A Breath of Fresh Air: The Cumulative Effects of Public Housing Exposure on Childhood Asthma*

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Abstract

Prior research has yielded inconsistent conclusions about the relationship between parental housing assistance receipt and child health. While some studies report that assistance is linked to better outcomes, approximately 40 percent find no association, and some even find the association to be negative. There are two key reasons for the inconsistency: the use of cross-sectional observational data and collider stratification bias, which is introduced by conditioning on time-varying confounders in conventional regression models. Our study addresses both limitations. We employ marginal structural models with inverse probability weights to estimate the effect of parental housing assistance receipt on children's probability of developing asthma using the Panel Study of Income Dynamics (1968-2009). In contrast to several prior studies, our preliminary results show that housing assistance receipt is not a risk factor for childhood asthma. We discuss alternative analytic strategies and specifications we intend to implement in advance of the annual meeting.

150 words

Introduction

Since the Housing Act of 1937, U.S. housing policy has been predicated on "the belief that decent and affordable housing will yield important social benefits to both the occupants and society, such as better health, fewer behavior problems, greater educational attainment, and increased labor force participation" (Newman 2008, 895). However, research has yet to present clear evidence of a link between housing assistance receipt and child health (Slopen et al. 2018). These mixed results may emerge because of the conflicting mechanisms through which housing assistance impacts health. On the one hand, housing assistance may improve health outcomes by providing greater housing stability and reducing household economic strain, but on the other, it may work to negatively impact health if low-income families are concentrated in dangerous, impoverished, and under-resourced neighborhoods.

We examine the cumulative effect of housing assistance receipt during childhood on asthma. Asthma poses a significant health burden to society, costing the US economy more than $80 billion between 2008 and 2013 (Nurmagambetov, Kuwahara, and Garbe 2018). In 2016, approximately 9% of adults and 8% of children in the US had asthma (Centers for Disease Control and Prevention 2016), with prevalence greater among non-Hispanic blacks, Latinos, and individuals from low-income families (Zahran et al. 2018). Recent evidence from cross-sectional data has found that housing tenure is linked to asthma prevalence, such that adults living in public housing and those receiving rental assistance were more than twice as likely to report current asthma compared to homeowners (Mehta et al. 2018). However, results based on cross-sectional data preclude researchers from examining the longer-term effects of rental assistance on asthma in later life. They also risk "controlling away" the indirect effects of housing assistance, such as housing quality, neighborhood conditions, and household finances, which

could underestimate the long-term effects of housing tenure on health, and in this case, an asthma diagnosis.

In this paper, we apply a marginal structural model approach to panel data from the Panel Study of Income Dynamics, which we link with administrative data on housing assistance from the U.S. Department of Housing and Urban Development (HUD) Assisted Housing Database. Using inverse probability of treatment weights from marginal structural models, we adjust for time-dependent confounders in the causal pathway between childhood receipt of housing assistance and childhood asthma. Our preliminary analysis suggests that exposure to public housing does not increase the likelihood of developing asthma by adulthood. This finding would suggest that cross-sectional studies identifying a connection between housing assistance are not fully accounting for selection into housing assistance. In the "next steps" section, we discuss additional analytic steps we plan to undertake before the PAA 2019 meeting that may change the present conclusions.

Housing Assistance and Health

Since its inception, the purpose of federal housing policy has been to address issues of affordability, housing quality, and neighborhood conditions for low-income households (Newman and Schnare 1997, Newman 2008). To date, research has provided mixed evidence about the extent to which housing assistance improves the health of recipients. Research based on observational data often reports that housing assistance is associated with worse health than the general population (Ruel et al. 2010, Manjarrez, Popkin, and Guernsey 2007, Digenis-Bury et al. 2008, Kalousová and Evangelist 2018), but studies that account for the potential selection bias of housing assistance receipt or for various types of housing assistance present more inconsistent

findings. For example, while Fenelon et al. (2017) found that public housing was associated with higher self-reported health and lower levels of psychological distress among adults, Fertig and Reingold (2007) found no such evidence of health benefits associated with public housing and concluded that public housing may in fact worsen mothers' overall health. In a recent review, Slopen and colleagues (2018) reported that approximately 40 percent of studies did not find any association between housing assistance and childhood health, and mixed results within a given study are also not uncommon. Although Meyers et al. (2005) found that food-insecure children who did not receive a housing subsidy were at greater risk of being underweight, they found no such effect on self-reported health.

In addition to this research, the Moving to Opportunity (MTO) study, a randomized social experiment sponsored by the U.S. Department of Housing and Urban Development in the 1990s, has provided experimental evidence about the relationship between housing assistance and health. In MTO, low-income participants were randomly assigned to either an experimental or control group; families who were part of the experimental group received a housing voucher to relocate to a low-poverty neighborhood, and families in the control group did not receive a voucher. Numerous studies have examined the long-term outcomes of MTO participation for both adults' and children's outcomes and have produced mixed results. While moving to lower-poverty areas seems to have improved the mental health, physical health, and subjective well-being of adults in the experimental group, results for children have been mixed (Katz, Kling, and Liebman 2001, Kling, Liebman, and Katz 2007, Ludwig et al. 2012, 2013).

Theoretical Foundations

Several theories suggest how housing assistance may benefit children's development (for a review see Leventhal and Newman 2010, Newman and Holupka 2017, Newman 2008). The

family stress, material hardship, and residential instability models each provide explanations for how child outcomes are directly or indirectly affected by housing assistance. In addition, the extent to which housing assistance influences exposure to poor quality housing and impoverished neighborhoods may directly affect the development of asthma and similar chronic conditions during childhood.

Family Stress

The family stress model posits that poverty increases parental stress, which contributes to punitive or inconsistent parenting that subsequently leads to more emotional difficulties and school problems for children (McLoyd et al. 1994, Conger et al. 1994). Housing unaffordability, poor quality housing, or overcrowding could increase parental stress and indirectly impact children's well-being through harsh parenting behavior. Parents who receive housing assistance, therefore, would experience less stress and deliver more consistent parenting, which could improve child outcomes.

Material Hardship

The material hardship model considers how sources of income help families afford goods and services, which could include directing additional investments into child development (Becker 1981, Haveman and Wolfe 1994, Mayer 1997). In the context of housing assistance, financially strained families who receive housing-based subsidies would have more money to spend on a range of services for their children. Additional expenditures on children's health and education, for example, may in turn improve their long-term outcomes. Newman and Holupka (2015) find that low-income families who spend a smaller fraction of their income on housing devote additional investments to their children's development, resulting in their improved cognitive performance.

Residential Instability

The residential instability model posits that because housing instability has detrimental effects on children and families, housing assistance would necessarily improve child health by decreasing the frequency of residential moves. Lower-income families typically experience greater residential mobility (Astone and McLanahan 1994) and more forced or unplanned moves (Bartlett 1997, Crowley 2003, Schafft 2006), which could lead to worse educational and developmental outcomes in children. For example, researchers have found that children who experience more moves do worse in school (Astone and McLanahan 1994, Ingersoll, Scamman, and Eckerling 1989, Haveman, Wolfe, and Spaulding 1991, Pribesh and Downey 1999, Tucker, Marx, and Long 1998, Wood et al. 1993), experience more adolescent violence (Haynie and South 2005), and are more likely to use substances (DeWit 1998). Housing assistance is expected to reduce multiple moves and provide greater housing stability (Kim, Burgard, and Seefeldt 2017), which could improve outcomes for children.

Housing Quality and Neighborhood Conditions

Poor housing quality may expose residents to a range of harmful conditions that increase the risk of infectious and chronic diseases as well as mental health problems (for a review see Krieger & Higgins, 2002). Lead has been shown to affect child development and impaired neurobehavioral function (Needleman et al. 1990), whereas poor air quality resulting from mold, rodents, and cockroaches has been linked to respiratory ailments and asthma (Rosenstreich et al. 1997, Phipatanakul et al. 2000, Brunekreef et al. 1989). At the same time, much of the evidence on housing quality is associative (Saegert et al. 2003). Studies have also found that features of the built environment such as green spaces, walkability, and proximity to grocery stores can lead to increased physical activity, healthy eating habits, and lower rates of chronic health conditions

and depression (Roux and Mair 2010). At the same time, neighborhood disadvantage has been associated with negative child outcomes such as low birthweight, infant mortality, and child maltreatment (Sampson, Morenoff, and Gannon-Rowley 2002).

Although public housing has had a negative reputation for decades (for example see Kotlowitz 1991, Aaron 1972) previous studies suggest that relative to other low-income renters, public housing residents are less likely to experience overcrowding or to live in high-density complexes (Currie and Yelowitz 2000). Matthew Desmond's (2016) recent ethnographic work also shows that the private rental market may expose low-income families to deplorable living conditions in addition to extreme housing instability. While attaining housing through vouchers, public housing, or privately managed assisted housing may expose children to poor housing and neighborhood conditions, it is not necessarily clear that these conditions are worse than what children would have faced in the absence of assistance.

As noted above, studies that have considered the relationship between housing assistance and health have methodological limitations. Experimental studies such as MTO do not observe the condition of no receipt of housing assistance. Because MTO tested the effectiveness of housing vouchers relative to a control group of individuals who remained eligible to receive housing assistance, results from such studies may be biased. A more policy-relevant experiment would test various forms of housing assistance receipt against the possibility of *no* assistance, but because the experimental condition of no receipt is ethically objectionable, the majority of studies on housing assistance and health are based on observational data that cover short time periods or rely on cross-sectional surveys. In our study, we address these limitations by using a prospective panel study that follows children over a 17-year period and uses inverse probability of treatment weights from marginal structural models to adjust for time-dependent confounders.

Data and Methods

We use longitudinal data on individuals and families from the Panel Study of Income Dynamics (PSID)—a national survey of U.S. residents administered every year from 1968 to 1997 and biennially thereafter. The PSID has several unique features that make it particularly useful for studying the long-term health effects of public housing, including the survey's longitudinal design, which enables us to track individuals throughout childhood. We also obtained access to the PSID's restricted Assisted Housing Database (AHD) and Geospatial Match Files. The AHD used PSID address information to match families with administrative data on housing assistance receipt from the U.S. Department of Housing and Urban Development for every year from 1968 to 2009 (except for 1969) (Newman and Schnare 1997). The AHD offers an advantage over survey data that rely on self-reports of housing assistance receipt, which are often unreliable (Shroder 2002, Gordon et al. 2005).

Using the Geospatial Match Files, we merged 39 waves of the PSID with annual HUD county income eligibility guidelines for housing assistance and socioeconomic data from the decennial censuses and the American Community Survey (ACS). The HUD income eligibility guidelines and the socioeconomic data from the decennial censuses and ACS enabled us to estimate housing assistance eligibility for every family in the PSID. The HUD income eligibility guidelines are available at the county level for the period 1990 to 2015. In general, eligibility guidelines are set at 80 percent of the area median income; although, for much of the study period, families with very low income (less than 50% of the area median) and extremely low income (less than 30% of the area median) have received preference for housing assistance. For years prior to 1990, we estimated the low-income, very low-income, and extremely low-income

eligibility thresholds using county median incomes from the decennial censuses, following the HUD method of adjusting income eligibility thresholds for family size and used linear interpolation to fill in missing values for intercensal years prior to 1990. We used the program Amelia II which is designed for time-series cross-sectional data to impute missing values for all predictors (Honaker and King 2010). We used both the Longitudinal Tract Data Base and Neighborhood Change Database to incorporate census tract data from the 1970, 1980, 1990, and 2000 Census as well as the 2010 and 2015 five-year American Community Surveys. The Longitudinal Tract Data Base harmonizes census data to 2010 tract boundaries, providing a consistent measure of neighborhood characteristics across the study period. We used linear interpolation to fill in missing values between the decennial censuses and the two American Community Surveys.

Analytic Sample

Our analytic sample consists of 5,488 individuals who were members of a PSID family and turned age one between 1969 and 1993. The final cohort of children turned age 17 in 2009—the last year that the AHD data is available, allowing us to observe respondents throughout childhood. We further restricted the sample to individuals continuously observed through the year they turn 19 with no missing data on the outcome and who were eligible for housing assistance in a given year. Our final analytic sample consists of 6,853 person-years for the pooled analysis predicting the level of housing assistance receipt and 1,451 individuals for the final analysis estimating the effect of public housing on asthma. Finally, we use only the odd years of data to account for the transition to biennial data collection in 1997 and to ensure that we measure respondents' public housing exposure based on an equal number of observations. Baseline family and neighborhood conditions are measured for all children at age one. We then

measure all time-varying characteristics at eight post-baseline follow-up periods corresponding to the odd-numbered ages from three to 17.

Childhood Asthma Measure

The dependent variable is whether or not a doctor diagnosed respondents with asthma at age 18 or earlier. Since 1999, the PSID has asked family heads and spouses if a doctor has ever told them they have or had asthma. We merged responses to identical asthma diagnosis questions from the Transition to Adulthood Study (TAS)—a supplemental survey of young adults that the PSID administered from 2005 to 2015. The TAS data allowed us to increase the sample size as we were able to incorporate information on the outcome variable for respondents that were never a family head or spouse. Because respondents may have provided different ages of diagnosis across survey waves, we took modal value across responses and defaulted to the smallest modal value in cases of ties.

Housing Assistance Receipt Measure

The primary variable of interest is housing assistance receipt. We measure receipt every other year from age one to 17 using a three-category variable indicating if families did not receive housing assistance but were income-eligible, lived in public housing, and lived in privately managed subsidized housings. As explained later, in the first part of the analysis, we use multinomial logistic regression to predict membership into each of these categories for ages three to 17. In the second part of the analysis we measure the cumulative number of years respondents were exposed to public housing for the eight waves spanning ages 3 to 17. We also measure cumulative exposure to housing assistance eligibility (but no receipt) and to other forms of privately managed housing assistance, including project-based assistance and properties financed with a Low-Income Housing Tax Credit. The other major form of housing assistance is

tenant-based housing voucher certificates, first available in 1974. One limitation of the administrative data on housing assistance is that it only tracks housing voucher receipt from 1995 to 2009. Because information on vouchers is only available for part of the series, these individuals may be included in the eligible category but are not counted as having received housing assistance.

Other Independent Variables

Our study includes a number of time-varying and time-constant controls that may predict housing assistance receipt and have been used in earlier studies related to housing assistance receipt. Time constant controls include indicators for female, non-white, birth weight less than 2500 grams, mother was married at birth, mother's age at birth, the family head's educational status when the respondent was age one (less than high school, high school graduate, or some college) and the respondent's birth year. We also incorporate time-varying indicators for whether family income is less than 30% of the county area median, family head is employed, family head has a work-limiting disability, family head is married, family is a female-headed household with children, family receives public assistance, family receives food stamps, and if there are opposite sex children present in the family. Because HUD does not allow older boys and girls to share a bedroom, families with opposite-sex children may have more difficulty finding housing units that meet HUD regulations (Kucheva 2018). Continuous time-varying controls are family-income adjusted for inflation to 2015 dollars using the Consumer Price Index (CPI-U), family head's work hours, number of children under six in the family, and cumulative number of moves prior to interview. In addition to individual and family characteristics, we include a categorical variable measuring neighborhood disadvantage form the lowest to highest quintile of disadvantage (see Wodtke, Harding, and Elwert 2011). The categorical variable derives from a

seven-time disadvantage scale based on a principle component analysis of neighborhood measures of poverty, unemployment, female-headed households, public assistance receipt, adults with less than a high school education, adults with a college education, and adults in a managerial or professional occupation. We also incorporated the median rent and vacancy rate at the census tract level as these factors relate to housing assistance receipt (Freeman 2005). All time-varying variables are measured at baseline (year in which respondent turns one) and with a two-year lag. We use a two-year lag because we only use every other year of data. This means that children have the same lag regardless of whether or not their childhood overlaps with the PSID's post-1997 transition to biennial surveys.

Analytical Methods

Previous observational studies relating public housing to various health outcomes have been limited in two important ways. They have examined the effects of housing assistance receipt among adults or only observed children and adults over a short period of time. These studies fail to capture the cumulative effects of housing assistance and to continuously observe receipt during childhood—perhaps the most crucial period for human development. Second, Wodtke, Harding, and Elwert (2011) explain two limitations of conventional regression models in the face time-varying treatments. Conventional regression models may over-control by blocking indirect pathways from the treatment to outcome or introduce collider-stratification bias if time-varying confounders are the common effect of previous exposure to the treatment and unobserved factors.

We address these limitations by estimating marginal structural logistic regression models using inverse probability treatment weights (IPTWs) (for a detailed introduction see Robins, Hernan, and Brumback 2000). IPTWs allow us to examine the indirect effects of public housing

exposure on asthma while still controlling for time-varying confounders that relate to both selection into public housing and health outcomes such as asthma. The analysis includes three stages. First, we construct the IPTWs using multinomial logistic regression models to estimate the probability that respondents are in one of the three categories of public housing assistance receipt (eligible, but no receipt, living in public housing, and living in privately managed subsidized housing). The multinomial logistic regression models are estimated using pooled data for all odd-numbered ages from three to 17. These models control for baseline measures of time-constant and time-varying covariates, time varying covariates measures at *t* and *t-1,* and a continuous measure of age. Based on the model coefficients, we then predict the probability that each individual receives his or her actual category of housing assistance receipt. The inverse of these probabilities is the IPTW. Because these weights are highly variable, we generate stabilized weights by multiplying the original weights by a second set of probabilities predicted using multinomial logistic regression models that only control for characteristics measured at baseline (see Wodtke, Harding, and Elwert 2011).

Because many children drop out of the study prior to age 19 it is necessary to account for differential probabilities of attrition. We observe children through age 19 to ensure that all respondents in the study have reached adulthood when the question about asthma was first asked. As suggested by previous studies, we account for attrition by estimating censoring weights (Robins, Hernan, and Brumback 2000, Wodtke, Harding, and Elwert 2011). This process is identical to the construction of the stabilized inverse probability of treatment weights except that we estimate the probability of being censored at a given age. The censoring weights are then multiplied by the stabilized inverse probability of treatment weights to generate a final weight used for the subsequent analysis.

In the third stage of the analysis, we estimate a marginal logistic regression model predicting the log odds that children are diagnosed with asthma by age 18. The final model is weighted using the stabilized inverse probability of treatment weights and includes three variables measuring the cumulative number of years children were eligible for housing assistance but did not receive assistance, living in public housing, and living in privately managed subsidized housing. Because baseline characteristics were included in both the numerator and denominator of the stabilized treatment weights, the final model also includes these controls. We estimated all models using Huber-White robust standard errors to account for clustering within families.

Preliminary Results

Tables 1 and 2 report descriptive statistics for time-invariant and time-varying sample characteristics. The final analytic sample described in Table 1 relates to the 1,451 individuals who were observed from ages one to 19, had complete data on the outcome, and were eligible for housing assistance in at least one wave from ages 3 to 17. Overall, 16 percent of this sample was diagnosed with asthma by age 18. This percentage is consistent with previous studies finding that low-income children had rates of asthma that were considerably higher than the national average of 9 percent. The sample is split relatively evenly by sex and race—non-black and black. Table 2 reports 6,853 person-year observations that correspond to the sample used to estimate the stabilized inverse probability of treatment weights. The sample is relatively disadvantaged in that it includes a high percentage of individuals whose families were headed by someone with a work disability (17 percent), had an unmarried head (50 percent), and received food stamps (40

percent). Table 3 reports the cumulative number of years exposed to housing assistance eligibility, public housing, and privately managed housing assistance.

The main results of the analysis are reported as odds ratios in Table 4. Because we are only interested in the effects of housing assistance we do not show the other covariates nor do we show the results of the multinomial models used to construct the IPTWs. The first model is a standard logistic regression model that includes cumulative exposure to the housing assistance categories. We have also controlled for the baseline covariates mentioned above and the mean of all time-varying covariates across ages three to 17. The results from the "naïve" specification that may be affected by over-control and stratification bias suggests that housing is negatively associated with asthma. Each year of exposure to public housing reduces the odds of being diagnosed with childhood asthma by 25 percent. In contrast, the coefficient for cumulative exposure to public housing for the IPWT model indicates public housing exposure does not increase the risk of asthma among the sample of individuals who were eligible for housing assistance in at least one wave. These preliminary results suggest that earlier observational studies may not adequately deal with selection into public housing. The IPWT estimates also suggest that exposure to privately managed assisted housing may be positively related to asthma, but the effect is imprecisely measured.

Preliminary Conclusion

The purpose of this study was to examine the effects of long-term exposure to public housing on childhood asthma. To our knowledge this is the first observational study to examine childhood asthma in the context of long-term exposure to public housing. Although earlier studies have identified an association between poor housing quality and chronic health

conditions our preliminary results suggest that exposure to public housing may not be as detrimental to some chronic conditions as one may assume based on public housing's negative image.

Next Steps

The results presented in this abstract are preliminary. Before PAA 2019, we intend to expand the analytic sample to include respondents born on even years, which will lead to greater sample size and more precise estimates. We further intend to evaluate the effect of housing assistance on other health outcomes such as self-reported health, psychological problems, smoking, and obesity. Finally, we are refining the multinomial logistic regression models to improve model fit and reduce variability in the IPTWs. Our results may change as a result of the planned analytic improvements.

References

Aaron, Henry J. 1972. *Shelter and subsidies: Who benefits from federal housing policies?* Washington, DC: Brookings Institution.

Astone, Nan Marie, and Sara S McLanahan. 1994. "Family structure, residential mobility, and school dropout: A research note." *Demography* 31 (4):575-584.

Bartlett, Sheridan. 1997. "The significance of relocation for chronically poor families in the USA." *Environment and Urbanization* 9 (1):121-132.

Becker, Gary S. 1981. *A treatise on the family*: Harvard University Press.

Brunekreef, Bert, Douglas W Dockery, Frank E Speizer, James H Ware, John D Spengler, and Benjamin G Ferris. 1989. "Home Dampness and Respiratory Morbidity in Children1-4." *Am Rev Respir Dis* 140:1363-1367.

Centers for Disease Control and Prevention. 2016. "BRFSS Prevalence & Trends Data." National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health, accessed September 10, 2018. https://www.cdc.gov/brfss/brfssprevalence/index.htmlret.

Conger, Rand D, Xiaojia Ge, Glen H Elder Jr, Frederick O Lorenz, and Ronald L Simons. 1994. "Economic stress, coercive family process, and developmental problems of adolescents." *Child development* 65 (2):541-561.

Crowley, Sheila. 2003. "The affordable housing crisis: Residential mobility of poor families and school mobility of poor children." *Journal of Negro Education*:22-38.

Currie, Janet, and Aaron Yelowitz. 2000. "Are public housing projects good for kids?" *Journal of public economics* 75 (1):99-124.

Desmond, Matthew. 2016. *Evicted: poverty and profit in the American city*. New York: Crown.

DeWit, David J. 1998. "Frequent childhood geographic relocation: Its impact on drug use initiation and the development of alcohol and other drug-related problems among adolescents and young adults." *Addictive behaviors* 23 (5):623-634.

Digenis-Bury, Eleni C., Daniel R. Brooks, Leslie Chen, Mary Ostrem, and C. Robert Horsburgh. 2008. "Use of a population-based survey to describe the health of Boston public housing residents." *American journal of public health* 98 (1):85-91.

Fenelon, A., P. Mayne, A. E. Simon, L. M. Rossen, V. Helms, P. Lloyd, J. Sperling, and B. L. Steffen. 2017. "Housing Assistance Programs and Adult Health in the United States." *Am J Public Health* 107 (4):571-578.

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 (4):831-860.

Freeman, Lance. 2005. "Does housing assistance lead to dependency? Evidence from HUD administrative data." *Cityscape*:115-133.

Gordon, Erika L, Sandra Chipungu, Lisa Marie Bagley, and Sophia I Zanakos. 2005. Improving Housing Subsidy Surveys: Data Collection Techniques for Identifying the Housing Subsidy Status of Survey Respondents. Calverton, MD: US Department of Housing and Urban Development, Office of Policy Development and Research.

Haveman, Robert, and Barbara Wolfe. 1994. *Succeeding generations: On the effects of investments in children*: Russell Sage Foundation.

Haveman, Robert, Barbara Wolfe, and James Spaulding. 1991. "Childhood events and circumstances influencing high school completion." *Demography* 28 (1):133-157.

Haynie, Dana L, and Scott J South. 2005. "Residential mobility and adolescent violence." *Social forces* 84 (1):361-374.
Honaker, James, and Gary King. 2010. "What to do about missing values in time-series cross-section data." *American Journal of Political Science* 54 (2):561-581.
Ingersoll, Gary M, James P Scamman, and Wayne D Eckerling. 1989. "Geographic mobility and student achievement in an urban setting." *Educational evaluation and policy analysis* 11 (2):143-149.
Kalousová, Lucie, and Michael Evangelist. 2018. "Rent assistance and health: findings from Detroit." *Housing Studies*:1-31. doi: 10.1080/02673037.2018.1441977.
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 (2):607-654.
Kim, Huiyun, Sarah A Burgard, and Kristin S Seefeldt. 2017. "Housing Assistance and Housing Insecurity: A Study of Renters in Southeastern Michigan in the Wake of the Great Recession." *Social Service Review* 91 (1):41-70.
Kling, Jeffrey R., Jeffrey B. Liebman, and Lawrence F. Katz. 2007. "Experimental Analysis of Neighborhood Effects." *Econometrica* 75 (1):83-119.
Kotlowitz, Alex. 1991. *There are no children here: The story of two boys growing up in the other America*: Anchor.
Kucheva, Yana. 2018. "Subsidized Housing and the Transition to Adulthood." *Demography* 55 (2):617-642.
Leventhal, Tama, and Sandra Newman. 2010. "Housing and child development." *Children and Youth Services Review* 32 (9):1165-1174.
Ludwig, Jens, Greg J. Duncan, Lisa A. Gennetian, Lawrence F. Katz, Ronald C. Kessler, Jeffrey R. Kling, and Lisa Sanbonmatsu. 2012. "Neighborhood Effects on the Long-Term Well-Being of Low-Income Adults." *Science* 337 (6101):1505-1510.
Ludwig, Jens, Greg J. Duncan, Lisa A. Gennetian, Lawrence F. Katz, Ronald C. Kessler, Jeffrey R. Kling, and Lisa Sanbonmatsu. 2013. "Long-term neighborhood effects on low-income families: Evidence from Moving to Opportunity." *American Economic Review* 103 (3):226-231.
Manjarrez, Carlos A., Susan J. Popkin, and Elizabeth Guernsey. 2007. Poor health: Adding insult to injury for HOPE VI families. Washington, DC: Urban Institute.
Mayer, Susan E. 1997. *What money can't buy : family income and children's life chances*: Harvard University Press.
McLoyd, Vonnie C, Toby Epstein Jayaratne, Rosario Ceballo, and Julio Borquez. 1994. "Unemployment and work interruption among African American single mothers: Effects on parenting and adolescent socioemotional functioning." *Child development* 65 (2):562-589.
Mehta, Amar J., Daniel P. Dooley, John Kane, Margaret Reid, and Snehal N. Shah. 2018. "Subsidized Housing and Adult Asthma in Boston, 2010–2015." *American Journal of Public Health* 108 (8):1059-1065.
Meyers, Alan, Diana Cutts, Deborah A. Frank, Suzette Levenson, Anne Skalicky, Timothy Heeren, John Cook, Carol Berkowitz, Maureen Black, Patrick Casey, and Nieves Zaldivar. 2005. "Subsidized housing and children's nutritional status: Data from a multisite surveillance study." *Archives of Pediatrics & Adolescent Medicine* 159 (6):551.

Needleman, Herbert L, Alan Schell, David Bellinger, Alan Leviton, and Elizabeth N Allred. 1990. "The long-term effects of exposure to low doses of lead in childhood: an 11-year follow-up report." *New England journal of medicine* 322 (2):83-88.

Newman, Sandra J, and C Scott Holupka. 2017. "Race and Assisted Housing." *Housing Policy Debate* 27 (5):751-771.

Newman, Sandra J. 2008. "Does housing matter for poor families? A critical summary of research and issues still to be resolved." *Journal of Policy Analysis and Management* 27 (4):895-925.

Newman, Sandra J., and C. Scott Holupka. 2015. "Housing affordability and child well-being." *Housing Policy Debate* 25 (1):116-151.

Newman, Sandra J., and Ann B. Schnare. 1997. ""… And a suitable living environment": The failure of housing programs to deliver on neighborhood quality." *Housing Policy Debate* 8 (4):703-741.

Nurmagambetov, Tursynbek, Robin Kuwahara, and Paul Garbe. 2018. "The economic burden of asthma in the United States, 2008–2013." *Annals of the American Thoracic Society* 15 (3):348-356.

Phipatanakul, Wanda, Peyton A Eggleston, Elizabeth C Wright, and Robert A Wood. 2000. "Mouse allergen. II. The relationship of mouse allergen exposure to mouse sensitization and asthma morbidity in inner-city children with asthma." *Journal of allergy and clinical immunology* 106 (6):1075-1080.

Pribesh, Shana, and Douglas B Downey. 1999. "Why are residential and school moves associated with poor school performance?" *Demography* 36 (4):521-534.

Robins, James M, Miguel Angel Hernan, and Babette Brumback. 2000. Marginal structural models and causal inference in epidemiology. LWW.

Rosenstreich , David L., Peyton Eggleston , Meyer Kattan , Dean Baker , Raymond G. Slavin , Peter Gergen , Herman Mitchell , Kathleen McNiff-Mortimer , Henry Lynn , Dennis Ownby , and Floyd Malveaux 1997. "The Role of Cockroach Allergy and Exposure to Cockroach Allergen in Causing Morbidity among Inner-City Children with Asthma." *New England Journal of Medicine* 336 (19):1356-1363.

Roux, Ana V. Diez, and Christina Mair. 2010. "Neighborhoods and health." *Annals of the New York Academy of Sciences* 1186 (1):125-145.

Ruel, Erin, Deirdre Oakley, G. Elton Wilson, and Robert Maddox. 2010. "Is public housing the cause of poor health or a safety net for the unhealthy poor?" *Journal of Urban Health* 87 (5):827-838.

Saegert, Susan C, Susan Klitzman, Nicholas Freudenberg, Jana Cooperman-Mroczek, and Salwa Nassar. 2003. "Healthy housing: a structured review of published evaluations of US interventions to improve health by modifying housing in the United States, 1990–2001." *American journal of public health* 93 (9):1471-1477.

Sampson, Robert J, Jeffrey D Morenoff, and Thomas Gannon-Rowley. 2002. "Assessing "neighborhood effects": Social processes and new directions in research." *Annual review of sociology* 28 (1):443-478.

Schafft, Kai A. 2006. "Poverty, residential mobility, and student transiency within a rural New York school district." *Rural Sociology* 71 (2):212-231.

Shroder, Mark. 2002. "Does housing assistance perversely affect self-sufficiency? A review essay." *Journal of housing Economics* 11 (4):381-417.

Slopen, Natalie, Andrew Fenelon, Sandra Newman, and Michel Boudreaux. 2018. "Housing Assistance and Child Health: A Systematic Review." *Pediatrics*.

Tucker, C Jack, Jonathan Marx, and Larry Long. 1998. "" Moving on": Residential mobility and children's school lives." *Sociology of Education*:111-129.

Wodtke, Geoffrey T., David J. Harding, and Felix Elwert. 2011. "Neighborhood Effects in Temporal Perspective: The Impact of Long-Term Exposure to Concentrated Disadvantage on High School Graduation." *American Sociological Review* 76 (5):713-736.

Wood, David, Neal Halfon, Debra Scarlata, Paul Newacheck, and Sharon Nessim. 1993. "Impact of family relocation on children's growth, development, school function, and behavior." *JAMA* 270 (11):1334-1338.

Zahran, Hatice S, Cathy M Bailey, Scott A Damon, Paul L Garbe, and Patrick N Breysse. 2018. "Vital signs: asthma in children—United States, 2001–2016." *Morbidity and Mortality Weekly Report* 67 (5):149.

Table 1. Time-Invariant Sample Characteristics

Variables	Obs.	Mean	Std. Dev.	Minimum	Maximum
Diagnosed with asthma by 18	1,451	0.16	0.37	0.00	1.00
Female	1,451	0.54	0.50	0.00	1.00
Non-black	1,451	0.52	0.50	0.00	1.00
Birth weight	1,451	0.09	0.29	0.00	1.00
Mother married at birth	1,451	0.67	0.47	0.00	1.00
Mother's age at birth	1,451	24.80	5.38	13.00	45.00
Less than high school	1,451	0.30	0.46	0.00	1.00
High school	1,451	0.42	0.49	0.00	1.00
At Least Some college	1,451	0.28	0.45	0.00	1.00
Birth year	1,451	1981.18	7.16	1968.00	1992.00

Table 2. Time-Varying Sample Characteristics

	Obs.	Mean	Std. Dev.	Minimum	Maximum
Eligible, no assistance	6,853	0.91	0.29	0.00	1.00
Public housing	6,853	0.05	0.22	0.00	1.00
Other housing assistance	6,853	0.04	0.19	0.00	1.00
Family income	6,853	30,561.87	17,607.73	0.00	136,160.98
Income less than 30% of area median	6,853	1.00	0.02	0.00	1.00
Family head employed	6,853	0.68	0.47	0.00	1.00
Family head's work hours	6,853	1,443.84	1,029.85	0.00	5,500.00
Family head is disabled	6,853	0.17	0.37	0.00	1.00
Family head married	6,853	0.50	0.50	0.00	1.00
Family size	6,853	4.49	1.67	1.00	17.00
Female-headed family	6,853	0.49	0.50	0.00	1.00
Family has children of the opposite sex	6,853	0.58	0.49	0.00	1.00
Number of children under 6	6,853	0.84	0.97	0.00	7.00
Family receives public assistance	6,853	0.16	0.37	0.00	1.00
Family receives food stamps	6,853	0.40	0.49	0.00	1.00
Cumulative number of moves	6,853	1.58	1.51	0.00	8.00
Neighborhood median rent	6,853	550.12	238.02	114.55	2,273.71
Neighborhood vacancy rate	6,853	0.10	0.07	0.00	0.63
Neighborhood Disadvantage					
1st quintile	6,853	0.05	0.22	0.00	1.00
2nd quintile	6,853	0.09	0.28	0.00	1.00
3rd quintile	6,853	0.14	0.35	0.00	1.00
4th quintile	6,853	0.21	0.40	0.00	1.00
5th quintile	6,853	0.51	0.50	0.00	1.00

Note: Student-year observations.

Table 3. Exposure to Public Housing Assistance Ages 3 to 17

Variables	Obs.	Mean	Std. Dev.	Minimum	Maximum
Cumulative eligible	1,451	4.29	2.53	0.00	8.00
Cumulative public housing	1,451	0.25	1.02	0.00	8.00
Cumulative other housing assistance	1,451	0.18	0.70	0.00	7.00

Table 4. Odds ratios for being diagnosed with Asthma for PSID

	Unweighted	IPWT
Cumulative years in public housing	0.75	0.96
standard error	(0.092)	(0.184)
t-statistic	-2.32	-0.21
Cumulative years in privately managed housing assistance	0.85	1.21
standard error	(0.113)	(0.313)
t-statistic	-1.20	0.75
Cumulative years eligible for public housing	0.95	0.94
standard error	(0.049)	(0.044)
t-statistic	-1.04	-1.34
Observations	1,451	1,451