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Examining mediators of housing mobility on adolescent asthma: Results from a housing voucher experiment

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ABSTRACT

Literature on neighborhood effects on health largely employs non-experimental study designs and does not typically test specific neighborhood mediators that influence health. We address these gaps using the Moving to Opportunity (MTO) housing voucher experiment. Research has documented both beneficial and adverse effects on health in MTO, but mediating mechanisms have not been tested explicitly. We tested mediation of MTO effects on youth asthma ($n = 2829$). MTO randomized families living in public housing to an experimental group receiving a voucher to subsidize rental housing, or a control group receiving no voucher, and measured outcomes 4–7 years following randomization. MTO had a harmful main effect vs. controls for self-reported asthma diagnosis ($b = 0.24$, $p = 0.06$), past-year asthma attack ($b = 0.44$, $p = 0.02$), and past-year wheezing ($b = 0.17$, $p = 0.17$). Using Inverse Odds Weighting mediation we tested mental health, smoking, and four housing dimensions as potential mediators of the MTO–asthma relationship. We found no significant mediation overall, but mediation may be gender-specific. Gender-stratified models displayed countervailing mediation effects among girls for asthma diagnosis by smoking ($p = 0.05$) and adult-reported housing quality ($p = 0.06$), which reduced total effects by 35% and 42% respectively. MTO treatment worsened boys' mental health and mental health reduced treatment effects on asthma diagnosis by 27%. Future research should explore other potential mediators and gender-specific mediators of MTO effects on asthma. Improving measurement of housing conditions and other potential mediators may help elucidate the "black box" of neighborhood effects.

1. Introduction

Asthma is one of the most common childhood ailments in the US, with 14% lifetime prevalence among children aged 0–17 in 2011 (CDC, 2011), and even higher prevalence among African American and low-income, urban populations (Akinbami et al., 2012). The Moving to Opportunity (MTO) program provides a unique opportunity to examine housing-related causes and mediators of asthma within an experimental design, among this population that is disproportionately affected. The MTO study randomized low-income families to receive a housing voucher to subsidize a private rental apartment and move out of public housing, thereby improving their neighborhood and housing environment compared to controls (Orr et al., 2003), which presumably should have reduced asthma. Although prior work has documented both beneficial and harmful effects of MTO on health (Kling et al., 2007; Ludwig et al., 2011; Orr et al., 2003; Osypuk et al., 2012a, 2012b), including harmful effects on asthma (Fortson and Sanbonmatsu, 2010), the mechanisms through which MTO affects asthma have not been formally tested. The MTO experiment provides a rich

Abbreviations: MTO, moving to opportunity; RCT, randomized controlled trial; MI, multiple imputation; MICE, multiple imputation by chained equations.

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source of data that we use to test whether specific potential mediators can explain these unexpected adverse effects on asthma, including: mental health, tobacco exposure, housing characteristics, and housing-related stressors. Potential mediators were selected based on evidence from prior research and on the feasibility of being affected by housing mobility. Before outlining our specific hypotheses, we review literature linking our candidate mediators with asthma.

Ample evidence, derived from multiple study designs, documents that asthma and mental health problems frequently co-occur (Katon et al., 2007, 2004; Richardson et al., 2006). Both asthma diagnosis (Katon et al., 2007, 2004) and asthma symptoms (Richardson et al., 2006) are highly co-morbid with depression and anxiety. For example, among adolescents with asthma, youth with depression or anxiety reported significantly more days with symptoms in the prior two weeks, than youth without depression or anxiety, even after controlling for asthma severity (Richardson et al., 2006). Explanations for the comorbidity range from cognitive, where the stress of coping with chronic asthma may provoke recurring panic attacks, to biological, where neurons in the brain are sensitized to produce an overactive fear response to recurrent asthma episodes (Katon et al., 2004).

Both environmental tobacco smoke exposure and active smoking are important triggers for asthma. The link between environmental tobacco smoke and asthma symptoms is well documented (Agabiti et al., 1999; Mannino et al., 2001; Martinez et al., 1995). A comprehensive review of the literature showed that active smoking is a risk factor for the onset of asthma, and is associated with decreased asthma control and increased mortality and symptom severity (McLeish and Zvolensky, 2010). Moreover, youth smoking may be an important mediator between neighborhood stressors and asthma symptomatology (Chen et al., 2007).

Housing characteristics may also trigger asthma, primarily through two mechanisms: poor housing conditions and housing-related stressors. Indoor air pollutants present in substandard quality housing environments, such as carpeted floors, pet dander, pest infestation, and dust mites (Institute of Medicine (2000)), can exacerbate asthma and respiratory symptoms (Sandel and Wright, 2006). The effects of physical housing characteristics on asthma are well-documented, but emotional and psychological aspects of housing can also adversely influence asthma (Sandel and Wright, 2006). Increasingly, research is linking housing-related stressors, such as crowded or cluttered living conditions, noise levels, hardship with paying for essentials like heat, and frequent residential moves, to asthma (Sandel and Wright, 2006; Suglia et al., 2010). Although informative, much of this research relies on observational studies, limiting causal inference. Moreover, much of the literature examining neighborhood effects on health has taken a "black box" approach, focusing on ill-defined concepts such as context and/or composition (e.g., area-level vs. individual-level poverty), rather than on specific mechanisms that may influence health (Macintyre et al., 2002). We address this gap by explicitly testing mediating mechanisms of the MTO experimental effects on adolescent asthma by examining a wide variety of asthma triggers as potential mediators, including mental health, tobacco exposure and use, housing quality, and residential mobility. Examining mediators at multiple levels, and including a range of factors from behavioral to neighborhood-level factors, is consistent with a broader eco-epidemiologic approach (Susser and Susser, 1996) and allows us to think beyond the black box to analyze "determinants and outcomes at different levels of organization" (Susser and Susser, 1996) (p. 676). We hypothesize that changes in mental health, tobacco exposure, and housing characteristics induced by the MTO experiment will partially explain some of the adverse findings of MTO on asthma. Prior research has documented that gender modifies some of the mediators of interest (e.g., mental health and smoking (Orr et al., 2003; Osypuk et al., 2012a, 2012b)). Therefore, we further hypothesize that gender-specific pathways of mediation may be present. Specifically, we expect the harmful effects of MTO on boys' mental health and smoking may partially account for some of the harmful effects of MTO on asthma. We apply an innovative weight-based method to estimate these indirect effects: Inverse Odds Weighting (IOW).

2. Methods

2.1. Data

The Moving to Opportunity for Fair Housing Demonstration Project (MTO) was a randomized controlled trial (RCT) sponsored by the US Department of Housing and Urban Development (HUD, 1996) in 5 US cities (Boston, Baltimore, Chicago, Los Angeles, New York). Eligible low-income families had children under age 18, qualified for rental assistance, and lived in public housing or project-based assisted housing in areas with high concentrations of poverty (Feins and McInnis, 2001). Applicants were drawn from waiting lists, signed enrollment agreements and informed consent, completed the Baseline Survey, and were evaluated for eligibility (Goering et al., 1999) by public housing authorities.

2.1.1. Treatment assignment

Special software randomly assigned 4610 eligible volunteer families to one of three MTO treatment arms: the "regular Section 8" treatment group was offered Section 8 housing vouchers to subsidize a private market rental apartment in any neighborhood; the "low-poverty-neighborhood" treatment group was offered Section 8 vouchers redeemable only in low-poverty neighborhoods (<10% of Census Tract in poverty) along with housing counseling services to aid relocation; the control group was offered no further assistance but could remain in public housing (Goering et al., 1999). Although MTO contained two experimental (voucher) groups, both groups experienced similar improvements in neighborhood poverty by 2002 (albeit larger improvements for the low-poverty group immediately after randomization), treatment effects on asthma were similar for both groups, and formal tests for each outcome could not reject treatment-effect homogeneity ($p > 0.05$). Therefore, we combined the voucher groups to improve statistical power and parsimony.

2.1.2. Assessment

Baseline surveys (1994–1998) and the interim follow-up survey (2001–2002) were conducted via in-person interviews with household heads and their children (Goering et al., 1999; Orr et al., 2003). Our sample includes adolescents ($n = 3537$ aged 12–19 as of 5/31/2001) randomized through 12/31/1997 in the MTO Tier 1 Restricted Access Data. The effective response rate was 89.3% (Orr et al., 2003), resulting in an analytic sample of 2829 youth (experimental group $n = 1950$; control group $n = 879$). Adults provided informed written consent for themselves and their children (Feins and McInnis, 2001; Goering et al., 1999; Orr et al., 2003).

2.2. Measures

See Table 1 for sources of data, coding, and descriptive statistics of outcomes and mediators by domain, overall and by treatment group. See Supplemental Table 1 for descriptive statistics by gender and treatment group.