



## Original article

# Adolescence Is a Sensitive Period for Housing Mobility to Influence Risky Behaviors: An Experimental Design

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Article history: Received August 5, 2016; Accepted October 24, 2016

Keywords: Risky behaviors; Sensitive periods; Adolescent behavior; Randomized controlled trial; Housing; Public housing; Adolescence

## A B S T R A C T

**Purpose:** Test whether neighborhood mobility effects on adolescent risky behaviors varies at different developmental ages and gender.

**Methods:** The Moving to Opportunity (MTO) study randomly assigned volunteer families (1994–1997) to receive a Section 8 voucher to move to lower poverty neighborhoods versus a public housing control group. We tested three-way treatment, gender, and age-at-randomization interactions using intent-to-treat linear regression predicting a risky behavior index (RBI; measured in 2002, N = 2,829), defined as the fraction of 10 behaviors the youth reported (six measuring risky substance use [RSU], four measuring risky sexual behavior), and the RSU and risky sexual behavior subscales.

**Results:** The treatment main effect on RBI was nonsignificant for girls (B = −.01, 95% confidence interval −.024 to .014) and harmful for boys (B = .03, 95% confidence interval .009 to .059; treatment-gender interaction  $p = .01$ ). The treatment, gender, and age interaction was significant for RBI ( $p = .02$ ) and RSU ( $p < .001$ ). Treatment boys 10 years or older at randomization were more likely ( $p < .05$ ) than controls to exhibit RBI and RSU, whereas there was no effect of treatment for boys <10 years. There were no treatment control differences by age for girls' RBI, but girls 9+ years were less likely than girls ≤8 years to exhibit RSU ( $p < .05$ ).

**Conclusions:** Moving families of boys aged 10 years or older with rental vouchers may have adverse consequences on risky behaviors but may be beneficial for girls' substance use. Developmental windows are different by gender for the effects of improving neighborhood contexts on adolescent risky behavior.

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**IMPLICATIONS AND CONTRIBUTION**

Using an experimental design that manipulated family housing context, this study found that a child's gender and older age at random assignment modified effects of moving to more advantaged neighborhoods on adolescent risky behavior, suggesting developmental windows where changes in social determinants of health are more influential for adolescent health.

**Conflicts of Interest:** The authors have no conflicts of interest relevant to this article to disclose.

**Disclaimer:** The Department of Housing and Urban Development (HUD) had no role in the analysis or the preparation of this manuscript. HUD reviewed the manuscript to ensure respondent confidentiality was maintained in the presentation of results. Funders did not have any role in design or conduct of the study; collection, management, analysis, and interpretation of the data; or preparation, review, or approval of the manuscript.

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Adolescent risky behaviors, including substance use and risky sexual behavior (RSB), are significant public health concerns [1,2]. These behaviors co-occur during adolescence [3,4] and have both short- and long-term detrimental consequences for social and health outcomes [5]. Developmental theories suggest that antisocial behaviors may escalate over time and persist into adulthood [6], therefore, identifying the early causes is critical. Neighborhood context is one such early cause and is associated with a wide range of health and social outcomes, including risky behaviors [7,8].

However, most prior research does not consider how the developmental timing of exposures, particularly during childhood, can modify exposure impacts on health and health behaviors (i.e., critical or sensitive periods) [9]. Housing mobility may be most impactful during adolescence, in particular, since it is a period marked by dramatic biological, psychological, and social changes shaping risk and protective factors for health [9].

Moving is a stressor for children [10–12], but the effects of mobility may differ by gender [13]. For example, boys moving to more advantaged neighborhoods may fall in with riskier peer groups in their new neighborhoods, increasing their vulnerability to housing mobility [14]. In contrast, girls from high-disorder neighborhoods (i.e., disadvantaged neighborhoods) may be three times more likely than those from low-disorder neighborhoods to report sexual victimization [15]. For girls, the benefit of escaping this stressor may outweigh the trauma of moving [16].

The Moving to Opportunity (MTO) Demonstration Project is the only large-scale experiment based on extant US affordable housing policy [17] to examine the health effects of moving to more affluent neighborhoods. Leveraging this policy-relevant experimental design, the gold standard for causal inference [17,18], we examine how housing mobility affects adolescent risky behaviors. Specifically, we test whether the child's age at random assignment and gender modify treatment effects, to identify developmental periods when housing mobility is more influential for health.

## Methods

The US Department of Housing and Urban Development sponsored MTO, a randomized controlled trial in 5 US cities (Baltimore, Boston, Chicago, Los Angeles, and New York) [19]. Eligible volunteer families were low income, had children younger than 18 years, qualified for rental assistance, and lived in distressed public housing in poor neighborhoods [19]. Volunteers were selected from waiting lists, and, once eligibility was confirmed, completed enrollment agreements, informed consent forms, and the baseline survey [19]. MTO is not a medical intervention and was not registered as a clinical trial. University of Minnesota's Institutional Review Board approved this research.

### Treatment group assignment

Specialized software randomly assigned eligible volunteer families ( $N = 4,610$ ) from 1994 to 1998 to: (1) a “low-poverty” group offered a rental voucher subsidizing rent in neighborhoods with <10% of the population in poverty, paired with housing relocation counseling; (2) a “Section 8” group offered a regular Section 8 voucher redeemable in any neighborhood; or (3) a control group that could remain in public housing [19]. Both voucher groups had 90 days to use the voucher, after which it expired.

### Assessment

We used data from the baseline (1994–1998) and interim surveys (2001–2002; 4–7 years later), conducted via in-person interviews with household heads and their children [20]. We do not use final survey data (2008–2010; 10–15 years later) because children in the pre-to late-adolescent period at study randomization (1994–1997) would be in early adulthood at the final survey, and our outcomes would not be developmentally

appropriate. Most of the 5- to 16-year olds at baseline were not interviewed at the final survey. This same sample was aged 12–19 years at interim, making the interim survey the appropriate target period for our study. Up to two randomly selected children per family were interviewed. We focus on adolescents aged 12–19 years by May 31, 2001 ( $n = 2,829$  of 3,537 youth eligible, 89.3% response rate) [20].

### Measures

Our outcome, the risky behavior index (RBI), is the fraction of 10 items (0 = no, 1 = yes) youth self-report relating to risky substance use (RSU) and RSB, including: past 30-day alcohol use, cigarette use, marijuana use, binge drinking, alcohol and (separately) marijuana use before or during school or work, no condom use during last sexual intercourse, no contraceptive use during last intercourse, early sexual initiation (before age 15), and 2 or more sexual partners in the past year (Cronbach's  $\alpha = .75$ , mean [SD] = .13 [.18]). The RBI focuses on more recent, and a wider range of, behavior than original work documenting gender effects of MTO on a four-item scale measuring lifetime alcohol, cigarette, and marijuana use, and sexual intercourse ever [20]. Analyses using the original scale were substantively similar. We also examined the RSU ( $\alpha = .74$ , mean [SD] = .08 [.17]) and RSB ( $\alpha = .64$ , mean [SD] = .20 [.27]) subscales.

Randomly assigned treatment consisted of two treatment arms (low poverty and Section 8) and the control group. Both treatment groups experienced improved neighborhood poverty compared with controls (Appendix Table 1), and homogeneous ( $p < .05$ ) treatment effects on all outcomes, therefore, we combined the two treatment arms. Analyses retaining the three treatment groups show identical patterns, with slightly larger effects for the low-poverty group. MTO families could move without a treatment voucher, which occurred throughout follow-up, sometimes more than once, so the exposure here is the initial housing voucher offer. The effect modifier is age at randomization (range: 5–16 years, mean = 10 years), which we model linearly. Sensitivity analyses confirmed linearity.

### Analytic approach

We estimated intention-to-treat (ITT) analyses, preserving the strength of the experimental design, to assess the average effect of being randomly offered a housing voucher compared with controls. We estimated linear regression models in Stata 13, adjusted for site and household clustering, and weighted for changing random assignment ratios and attrition [21]. Missing data on the outcomes were minimal (range: 1%–4%), so we estimated complete case analyses.

We tested three-way treatment-gender-age interactions to preserve power and accommodate well-documented gender modification [20–23]. We output age-specific treatment control differences using postestimation commands and calculated effect sizes [24] and number needed to harm/treat (NNH/NTT) [25], to quantify the magnitude of our effects (Appendix Table 2). We graphed the treatment control differences by age at randomization and gender, with 95% confidence intervals (CIs). Since these outcomes are more likely to manifest among older youth, we estimated sensitivity analyses by (1) adjusting for interim survey age and (2) restricting the sample to older children (15- to 19-year-olds) to confirm the robustness of our findings.

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