subject to the same issues of attrition as individual-level variables. First-wave measures, based on the community survey, are representative of all individuals in Chicago at the time. At the time of the second and third waves, however, these variables are measured in the longitudinal survey, and therefore may be biased by loss to follow-up. Because these measures are expected to be affected by the very changes in neighborhoods that are explicitly the object of this study, however, adjusting for attrition may control for the effects which I seek to describe. For example, if a non-random selection of individuals moves out of a neighborhood in response to public housing demolition, while they may systematically report different levels of collective efficacy than those who stay, their leaving the neighborhood might actually affect the collective efficacy of those

Beyond variables of interest, controls were included for age, age squared,[11] race/ethnicity,[12], primary caregiver education,[13], the maximum socioeconomic index (SEI) of adults in the household, and fixed effects for wave of interview.

Variable	Coding	Level
Self-rated health (*Outcome*)	Continuous (1-5)	Individual
Exposure to public housing demolition (*Treatment*)	Dichotomous	Individual
Neighborhood current percent White	Continuous (0-100)	Neighborhood
Neighborhood current percent Black	Continuous (0-100)	Neighborhood
Neighborhood current percent below poverty line	Continuous (0-100)	Neighborhood
Neighborhood current entropy	Continuous (0-100)	Neighborhood
Community participation	Continuous (0-4)	Neighborhood
Collective efficacy	Continuous (5-25)	Neighborhood

Table 1: Definition of selected measures of interest.

3.3 Modeling approach

This study breaks the analyses into two parts: first, describing the neighborhood compositional and contextual changes which occur subsequent to public housing demolition, and then including these measures of neighborhood change in models predicting individual health. In the first, descriptive, phase, I model change in neighborhood composition measures as predicted by public housing demolitions. Here, neighborhood compositional change is measured as the change in racial and ethnic composition and percent below the poverty line between decennial censuses, while controlling for baseline neighborhood composition and neighborhood fixed effects, as shown in equation 1 below.

who remain. For this reason, measures of collective efficacy and community participation are left unadjusted, and should be interpreted as the reported social capital of measured respondents in the neighborhood, though perhaps not of the neighborhood residents as a whole.

[11] Age squared was included to allow for limited non-linear effects of age on health

[12] Coded as non-Hispanic White, non-Hispanic Black, Hispanic of any race, or any other race/ethnicity. Non-Hispanic White was considered the reference category

[13] Coded as less than high school, a high school diploma, or more than high school

$$D_{jt} = \alpha_0 + \alpha_j + \alpha_t + \beta T_{jt} + \delta_N N_{jt} + \epsilon \quad (1)$$

D_{jt} in the equation above is the change in the neighborhood characteristic D over decade t (either 1990-2000 or 2000-2010[14]) as a function of a fixed neighborhood trend in that characteristic (α_j), fixed effects of overall trend of that characteristic in that decade (α_t), exposure to to public housing over the course of decade t (T_{jt}), and the vector of neighborhood composition measures at the beginning of decade t (N_{jt}). Changes in neighborhood composition measures as dependent variables (D_{jt}) are tested separately, and include change in percent non-Hispanic White, change in percent non-Hispanic Black, change in percent below the federal poverty line (BPL), and change in neighborhood entropy. The level of each of these characteristics at the beginning of the decade in question is then included in vector of neighborhood composition measures N_{jt}.

In describing neighborhood effects, it is predicted that public housing demolition in a neighborhood will reduce overall levels of neighborhood social capital–here measured as participation in community organizations ("community participation") and collective efficacy–through the mechanism of large-scale turnover of population and gentrification of the neighborhood. This process would be measured as an increase in percent non-Hispanic White and entropy, and a decrease in non-Hispanic Black and percent BPL, and should mediate the association between public housing demolition and social capital. Therefore, equation 2 shows level of social capital variables C in neighborhood j at time t as a function of fixed neighborhood and time effects (α_j and α_t, respectively), public housing demolition in the neighborhood (T_{jt}), neighborhood composition (N_{jt}), and change in neighborhood composition (D_{jt}).

[14]There are therefore two observations for each neighborhood: change from 1990 to 2000, with baseline characteristics in 1990; and change from 2000 to 2010, with baseline characteristics in 2000

$$C_{jt} = \alpha_0 + \alpha_j + \alpha_t + \beta T_{jt} + \delta_N N_{jt} + \delta_D D_{jt} + \epsilon \tag{2}$$

In order to describe the effects of public housing demolition on individual health, this study uses nested hierarchical linear models (HLM) to test first the association between public housing demolitions and health when controlling for neighborhood composition, and then test whether this association is mediated substantially by either observed neighborhood change or neighborhood-level social capital (as measured by community participation and collective efficacy). Models were estimated with standard errors corrected for both heteroskedasticity, with random effects present at the individual and neighborhood levels, and fixed effects at each wave. The neighborhood composition model, shown in equation 3, includes individual binary exposure to public housing demolitions at each wave, T_{jt}, and a vector of individual-level controls, X_{ijt} that are described above. Current neighborhood composition is measured in vector N_{jt}, which includes current neighborhood proportion White, current neighborhood proportion Black, and current neighborhood proportion below the federal poverty line (BPL). In this model, w_j represents the neighborhood-level random intercept (assumed $\sim N(0, \sigma_w^2)$), v_{ij} the individudal-level random intercept (assumed $\sim N(0, \sigma_v^2)$), and u_{ijt} the residual for each observation (assumed $\sim N(0, \sigma_u^2)$).

$$H_{ijt} = \alpha_0 + \alpha_t + \beta T_{jt} + \delta_X X_{ijt} + \delta_N N_{jt} + u_{ijt} + v_{ij} + w_j \tag{3}$$

The neighborhood change model, shown in equation 4, includes the annual change in neighborhood composition measures ($\Delta N_{\cdot jt}$) in addition to the measures included above.

$$H_{ijt} = \alpha_0 + \alpha_t + \beta T_{jt} + \delta_B X_{ijt} + \delta_N N_{jt} + \delta_D D_{jt} + u_{ijt} + v_{ij} + w_j \tag{4}$$

Under the theoretical framework laid out above, the effect of exposure to public housing on health (β) should at this point be reduced in magnitude and significance, while the individual components measuring the association between neighborhood change and health, δ_D, should have a significant association with health.

The final model, incorporating social capital variables, is shown in equation 5. This model incorporates neighborhood-level measures of community participation and collective efficacy in vector S_{jt}.

$$H_{ijt} = \alpha_0 + \alpha_t + \beta T_{jt} + \delta_B X_{ijt} + \delta_N N_{jt} + \delta_D D_{jt} + \delta_S S_{jt} + u_{ijt} + v_{ij} + w_j \quad (5)$$

Here, lower social capital in neighborhoods experiencing rapid change in composition should mediate the effects of public housing demolition and neighborhood change and health. The coefficients on neighborhood change, δ_D, should therefore be reduced in magnitude and significance, while the coefficients on social capital variables, δ_S, should be significant and positive.

4 Results

Table 2 shows individual level characteristics by wave of the PHDCN. While health, age, and exposure were measured at each wave of the survey, all other measures were recorded only at baseline and thus any changes seen are due to attrition from the study. Notably, less-educated, non-Hispanic Black individuals are seen to be lost to follow-up at a greater rate than other groups.

Table 3 shows neighborhood-level characteristics by wave,[15] within the 80 neighborhood clusters sampled in the PHDCN longitudinal study. Neighborhoods overall became more diverse and slightly less impoverished over the course of the study. In-

[15]Wave at the neighborhood level is determined as the mean date of interview for all individuals within that neighborhood

Variable	Wave 1	Wave 2	Wave 3
Self-reported health	3.885	4.011	3.932
	(0.996)	(0.976)	(0.98)
Exposure to public housing demolition (%)	7.9	13.8	23.6
	(26.9)	(34.5)	(42.5)
Age	10.239	12.306	14.025
	(3.36)	(3.37)	(3.42)
Sex (% male)	49.8	50.1	50.2
	(50.0)	(50.0)	(50.0)
Race/Ethnicity (%)			
White, non-Hispanic	16.0	17.9	20.5
	(36.7)	(38.4)	(40.4)
Black, non-Hispanic	34.8	31.8	29.5
	(47.6)	(46.6)	(45.6)
Hispanic, any race	44.5	45.6	45.2
	(49.7)	(49.8)	(49.8)
Other	4.6	4.7	4.8
	(21.0)	(21.1)	(21.5)
SEI at baseline	41.9	42.3	42.7
	(17.2)	(17.6)	(17.8)
Parent education (%)			
Less than high school	37.5	37.4	34.5
	(48.4)	(48.4)	(47.5)
High school	13.4	12.8	14.3
	(34.1)	(33.4)	(35.1)
Greater than high school	49.0	49.8	51.2
	(50.0)	(50.0)	(50.0)
N	3210	2051	1074

Table 2: Descriptive table of individual characteristics, by wave. Standard deviations in parentheses.

terestingly, the index of community participation (ranging from 0 to 3) fell markedly, while indices of collective efficacy (ranging from 5 to 25) rose over the same period, a result which would not be predicted by the literature.[16]

Variable	Wave 1	Wave 2	Wave 3
Exposure to public housing demolition	0.125	0.19	0.238
	(0.333)	(0.395)	(0.428)
Percent White	32.684	30.607	29.845
	(24.754)	(24.004)	(23.838)
Percent Black	34.886	35.446	34.959
	(33.157)	(33.182)	(33.105)
Percent BPL	21.01	20.785	20.524
	(9.939)	(9.306)	(8.803)
Entropy	54.046	55.241	56.145
	(21.141)	(21.463)	(21.367)
ΔPercent White	-0.787	-0.761	-0.023
	(1.26)	(1.259)	(0.826)
ΔPercent Black	0.069	0.064	-0.178
	(0.574)	(0.581)	(0.393)
ΔPercent BPL	-0.194	-0.196	0.162
	(0.466)	(0.467)	(0.371)
ΔEntropy	0.526	0.49	0.233
	(0.937)	(0.913)	(0.621)
Community participation	0.892	0.7	0.949
	(0.195)	(0.268)	(0.375)
Collective efficacy	17.582	–	19.179
	(1.816)	–	(1.979)
N	80	79	80

Table 3: Descriptive table of neighborhood characteristics, by wave.

Figures 3, 4, and 5 show the exposure to public housing demolition in 1996, 1998, and 2001, which are the median dates of waves 1, 2, and 3, respectively. At the outset, exposure to public housing demolition is confined primarily to West, North, and South side areas near the city center. By 1998 exposure has spread fully across the City

[16]Putnam specifically theorizes that participation in community activities will lead to greater feelings of social control and enforcement of community norms, and hence higher levels of collective efficacy

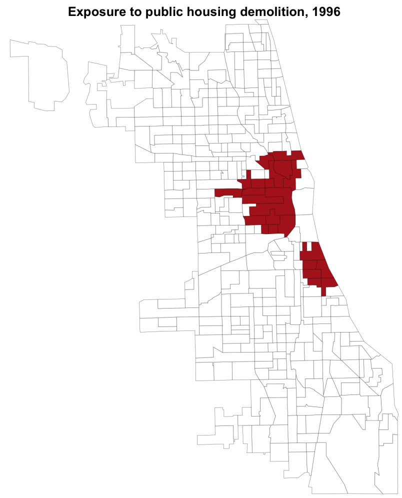

Figure 3: Neighborhood exposure to public housing demolition in 1996, approximately wave 1.

of Chicago to the West and South to encompass the State Street corridor, though central Chicago remains unexposed. Finally, by 2001, the central city is exposed, and exposure spreads westward from the State Street corridor into the Lower West Side and McKinley park areas. Notably, at no time does exposure increase northwards (beyond demolitions at such near North side sites as Cabrini-Green), but rather the overall trend is towards the South and the West.

Table 4 shows, by way of description, the relationship between public housing demolition and neighborhood change, at the neighborhood level. Accounting only for decade and neighborhood fixed effects, public housing demolition in a neighborhood is weakly associated with a decrease in the percent non-Hispanic White population, and strongly associated with an increase in entropy. Once baseline neighborhood characteristics are controlled for, however, these associations reduce to null, but public housing demolitions are significantly and negatively associated with change in percent non-Hispanic Black in a neighborhood. This association is to be expected, given that public housing projects managed by the CHA serve a population which is overwhelmingly Black.[17]

[17] The average public housing project managed by the CHA in 1996 was approximately 75%

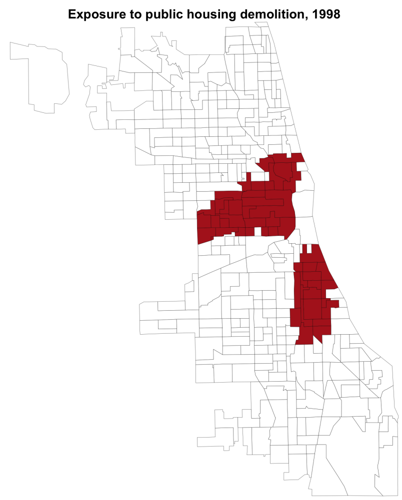

Figure 4: Neighborhood exposure to public housing demolition in 1998, approximately wave 2.

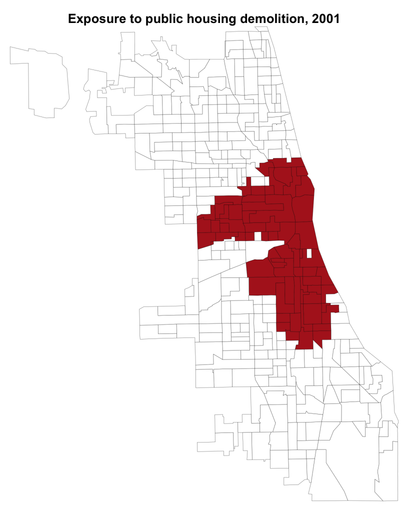

Figure 5: Neighborhood exposure to public housing demolition in 2001, approximately wave 3.

non-Hispanic Black, and the overall population of residents living in CHA-managed public housing project was over 90% (HUD, 1996; Hunt, 2009).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δ % White	Δ % White	Δ % Black	Δ % Black	Δ % BPL	Δ % BPL	Δ Entropy	Δ Entropy
Demolition	-0.215†	-0.026	-0.061	-0.178***	0.050	0.038	0.480**	0.034
	(0.121)	(0.063)	(0.070)	(0.044)	(0.050)	(0.044)	(0.149)	(0.082)
Year fixed effect	0.720***	0.161***	-0.200***	-0.116***	0.319***	0.274***	-0.376***	0.325***
	(0.048)	(0.036)	(0.028)	(0.025)	(0.020)	(0.025)	(0.059)	(0.047)
% White		-0.071***		0.000		-0.002		0.019***
		(0.003)		(0.002)		(0.002)		(0.004)
% Black		0.009		-0.081***		0.009*		-0.022**
		(0.006)		(0.004)		(0.004)		(0.007)
% BPL		-0.066***		0.030***		-0.042***		0.004
		(0.007)		(0.005)		(0.005)		(0.008)
Entropy		-0.021***		0.004*		-0.006**		-0.081***
		(0.003)		(0.002)		(0.002)		(0.004)
Constant	-0.745***	3.802***	0.068**	2.549***	-0.152***	0.764**	0.496***	4.146***
	(0.038)	(0.370)	(0.022)	(0.260)	(0.016)	(0.259)	(0.047)	(0.476)
Observations	686	686	686	686	686	686	686	686

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 4: Fixed-effects regressions of change in neighborhood composition as predicted by public housing demolitions.

Table 5 shows the relationship between demolition and community participation (columns 1 and 2) and collective efficacy (columns 3 and 4). Public housing demolition is weakly associated with a decrease in community participation, and significantly associated with decreases in collective efficacy. Overall, a decrease in community participation is weakly associated with public housing demolition when controlling for neighborhood composition, while collective efficacy is more strongly and again negatively associated with public housing demolition when controlling for neighborhood variables. Contrary to what is predicted by theory, these associations are stronger when one controls for neighborhood composition and change. Specifically, the inclusion of the percent of the population that is non-Hispanic Black (percent Black) in the model largely accounts for this change in estimated effect size, increasing the estimated magnitude of effect of public housing demolition on collective efficacy by over 33%, though there is no significant interaction effect between the two (regressions not shown).

Table 6 shows the results of hierarchical linear models using public housing demolition to predict public housing demolition to predict health, while testing for mediation by neighborhood composition, neighborhood change, and community participation, with random intercepts at both the individual and neighborhood level.[18] There is a significant negative effect of public housing demolition on health when controlling for neighborhood composition, but this effect is reduced in magnitude and significance when additional controls for neighborhood change and community participation are introduced, for an overall reduction of approximately 15%. There are, however, no significant effects of neighborhood change or community participation on health.

Table 7 shows the results of the hierarchical linear modelsusing wave 1 & 3 observations, in order to include neighborhood collective efficacy as a predictor.[19] Though

[18]Individual-level variables for age, age^2, sex, race/ethnicity, parent education, socioeconomic index, and fixed effects for wave were included in the regression but excluded from the table for brevity.

[19]Again, individual-level variables and fixed effects by wave were included in the models estimated,

	Community participation		Collective efficacy	
	(1)	(2)	(3)	(4)
Demolition	-0.141	-0.165†	-1.021*	-1.474**
	(0.094)	(0.096)	(0.494)	(0.542)
Wave 2	-0.174***	-0.181***		
	(0.033)	(0.040)		
Wave 3	0.073†	0.160*	1.712***	1.834***
	(0.042)	(0.069)	(0.197)	(0.313)
% White		0.004		0.015
		(0.015)		(0.071)
% Black		0.007		-0.193
		(0.026)		(0.130)
% BPL		-0.052*		-0.054
		(0.025)		(0.148)
Entropy		-0.007		0.027
		(0.013)		(0.074)
Δ % White		-0.081		0.292
		(0.053)		(0.291)
Δ % Black		-0.083		0.284
		(0.068)		(0.437)
Δ % BPL		-0.125		-0.849
		(0.101)		(0.591)
Δ Entropy		-0.008		-0.182
		(0.043)		(0.303)
Constant	0.907***	1.897	17.709***	23.831**
	(0.025)	(1.635)	(0.103)	(8.565)
Observations	239	239	160	160

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 5: Fixed-effects regression of effects of public housing demolition on community participation and collective efficacy.

	(1)	(2)	(3)
Demolition	-0.098*	-0.083†	-0.085†
	(0.046)	(0.048)	(0.048)
% White	0.003*	0.004*	0.004*
	(0.001)	(0.002)	(0.002)
% Black	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
% BPL	0.003	0.007†	0.006†
	(0.002)	(0.003)	(0.003)
Entropy	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Δ % White		-0.002	-0.003
		(0.019)	(0.019)
Δ % Black		0.034	0.034
		(0.032)	(0.032)
Δ % BPL		0.039	0.037
		(0.053)	(0.054)
Δ Entropy		0.006	0.007
		(0.019)	(0.019)
Community participation			-0.031
			(0.064)
Constant	4.050***	3.969***	3.992***
	(0.161)	(0.177)	(0.183)
Observations	6335	6335	6335

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 6: Random-intercept models of self-rated health using community participation variables, Waves 1, 2, & 3.

this model omits wave 2 observations relative to the above results, point estimates are essentially the same as found above. Collective efficacy (but not community participation) does appear to have a significant and positive effect on health, controlling for neighborhood composition and change, though theory would predict that collective efficacy would (partially) mediate the effect of these variables. Overall, there is at best minimal evidence of mediation by any variables of the effect of public housing demolition on self-rated health, with a reduction in magnitude of the coefficient of less than 6%. Interestingly, there is a significant and positive effect of neighborhood poverty on health, when controlling for neighborhood collective efficacy.

but not shown in the table.

	(1)	(2)	(3)
Demolition	-0.108^{*}	-0.110^{*}	$-0.102^{\dagger}$
	(0.053)	(0.056)	(0.056)
% White	$0.002^{\dagger}$	$0.003^{\dagger}$	$0.003^{\dagger}$
	(0.001)	(0.002)	(0.002)
% Black	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)
% BPL	$0.005^{\dagger}$	0.006	0.008^{*}
	(0.002)	(0.004)	(0.004)
Entropy	0.000	−0.001	0.000
	(0.001)	(0.001)	(0.001)
Δ % White		−0.009	−0.009
		(0.020)	(0.020)
Δ % Black		0.039	0.033
		(0.036)	(0.036)
Δ % BPL		−0.029	−0.014
		(0.061)	(0.061)
Δ Entropy		−0.014	−0.015
		(0.021)	(0.022)
Community participation			−0.046
			(0.079)
Collective efficacy			0.028^{**}
			(0.010)
Constant	4.107^{***}	4.064^{***}	3.531^{***}
	(0.171)	(0.190)	(0.281)
Observations	4284	4284	4284

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 7: Random-intercept regression of self-rated health using community participation and collective efficacy variables, Waves 1 & 3.

5 Discussion

The above analysis of PHDCN data shows a clear correlation between public housing demolition, neighborhood change, and the community participation and collective efficacy aspects of neighborhood social capital. This association appears to weakly mediate a portion of the effect of public housing demolition on health, which itself is significant and negative. Neighborhood collective efficacy has a significant and positive association with health among children, while community participation has a null effect.

Public housing demolition appears to have the intended association with neighborhood change–disadvantage, as defined by concentration of minority and impoverished individuals, was significantly reduced in areas with public housing demolitions, at the same time that poverty and minority concentration was increasing in most neighborhoods. Additionally, diversity, as measured by entropy, significantly increased in areas experiencing public housing demolition. These changes indicate that, over the decades in which they experienced demolition, neighborhoods became significantly more diverse, both racially and economically, potentially drawing in additional services and amenities that would improve the well-being of individuals remaining in the neighborhood.

Net of neighborhood-level predictors, however, public housing demolition is only weakly associated with decreases in community participation, but strongly predictive of decreases in measures of perceived collective efficacy. While sociological theory predicts that these two measures would be strongly correlated, in this instance the larger decrease in collective efficacy relative to community participation seems reasonable. Those most most likely to participate in local government, churches, and neighborhood associations may be less likely to move from their neighborhoods in the wake of large changes, while those likely moving into these areas would be unlikely to initiate participation in neighborhood organizations in the short-term, thus leading to null changes in the wake of public housing demolitions. Collective efficacy, on the other hand, decreases significantly as a direct effect of perceptions both of and by newcomers in a neighborhood. Individuals staying in the neighborhood, while they may have had initially higher trust in the enforcement of norms by neighbors, report lower levels of trust due to newcomers moving in, while the newcomers have yet to form the interpersonal trust that promotes collective efficacy, leaving a net decrease in the aftermath of public housing demolition.

In affecting health, public housing demolition has a weakly negative effect, which is mediated somewhat by changing neighborhood conditions in the model employing three waves of data. In this model, the effect of public housing demolition on health decreases by over 15% when including neighborhood change measures (though no neighborhood change measures are independently significant), and the inclusion of the index of community participation does not alter the estimate further.

Using only two waves of data, the initial point estimate of the effect of public housing demolition on health remains the same, but this effect does not appear to be mediated by changes in neighborhood composition or community participation between wave 1 and wave 3, but rather only slightly affected by the inclusion of a measure of collective efficacy, which itself has a significant and positive effect on health.

The effect of collective efficacy on children's health may stem from two possible (and possibly complementary) directions: first, higher collective efficacy may reduce neighborhood-level environmental stressors which may directly or indirectly (through mediation in the home environment) lead to worse health outcomes. Second, as many of the collective efficacy questions utilized in this study deal directly with control of youth behavior, this type of collective efficacy may directly impact youth behavior through direct enforcement of community norms, or signal communities in which parents more closely monitor and control youth behavior. If this monitoring and control leads to greater participation in positive health behaviors (or lower exhibition of negative behaviors), then collective efficacy or the parental efficacy it may signal may directly impact child health. Greater school attendance (which would be directly affected by the collective efficacy measured here), in particular, may have an effect both through preventive attention from school nurses and through the potential improved nutrition via free and reduced-price lunch programs.

In either case, there is a substantial unexplained effect of public housing demolition on children's health, which is neither explained by changes in the neighborhood composition or changes in the measured social characteristics of the neighborhood. There may be direct effects of demolition health through noise and dust pollution, and moreover, public housing demolitions may signal broader demolition and building drives in the neighborhood, amplifying the actual effect. Additionally, neighborhood crime, which was not measured here, may play a substantial role in changing neighborhoods. While crime would not necessarily be impacted by changing racial composition, the demolition of public housing, and especially large public housing projects, may have disrupted gang and other criminal activity, without affecting the specific activities addressed in the collective efficacy measures.

The above results are limited in a few ways. First, while they control for the correlation of random errors at the individual and neighborhood levels, the models above to not fully account for error that is systematic at the level of the individual or neighborhood (in the case of omitted variables bias). Systematic biases may result from unmeasured factors at the individual or neighborhood levels, such as those causing individuals with worse health to concentrate in poor neighborhoods, or unmeasured neighborhood factors affecting composition of individuals within them and their probability of exposure to public housing demolition. While fixed effects estimation results in a a meaningful reduction in effect size, there are methodological reasons that may make these specifications less than ideal under certain assumptions.

These issues are explored more fully in appendix B.

The second issue of bias results from the possible misspecification of the functional form of both exposure to public housing demolition as well as observed covariates. Exposure, as it is defined here, is dichotomous, permanent, and, and has a sharp "boundary" at one neighborhood cluster of adjacency. Other specifications might consider time lags, more flexible functions of geographic distance, and functions relating to the number of individuals displaced by demolitions, all of which are considered more fully in appendix A. The current measure was chosen for its parsimony, and alternative spatial or magnitude-related exposure measures, again, make little difference in the conclusions drawn by the current study.

Finally, the nature of the observational data, with exclusion of individuals lost to follow-up and of "movers" from the analyses, introduces biases if these individuals are systematically different with respect to both exposure to public housing demolition and health status from those individuals and observations which are actually observed. The sensitivity of the current findings to these potential biases are explored in appendix C, with findings accounting for these biases largely confirming the results presented above.

In spite of the limitations described above, this study does provide important evidence that exposure to public housing demolitions is associated with short- and medium-term differences in individual health, though the actual mechanisms for this difference are not fully explained. This finding has implications for public housing policy, in that the experiences, and health, of residents of neighborhoods hosting public housing projects must be taken into account when redevelopment of public housing projects is taking place.

Appendix A Selection of exposure measures

The exposure measure used here was, as indicated above, a dichotomous indicator variable of any demolition observed within a neighborhood cluster or an adjacent neighborhood cluster prior to a given date. This measure was, for the most part, chosen due to its simplicity, and could have been defined differently. Specifically, there are three dimensions along which decisions may be made (given no detailed knowledge of the nature of interactions between individuals in different residential locations in Chicago at this time): exposure might take into account different temporal leads or lags; exposure might incorporate different functions of distance; and exposure might be weighted by a function of the number of residents of each building.

The data available from the CHA include three types of information which are applicable to the construction of the exposure measure: the address of the building, which was converted to a point through geocoding; the "start date" of the demolition, which was taken to be the "effective" date of demolition; and the number of units (apartments) in the building. Data on the number of units occupied in the building prior to the demolition, the total number of tenants prior to demolition, when tenants and community members were informed of demolition, and when the final tenants were moved out, were not available. Because these data were not available, more specific measures of the "social" timing of demolitions, or the neighborhood impact beyond the size of buildings, are not possible.

The scale of demolitions is of primary concern in this analysis: larger demolitions, and thus a larger movement of individuals out of neighborhood, should lead to larger effects on individuals. However, it is likely that there is a threshold or marginally declining effect effect: the effect of one more unit being demolished in a neighborhood is likely greater in a neighborhood with few demolitions up to that point relative to the effect in a neighborhood which has already had a large number of demolitions. For this reason, a number of formulations designed to weight exposure by the number of units (apartments, in most cases) demolished were considered, including a linear term (no declining marginal effect, $T = U$ where U is the number of units), scaling exposure by the square root of the number of units demolished ($T = \sqrt{U}$), and scaling it by the natural log of the number of units demolished plus one ($T = \log(U + 1)$, the most sharply declining marginal effect). Dichotomous threshold effects were also considered, which set a threshold of exposure at a certain number of units demolished within a neighborhood, above which individuals and neighborhoods were considered uniformly exposed (thus $T = 1$) and below which they were considered unexposed ($T = 0$). Three thresholds were set, which were based on an examination of the building-specific data provided by the CHA: any demolitions versus none (threshold set at 1), demolition of more than 12 units, and demolitions more than 75 units. The threshold at 12 was set because there were a large number of smaller buildings with 12 or fewer units, and buildings over 12 units tended to be much larger, indicating a natural break point. The 75-unit threshold was set because buildings over 75 units accounted for approximately 50% of public housing units demolished, and thus 75 was approximately the total building size from the perspective of the "average" public housing unit.

In order to avoid possible data mining, exposure measures were tested in a simple bivariate model of exposure on health using only wave 1 data (to avoid issues of attrition), and a final decision on the scaling of the unit was made before multivariate analysis began. The median number of units demolished within an individual's neighborhood among those exposed at wave 1 was 367, while the mean number was 245. The coefficient on the dichotomous exposure variable with the threshold at 1 ("any versus none") was -0.197, indicating a decrease in health of about 0.2. When using a linear scaling by the number of units, the detriment to health for a median-exposed individual was approximately 0.15, while the detriment to health for a mean-exposed individual was 0.1, indicating a slightly smaller effect on health. Using the square root exposure measure, median-exposed individuals' health was decreased by about 0.18, while mean-exposed individuals suffered a decrease in health by about 0.15. Similarly, for the log-transformed exposure measure, median-exposed health decreased by approximately 0.2, while mean-exposed health decreased by approximately 0.18. Coefficients on dichotomous measures were approximately -0.19 for the threshold at 12 units and -0.14 for the threshold at 75 units. All associations were significant at the $\alpha = 0.05$ level except for the linear measure ($p = 0.065$) and the threshold at 75 ($p = 0.051$). Overall, all measures led to the same basic conclusion, and therefore the threshold at 1 was selected for parsimony.

Proper spatial measurement of exposure was also considered, though was not tested as thoroughly. Other types of measures could have considered monotonic decreasing functions of geographic distance (rather than adjacency) to be the primary distance weight function, for example, $\frac{1}{e^{-D}}$, where D is the distance between the centroid of the neighborhood cluster and the housing demolition. In the end, a 1-adjacency measure was used for two reasons: first, it lends itself to a direct interpretation in a model, rather than a more esoteric spatial weight multiplier; and second, because it creates boundaries around potentially meaningful neighborhoods, with a radius (from the centroid of the target neighborhood cluster) of on average less than 1.5 kilometers. While this neighborhood is certainly larger than the "walkable" immediate neighborhood within approximately 500 meters of a household, it seems reasonable that with public transit in a dense city, residents will be able to regularly utilize resources in this area. Using a more narrowly-defined neighborhood limited just to the individual's neighborhood cluster would both drastically limit the analysis (because relatively few neighborhoods at this point would be considered "exposed") and potentially miss important effects of demolition on residents of similar neighborhoods nearby: among the exposed over 95% were exposed to a public housing demolition of over 60 units near their neighborhood, indicating that this broadening is unlikely to be picking up small, unimportant exposures to demolition.

Finally, the effects of exposure may lead or lag actual demolition of a building because of its central social character. The theory presented in the above analysis is that the social changes which are brought about by the demolition of public housing projects are linked to the rapid change of population in the area. Because households are informed of the impending demolition of their building months or even years in advance, the process of population change in a neighborhood may lead the actual demolition of a public housing project. On the other hand, the accumulation of stress due to rapid neighborhood change and the long-term effects of this chronic stress may take months or years to manifest, thus leading to substantially downward-biased estimates of effects if a lagged exposure measure is not used. Because of the theoretical uncertainty surrounding the actual timing of effects of exposure on health in neighborhoods, this study employed neither leads nor lags in its assignation of exposure status.

Appendix B Alternative model specifications

The analyses presented in the main text account for correlated random errors of observations within individuals and of individuals nested within neighborhood clusters. This approach allows for correlated errors within each level, under the assumption that within clusters, these errors are normally distributed with a mean of zero. If these issues are not random, however, there may be biases with respect to the "true" effect of exposure to public housing demolition on health. In particular, there may be unmeasured or unobservable, fixed characteristics which lead certain types of individuals to reside in specific neighborhoods, and unobserved characteristics of neighborhoods which make them more or less likely to be exposed to public housing demolitions.

B.1 Fixed-effects approaches

A potential issue for this analysis is the presence of unmeasured variables which affect both the treatment (exposure to public housing demolition) and the outcome (self-rated health of children). Because of the hierarchical design of the study, these unmeasured factors could affect treatment and outcome at two levels: in leading to endogenous of selection of individuals into neighborhoods, and by leading to non-random selection of neighborhoods into treatment and control.

Fixed-effects regression incorporating fixed effects for individuals or neighborhoods removes bias associated with time-invariant characteristics at that level, and is already employed to adjust for variation by wave. The closest approximation to randomization with the current data is to incorporate an interaction between neighborhood and wave fixed effects, as shown in equation 6

$$H_{ijt} = \beta_0 + \beta_1 T_{jt} + \beta_2 WAVE_t + \beta_3 NC_j + \gamma WAVE_t \times NC_j + \beta_4 X_{ijt} + \beta_5 X_{jt} + u \quad (6)$$

Equation 6 identifies the average treatment effect[20] (β_1) as the difference in mean health between exposed and unexposed individuals within the same neighborhood at the same wave, adjusting for individual observable characteristics (X_{ijt}) and neighborhood observable characteristics (X_{jt}). This identification is possible because exposure, while a neighborhood-level characteristic, is determined at the time of interview, and interviews for the same wave stretched out over as much as two years. In this specification, the actual differences in neighborhood characteristics are likely to be extremely small for composition measures (which are linearly-interpolated at interview points) and null for social capital measures (which are pooled by neighborhood and wave), and thus the effects of these measures on health (and their mediation of

[20] For all of these specifications, there is an assumption that the effect of the treatment on individuals is not correlated with the probability of receiving treatment.

the relationship between exposure and health) are expected to be null.

While this model should approximate a "pure" average treatment effect[21], it is entirely possible (even probable) that any identified effect would be noise. Because plausible time lags may be positive, negative, or null (see discussion in appendix A), and this model identifies effects based on differences in exposure over the course of a few months between interviews in the same wave, it will be extremely susceptible to misspecification of exposure time, and therefore likely biasing the results towards the null.

$$H_{ijt} = \beta_0 + \beta_1 T_{jt} + \beta_2 WAVE_t + \beta_3 NC_j + \beta_4 X_{ijt} + \beta_5 X_{jt} + u \tag{7}$$

Equation 7 includes fixed effects within waves and within neighborhoods, but not the interaction of the two, thus identifying the effect as the difference in mean health between treated and untreated individuals in the same neighborhood, adjusted for the pooled (across neighborhoods) mean health in each observation's wave and the the composition of individuals across neighborhoods. While this model directly controls for the issue of non-random selection into treatment by neighborhood, it does directly not address non-random selection of individuals into neighborhoods.

Table 8 shows the results of the model specified in equation 7 using observations from all three waves, while table 9 includes only observations from waves 1 and 3 in order to include collective efficacy variables.[22] Here we see that the inclusion of neighborhood fixed effects (while still adjusting standard errors for individual-level clustering) meaningfully reduces the observed effect of exposure to public housing demolition on health. This large change (from ≈ -0.10 to ≈ -0.07, a 30% reduction) indicates substantial selection effects of treatment towards neighborhoods with worse

[21] Under the joint assumption of (1) non-correlation between the effect of treatment and living in a neighborhood that receives treatment and (2) the random ordering of interviews within neighborhoods

[22] As in previous models, individual-level characteristics were included in the model but excluded from the table for the sake of clarity.

mean health at the outset.

These unmeasured neighborhood-level factors which determine may be meaningful confounders of the relationship between public housing demolition and health. On the other hand, given the selection of exposure measure, this approach leads to identification of effect based only on neighborhoods which experienced public housing demolition during the PHDCN–exposed neighborhoods at the outset and those neighborhoods which remained unexposed throughout are controlled out through fixed effects.

A second approach to fixed effects would be to include fixed effects at the individual level, as shown in equation 8. Because observations of individuals are limited to individuals remaining in the same neighborhood as at baseline, the inclusion of individual fixed effects also controls for neighborhood fixed effects. Individual-level fixed effects in this context control for unmeasured individual characteristics which lead to both selection into a neighborhood which will be exposed to public housing demolition, and fixed neighborhood-level characteristics that control for selection of neighborhoods into exposure.

$$H_{ijt} = \beta_0 + \beta_1 T_{jt} + \beta_2 WAVE_t + \beta_3 SUBID_{ij} + \beta_4 X_{ijt} + \beta_5 X_{jt} + u \tag{8}$$

Tables 10 and 11 show the results of OLS regressions incorporating subject-level fixed effects, utilizing all waves of data and waves 1 and 3, respectively. Here we see that adjusting for individual selection into neighborhoods and neighborhood selection into exposure or treatment, results are mixed on the magnitude of effect of public housing demolition on health, ranging from approximately 30% below the estimates given by random intercepts models to 75% above those estimates, depending on the measures employed. At this point, standard errors on all variables have increased such that no coefficients are significant at the $\alpha = 0.05$ level. This approach, however, has the effect of removing all variables which do not change over the course of the study,

	(1)	(2)	(3)
Demolition	-0.069	-0.061	-0.065
	(0.071)	(0.072)	(0.073)
% White	0.003	0.008	0.008
	(0.010)	(0.013)	(0.013)
% Black	-0.008	0.001	0.001
	(0.018)	(0.020)	(0.020)
% BPL	0.009	0.020	0.019
	(0.024)	(0.027)	(0.027)
Entropy	0.003	0.007	0.007
	(0.009)	(0.010)	(0.010)
Δ % White		0.033	0.032
		(0.047)	(0.047)
Δ % Black		0.066	0.064
		(0.068)	(0.068)
Δ % BPL		0.127	0.120
		(0.102)	(0.104)
Δ Entropy		0.015	0.014
		(0.032)	(0.032)
Community participation			-0.036
			(0.081)
Constant	4.002***	3.136*	3.189*
	(1.184)	(1.366)	(1.373)
Observations	6335	6335	6335

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 8: OLS regression with neighborhood fixed effects, all waves.

	(1)	(2)	(3)
Demolition	-0.066	-0.039	-0.000
	(0.086)	(0.089)	(0.099)
% White	-0.004	0.000	0.001
	(0.011)	(0.018)	(0.018)
% Black	-0.002	0.015	0.020
	(0.020)	(0.027)	(0.027)
% BPL	-0.023	-0.035	-0.027
	(0.026)	(0.034)	(0.035)
Entropy	-0.006	-0.020	-0.021
	(0.010)	(0.015)	(0.015)
Δ % White		0.005	0.005
		(0.067)	(0.068)
Δ % Black		0.099	0.099
		(0.089)	(0.091)
Δ % BPL		-0.076	-0.039
		(0.124)	(0.127)
Δ Entropy		-0.067	-0.066
		(0.046)	(0.046)
Community participation			0.073
			(0.116)
Collective efficacy			0.028
			(0.023)
Constant	5.238***	5.500**	4.589*
	(1.281)	(1.842)	(2.014)
Observations	4284	4284	4284

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 9: OLS regression with neighborhood fixed effects, waves 1 and 3.

such at sex, race, parental education, and economic status (SEI was measured only at the first wave).

While this approach would controls for these variables and others, it is possible, and even probable, that these variables should have effects on both the levels and the trajectories of health over the course of the study, and thus interactions between these variables and wave of interview may better control for these effects. Additionally, and similar to neighborhood-level fixed effects, in this formulation the effect of public housing demolition is only identified among individuals who experience change in their exposure status during the study, while individuals who are exposed at the outset or remain unexposed throughout are essentially removed, leading to potentially more severe biases if the spatial or temporal character of exposure is misspecified.

The above results for fixed effects approaches show that, while the inclusion of individual- or neighborhood-level fixed effects addresses some biases within the study, they may also lead to other biases due to misspecification of exposure measures, either due to left-censoring of observations or due to misspecification of the functional (temporal or spatial) form of the exposure measure. In any case, fixed effects regression controlling for both individual- and neighborhood-level effects find point estimates of the effect of public housing demolition on health that broadly agree with the results from random intercept models, though standard errors in this case are greatly increased with the inclusion of a large number of additional dummy variables.

B.2 Propensity score approaches

In order to most most directly model the effect of selection on *observable* characteristics, a propensity score approach was also employed. Under this approach, as described by Rubin and Rosenbaum (1984), the propensity score is modeled iteratively as the probability of treatment, which is a function of polynomials and interaction terms of observable characteristics related to selection. Therefore, in the current

	(1)	(2)	(3)
Demolition	-0.071	-0.064	-0.075
	(0.131)	(0.130)	(0.128)
% White	0.011	0.015	0.016
	(0.020)	(0.024)	(0.024)
% Black	0.002	0.014	0.015
	(0.028)	(0.034)	(0.034)
% BPL	0.025	0.033	0.030
	(0.048)	(0.059)	(0.060)
Entropy	0.006	0.011	0.010
	(0.015)	(0.016)	(0.016)
Δ % White		0.029	0.027
		(0.068)	(0.067)
Δ % Black		0.082	0.080
		(0.095)	(0.096)
Δ % BPL		0.122	0.103
		(0.171)	(0.177)
Δ Entropy		0.023	0.021
		(0.047)	(0.046)
Community participation			-0.082
			(0.140)
Constant	3.282	2.324	2.420
	(2.413)	(2.736)	(2.754)
Observations	6335	6335	6335

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 10: OLS regression with individual fixed effects, all waves.

	(1)	(2)	(3)
Demolition	-0.150	-0.118	-0.178
	(0.183)	(0.184)	(0.202)
% White	0.004	-0.002	-0.005
	(0.026)	(0.043)	(0.040)
% Black	0.006	0.041	0.035
	(0.038)	(0.072)	(0.072)
% BPL	-0.018	-0.053	-0.061
	(0.062)	(0.062)	(0.064)
Entropy	-0.003	-0.011	-0.011
	(0.020)	(0.031)	(0.030)
Δ % White		-0.042	-0.057
		(0.174)	(0.168)
Δ % Black		0.156	0.131
		(0.234)	(0.243)
Δ % BPL		-0.143	-0.168
		(0.266)	(0.270)
Δ Entropy		-0.007	-0.001
		(0.093)	(0.098)
Community participation			-0.175
			(0.288)
Collective efficacy			-0.004
			(0.044)
Constant	5.042	4.877	5.549
	(3.233)	(4.710)	(4.709)
Observations	4284	4284	4284

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 11: OLS regression with neighborhood fixed effects, waves 1 and 3.

analysis, the propensity score is included as follows:

$$H_{ijt} = \beta_0 + \beta_1 T_{ijt} + \beta_2 X_{ijt} + \beta_3 \hat{P}_j + \beta_4 X_{jt} + u \tag{9}$$

where

$$\hat{P}_j = P(T_{jY} = 1 | X_{j0}) = f(X_{j0}). \tag{10}$$

In the above equation, T_{jY} is the exposure status of neighborhood j in year Y, with Y being defined as an arbitrary endpoint that is beyond the end of observation of the PHDCN. In this way, what is explicitly being modeled is the probability that a neighborhood will be exposed to public housing demolition by year Y, not that an individual or neighborhood is exposed in a specific year. As such, this approach identifies a "latent" treatment group, assuming differences in actual treatment for individuals or neighborhoods at a given level of probability of treatment are due to random differences in the timing of treatment, and are uncorrelated with either observable or unobservable neighborhood characteristics.

This approach address assignation of exposure status realistically in a number of ways. First, as exposure to public housing demolition is assigned at the neighborhood level, with all individuals in a neighborhood being assumed to have the same exposure status, this approach models the probability of exposure at the neighborhood level. Second, while treatment status is readily observed for individuals at the time of the survey, it is likely that neighborhood-level exposure occurs both before and after the observation period (and depending on the temporal lead or lag employed, these neighborhoods may actually be "exposed"). The data on demolitions occurring after the PHDCN was completed in 2002 provides additional information on neighborhoods which could be matched according to being the *type* of neighborhood which *would be* exposed. For this reason, the propensity score is constructed according to end dates of 2008 and 2011 (the final year of available CHA data), where it is directly modeling the probability of exposure in a neighborhood by an arbitrary end date. Because of the larger proportion of potentially exposed observations, propensity scores using later end dates were more easily balanced than those using earlier dates.

Tables 12 and 13 show the results of a random intercept regression (as described in equation 5) employing a propensity score estimated based on neighborhood exposure by 2011. The estimated propensity scores have null effects on self-rated health, and their inclusion in models changes little from early random intercepts models. Results from models including an estimated propensity score based on exposure by 2008 (not shown) are nearly identical. Given that the estimated propensity scores employed are unbiased estimates of the "true" propensity score, there does not seem to be significant selection on observable neighborhood characteristics driving the models.

Propensity scores were estimated using 2008 and 2011 as end dates because of the relatively low number of exposed neighborhoods by 2002 and 2005, and therefore greater difficulty in achieving "balance" of the scores for these earlier dates. This approach may introduce bias into the results if there are large differences in those individuals or neighborhoods that are exposed earlier (prior to 2002) versus later (between 2002 and 2011). Table 14 focuses on the 1,087 individuals who were living in neighborhoods which were exposed to public housing by 2011, and compares baseline characteristics of groups who were or would have been exposed by the end of the observed period (by 2002) with those who would have been exposed later. There are significant differences in race and ethnicity, with Hispanic and non-Hispanic white individuals being more likely to be exposed in earlier time periods, and non-Hispanic black individuals exposed in later periods. Similarly, poorer, less-educated households were exposed in earlier time periods, while more wealthy and better-educated households were exposed between 2002 and 2011. These differences, especially in SEI and education, would likely bias results away from the null, which may be partially off-set

	(1)	(2)	(3)
Demolition	-0.097*	-0.087†	-0.088†
	(0.048)	(0.049)	(0.049)
Propensity score - 2011	-0.013	0.068	0.063
	(0.142)	(0.151)	(0.151)
% White	0.003*	0.003*	0.003*
	(0.002)	(0.002)	(0.002)
% Black	-0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.001)
% BPL	0.004	0.005	0.005
	(0.005)	(0.005)	(0.005)
Entropy	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Δ % White		-0.003	-0.003
		(0.019)	(0.019)
Δ % Black		0.036	0.035
		(0.032)	(0.032)
Δ % BPL		0.047	0.044
		(0.056)	(0.057)
Δ Entropy		0.006	0.006
		(0.019)	(0.019)
Community participation			-0.029
			(0.064)
Constant	4.041***	4.000***	4.019***
	(0.185)	(0.190)	(0.195)
Observations	6335	6335	6335

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 12: Random intercepts incorporating propensity score for probability of exposure by 2011, waves 1 and 3.

	(1)	(2)	(3)
Demolition	-0.106†	-0.110†	-0.105†
	(0.056)	(0.057)	(0.056)
Propensity score - 2011	0.035	0.066	0.065
	(0.156)	(0.165)	(0.161)
% White	0.002	0.003	0.003
	(0.002)	(0.002)	(0.002)
% Black	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
% BPL	0.003	0.004	0.007
	(0.005)	(0.005)	(0.005)
Entropy	-0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.001)
Δ % White		-0.009	-0.009
		(0.021)	(0.020)
Δ % Black		0.041	0.034
		(0.037)	(0.036)
Δ % BPL		-0.022	-0.006
		(0.064)	(0.064)
Δ Entropy		-0.015	-0.016
		(0.022)	(0.022)
Community participation			-0.043
			(0.079)
Collective efficacy			0.028**
			(0.010)
Constant	4.125***	4.094***	3.557***
	(0.202)	(0.208)	(0.289)
Observations	4284	4284	4284

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 13: Random intercepts incorporating propensity score for probability of exposure by 2011, waves 1 and 3.

by the racial and ethnic differences in the sample, which may bias results towards the null.

Variable	Total	Exposed by 2002	Exposed between 2002 & 2011	p
Self-rated health	3.87 (1.03)	3.83 (1.04)	3.93 (1.01)	0.12
Age	10.30 (3.34)	10.27 (3.34)	10.35 (3.35)	0.68
Female	0.51 (0.50)	0.50 (0.50)	0.51 (0.50)	0.71
Race/Ethnicity				
Non-Hispanic White	0.10 (0.30)	0.14 (0.35)	0.041 (0.20)	<0.01
Non-Hispanic Black	0.44 (0.50)	0.27 (0.44)	0.70 (0.46)	<0.01
Hispanic, any race	0.43 (0.50)	0.56 (0.50)	0.24 (0.43)	<0.01
Any other race	0.03 (0.17)	0.03 (0.18)	0.03 (0.16)	0.41
Primary caregiver education				
Less than high school	0.49 (0.5)	0.55 (0.50)	0.41 (0.49)	<0.01
High school diploma	0.12 (0.33)	0.13 (0.34)	0.12 (0.32)	0.47
More than high school	0.39 (0.49)	0.33 (0.47)	0.48 (0.50)	<0.01
Socioeconomic index	40.62 (16.72)	39.35 (17.07)	42.51 (16.01)	<0.01
Neighborhood proportion white	0.212 (0.179)	0.264 (0.174)	0.135 (0.156)	<0.01
Neighborhood proportion BPL	0.283 (0.108)	0.314 (0.111)	0.238 (0.086)	<0.01
N	1087	651	436	

Table 14: Comparision of baseline characteristics of individuals who were exposed to public housing demolition by 2002 and those who were not exposed by 2002 but exposed by 2011.

Appendix C Sensitivity analyses

In order to examine issues related to the imposed restrictions on data in this study, namely that individuals do not move from their original neighborhoods and are not lost to follow-up, two additional sets of models were estimated. The concern is that if individuals attrit or move non-randomly, this would bias estimates. Non-random moving and attrition are especially concerning in this instance due to the time-sensitive nature of the exposure–by the above definition, as time goes on, more individuals move into the exposed category without any individuals leaving this category. If poor health is positively associated with attrition or moving, the sample over time will be both healthier and more exposed to demolition, thus leading to a spurious (positive) correlation. This may be balanced out by increased attrition or moving by those who would otherwise be exposed, which would tend to bias results downwards.

Table 15 shows results for random intercept models using only observations from wave 1.[23] Tables 16 and 17 show results for random intercept models which restrict the sample to only individuals who do not move at any point[24] (table 16) and only individuals who do not attrit at any point during the survey (table 17). It can be seen that, overall, these models lead to the same conclusions (and nearly identical point estimates) as the earlier results. These findings indicate that, while selection may play some role in driving associations, the basic correlation are likely to remain the same even when if there was no attrition or moving from the sample.

[23]As there was less than 3% missing data on all variables included, this sample, which is not subject to either moving or loss to follow-up, is representative of all children in Chicago. Because only one observation per subject is used, random intercepts are estimated at only the neighborhood level.

[24]Previous models included all individuals up until the time they moved, and thus included first-wave observations for individuals who moved between the first and third waves. The models presented here exclude those first-wave observations for individuals who had moved by the third wave.

	(1)	(2)	(3)
Demolition	-0.137†	-0.167*	-0.173*
	(0.070)	(0.079)	(0.079)
% White	0.003†	0.003†	0.004†
	(0.002)	(0.002)	(0.002)
% Black	-0.001	-0.000	-0.001
	(0.001)	(0.001)	(0.001)
% BPL	0.004	0.003	0.003
	(0.003)	(0.004)	(0.004)
Entropy	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Δ % White		-0.238	-0.253
		(0.243)	(0.244)
Δ % Black		0.179	0.165
		(0.410)	(0.410)
Δ % BPL		-0.891	-0.966
		(0.737)	(0.744)
Δ Entropy		-0.024	-0.030
		(0.028)	(0.030)
Community participation			0.084
			(0.118)
Constant	4.523***	4.501***	4.423***
	(0.235)	(0.256)	(0.278)
Observations	3210	3210	3210

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 15: Random intercept model restricted to only observations from wave 1.

	(1)	(2)	(3)
Demolition	-0.106*	-0.093†	-0.097†
	(0.048)	(0.050)	(0.050)
% White	0.003*	0.003*	0.004*
	(0.001)	(0.002)	(0.002)
% Black	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)
% BPL	0.004	0.006†	0.006†
	(0.002)	(0.004)	(0.004)
Entropy	0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
Δ % White		-0.012	-0.013
		(0.019)	(0.019)
Δ % Black		0.015	0.015
		(0.033)	(0.033)
Δ % BPL		0.025	0.020
		(0.055)	(0.055)
Δ Entropy		0.004	0.005
		(0.019)	(0.019)
Community participation			-0.066
			(0.066)
Constant	4.112***	4.021***	4.071***
	(0.174)	(0.191)	(0.198)
Observations	5331	5331	5331

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 16: Random intercepts model restricted to only individuals who did not move at any time during the study.

	(1)	(2)	(3)
Demolition	-0.093†	-0.088	-0.086
	(0.054)	(0.057)	(0.057)
% White	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)
% Black	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
% BPL	0.001	0.003	0.003
	(0.003)	(0.004)	(0.004)
Entropy	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
Δ % White		0.013	0.013
		(0.022)	(0.023)
Δ % Black		0.040	0.040
		(0.040)	(0.040)
Δ % BPL		0.021	0.023
		(0.065)	(0.065)
Δ Entropy		0.002	0.002
		(0.022)	(0.023)
Community participation			0.029
			(0.076)
Constant	4.040***	4.021***	4.002***
	(0.204)	(0.225)	(0.231)
Observations	3854	3854	3854

Standard errors in parentheses

† $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 17: Random intercepts model restricted only to individuals who were not lost to follow-up at any point in the study.

References

Bourdieu, Pierre. 1985. "The Forms of Capital." In *Handbook of Theory and Research for the Sociology of Education*, edited by JG Richardson, pp. 241–258. New York: Greenwood.

Cattell, V. 2001. "Poor people, poor places, and poor health: the mediating role of social networks and social capital." *Social Science & Medicine* 52:1501–16.

Caughy, Margaret O'Brien, Patricia J O'Campo, and Carles Muntaner. 2003. "When being alone might be better: neighborhood poverty, social capital, and child mental health." *Social Science & Medicine* 57:227–37.

Chaplin, D. 2002. "Estimating the impact of economic integration." In *Divided we fail: Coming together through public school choice*, edited by Century Foundation, pp. 87–113. New York: Century Foundation Press.

Chen, Edith and Laurel Q Paterson. 2006. "Neighborhood, family, and subjective socioeconomic status: How do they relate to adolescent health?" *Health Psychology* 25:704–14.

Coleman, James S. 1988. "Social Capital in the Creation of Human Capital." *The American Journal of Sociology* 94:S95–S120.

Dekeseredy, Walter S and Martin D Schwartz. 2002. "Theorizing Public Housing Woman Abuse as a Function of Economic Exclusion and Male Peer Support." *Women's Health and Urban Life* 1:26–45.

Dulin-Keita, Akilah, Krista Casazza, Jose R Fernandez, Michael I Goran, and Barbara Gower. 2012. "Do neighbourhoods matter? Neighbourhood disorder and long-term trends in serum cortisol levels." *Journal of Epidemiology and Community Health* 66:24–9.

Durkheim, Emile. 1997. *The Division of Labor in Society*. New York: Free Press.

Evans, Gary W and Michelle a Schamberg. 2009. "Childhood poverty, chronic stress, and adult working memory." *Proceedings of the National Academy of Sciences of the United States of America* 106:6545–9.

Fauth, Rebecca C, Tama Leventhal, and Jeanne Brooks-Gunn. 2004. "Short-term effects of moving from public housing in poor to middle-class neighborhoods on low-income, minority adults' outcomes." *Social science & medicine* 59:2271–84.

Fertig, Angela R and David A Reingold. 2007. "Public Housing, Health, and Health Behaviors: Is There a Connection ?" *Journal of Policy Analysis and Management* 26:831–859.

Fosburg, Linda B, Susan J Popkin, and Gretchen P Locke. 1996. "An Historical and Baseline Assessment of HOPE VI: Volume I Cross-Site Report." Technical report, U.S. Department of Housing and Urban Development: Office of Policy Development and Research, Washington, DC.

Granovetter, Mark S. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78:1360–1380.

Green, William and Vincent Lane. 1992. "Final Report of the National Commission on Severely Distressed Public Housing." Technical report, National Commission on Severely Distressed Public Housing, Washington, DC.

Heinrich, Katie M, Rebecca E Lee, Richard R Suminski, Gail R Regan, Jacqueline Y Reese-smith, Hugh H Howard, C Keith Haddock, S Walker, Carlos Poston, and Jasjit S Ahluwalia. 2007. "Associations between the built environment and physical activity in public housing residents." *International Journal of Behavioral Nutrition and Physical Activity* 4:56.

Henderson, Claire, Ana V Diez Roux, David R Jacobs, Catarina I Kiefe, Delia West, and David R Williams. 2005. "Neihbourhood characteristics, individual level socioeconomic factors, and depressive symptoms in young adults: the CARDIA study." *Journal of Epidemiology and Community Health* 59:322–328.

Hill, T. D., C. E. Ross, and R. J. Angel. 2005. "Neighborhood Disorder, Psychophysiological Distress, and Health." *Journal of Health and Social Behavior* 46:170–186.

Hipp, John R. 2007. "Block, Tract, and Levels of Aggregation: Neighborhood Structure and Crime and Disorder as a Case in Point." *American Sociological Review* 72:659–680.

Hota, Bala, Charlotte Ellenbogen, Mary K. Hayden, Alla Aroutcheva, Thomas W. Rice, and Robert A. Weinstein. 2007. "Community-Associated Methicillin-Resistant Staphylococcus aureus Skin and Soft Tissue Infections at a Public Hospital: Do Public Housing and Incarceration Amplify Transmission?" *Archives of Internal Medicine* 167:1026–1033.

HUD. 1996. "A Picture of Subsidized Housing."

HUD. 2012a. "A Picture of Subsidized Housing."

HUD. 2012b. "About HOPE VI."

Hunt, D Bradford. 2009. *Blueprint for Disaseter*. Chicago: University of Chicago Press.

Idler, E L and Y Benyamini. 1997. "Self-rated health and mortality: a review of twenty-seven community studies." *Journal of Health and Social Behavior* 38:21–37.

Joseph, M. L., R. J. Chaskin, and H. S. Webber. 2007. "The Theoretical Basis for

Addressing Poverty Through Mixed-Income Development." *Urban Affairs Review* 42:369–409.

Jylhä, Marja. 2009. "What is self-rated health and why does it predict mortality? Towards a unified conceptual model." *Social Science & Medicine* 69:307–316.

Katz, Lawrence F, Jeffrey R Kling, and Jeffrey B LIebman. 2001. "Moving to Opportunity in Boston: Early Results of a Randomized Mobility Experiment." *The Quarterly Journal of Economics* 116:607–654.

Kawachi, Ichiro, Bruce P Kennedy, Kimberly Lochner, and Deborah Prothrow-stith. 1997. "Social Capital, Income Inequality, and Mortality." *American Journal of Public Health* 87:1491–1498.

Kim, Joongbaeck. 2010. "Neighborhood disadvantage and mental health: The role of neighborhood disorder and social relationships." *Social Science Research* 39:260–271.

Kling, Jeffrey R, Jeffrey B Liebman, and Lawrence F Katz. 2007. "Experimental Analysis of Neighborhood Effects." *Econometrica* 75:83–119.

Kohen, Dafna E, Tama Leventhal, V Susan Dahinten, and Cameron N McIntosh. 2008. "Neighborhood disadvantage: pathways of effects for young children." *Child development* 79:156–69.

Leventhal, Tama and Jeanne Brooks-Gunn. 2003. "Moving to opportunity: an experimental study of neighborhood effects on mental health." *American journal of public health* 93:1576–82.

Lewis, C E, J M Raczynski, G W Heath, R Levinson, and G R Cutter. 1993. "Physical activity of public housing residents in Birmingham, Alabama." *American journal of public health* 83:1016–20.

Lochner, Kimberly A, Ichiro Kawachi, Robert T Brennan, and Stephen L Buka. 2003. "Social capital and neighborhood mortality rates in Chicago." *Social Science & Medicine* 56:1797–805.

Ludwig, Jens, Greg J Duncan, Lisa A Gennetian, Lawrence F Katz, Ronald C Kessler, Jeffrey R Kling, and Lisa Sanbonmatsu. 2013. "Neighborhood Effects on the Long-Term Well-Being of Low-Income Adults." *Science* 337:1505–1510.

Ludwig, Jens, Greg J Duncan, and Paul Hirschfield. 2001. "Urban poverty and juvenile crime: evidence from a randomized housing-mobility experiment." *Quarterly Journal of Economics* 116:655–679.

Ludwig, Jens, JeffreyB. Liebman, JeffreyR. Kling, GregJ. Duncan, LawrenceF. Katz, RonaldC. Kessler, and Lisa Sanbonmatsu. 2008. "What Can We Learn about Neighborhood Effects from the Moving to Opportunity Experiment?" *American Journal of Sociology* 114:144–188.

Ludwig, Jens, Lisa Sanbonmatsu, Lisa Gennetian, Emma Adam, Greg J Duncan, Lawrence F Katz, Ronald C Kessler, Jeffrey R Kling, Stacy Tessler Lindau, Robert C Whitaker, and Thomas W McDade. 2011. "Neighborhoods, obesity, and diabetes–a randomized social experiment." *The New England journal of medicine* 365:1509–19.

McEwen, Bruce S. 2012. "Brain on stress: How the social environment gets under the skin." *Proceedings of the National Academy of Sciences* 109:17180–17185.

Miilunpalo, S, I Vuori, P Oja, M Pasanen, and H Urponen. 1997. "Self-rated health status as a health measure: the predictive value of self-reported health status on the use of physician services and on mortality in the working-age population." *Journal of clinical epidemiology* 50:517–28.

Orr, Larry, Judith Feins, Robin Jacob, Erik Beecroft, Lisa Sanbonmatsu, Lawrence F Katz, Jeffrey B Liebman, and Jeffrey R Kling. 2003. "Moving to Opportunity for Fair Housing Demonstration Program: Interim Impacts Report." Technical report, U.S. Department of Housing and Urban Development, Washington.

Putnam, Robert D. 1995. "Bowling Alone: America's Declining Social Capital." *Journal of Democracy* 6:65–78.

Quinn, Kelly, Jay S Kaufman, Arjumand Siddiqi, and Karin B Yeatts. 2010. "Parent Perceptions of Neighborhood Stressors are Associated with General Health and Child Respiratory Health among Low-income, Urban Families." *Journal of Asthma* 47:281–289.

Ross, Catherine E and John Mirowsky. 2001. "Neighborhood Disadvantage, Disorder, and Health." *Journal of Health and Social Behavior* 42:258–276.

Rubin, Donald B and Paul R Rosenbaum. 1984. "Reducing Bias in Observational Studies Using Subclassification on the Propensity Score." *Journal of the American Statistical Association* 79:516–524.

Sampson, R. J. 1997. "Neighborhoods and Violent Crime: A Multilevel Study of Collective Efficacy." *Science* 277:918–924.

Sampson, Robert J. 2008. "Moving to Inequality: Neighborhood Effects and Experiments Meet Social Structure." *American Journal of Sociology* 114:189–231.

Sampson, Robert J. 2012. *Great American City: Chicago and the Enduring Neighborhood Effect*. Chicago: University of Chicago Press.

Sampson, Robert J, Jeffrey D Morenoff, and Felton Earls. 1999. "Beyond Social Capital: Spatial Dynamics of Collective Efficacy for Children." *American Sociological Review* 64:633–660.

Sampson, Robert J and Stephen W Raudenbush. 1999. "Systematic Social Observation of Public Spaces: A New Look at Disorder in Urban." *American Journal of Sociology* 105:603–651.

Sanders, Sara, Stan L Bowie, and Yvonne Dias Bowie. 2003. "Lessons Learned on Forced Relocation of Older Adults: The Impact of Hurricane Andrew on Health, Mental Health, and Social Support of Public Housing Residents." *Journal of Geronotological Social Work* 40:23–35.

Sapolsky, Robert M. 2004. "Social Status and Health in Humans and Other Animals." *Annual Review of Anthropology* 33:393–418.

Shalowitz, Madeleine U, Tod Mijanovich, Carolyn a Berry, Elizabeth Clark-Kauffman, Kelly a Quinn, and Elizabeth L Perez. 2006. "Context matters: a community-based study of maternal mental health, life stressors, social support, and children's asthma." *Pediatrics* 117:e940–8.

Shively, C. A. and T. B. Clarkson. 1994. "Social status and coronary artery atherosclerosis in female monkeys." *Arteriosclerosis, Thrombosis, and Vascular Biology* 14:721–726.

Skipper, James K and Robert C Leonard. 1968. "Children, Stress, and Hospitalization: A Field Experiment." *Journal of Health and Social Behavior* 9:275–287.

Wellman, Barry and Scot Wortley. 1990. "Different Strokes from Different Folks: Community Ties and Social Support." *American Journal of Sociology* 96:558–588.

Williamson, A. R., M. T. Smith, and M. Strambi-Kramer. 2009. "Housing Choice Vouchers, the Low-Income Housing Tax Credit, and the Federal Poverty Deconcentration Goal." *Urban Affairs Review* 45:119–132.

Wilson, James Q and George L Kelling. 1982. “Broken Windows.” *Atlantic Monthly* 127:29–38.

Wilson, William Julius. 1987. *The Truly Disadvantaged*. Chicago: University of Chicago Press.