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Were the mental health benefits of a housing mobility intervention larger for adolescents in higher socioeconomic status families?

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Abstract

Moving to Opportunity (MTO) was a social experiment to test how relocation to lower poverty neighborhoods influences low-income families. Using adolescent data from 4–7 year evaluations (aged 12–19, n=2829), we applied gender-stratified intent-to-treat and adherence-adjusted linear regression models, to test effect modification of MTO intervention effects on adolescent mental health. Low parental education, welfare receipt, unemployment and never-married status were not significant effect modifiers. Tailoring mobility interventions by these characteristics may not be necessary to alter impact on adolescent mental health. Because parental enrollment in school and teen parent status adversely modified MTO intervention effects on youth mental health, post-move services that increase guidance and supervision of adolescents may help support post-move adjustment.

Keywords

adolescent mental health; housing mobility; randomized controlled trial; housing policy; neighborhood effects

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INTRODUCTION

Living in areas of concentrated poverty has been linked to an array of harmful outcomes including worse mental and physical health, delinquency, and risky sexual behaviors for adolescents (Kim, 2008; Leventhal and Brooks-Gunn, 2000; Mair et al., 2008; Pickett and Pearl, 2001; Sampson et al., 2002). Although this evidence is mounting, most studies are observational and, therefore, potentially biased due to unaccounted for differences between comparison groups (Oakes, 2004). The Moving to Opportunity study with its strong experimental design has unique potential to inform the literature on neighborhood characteristics and housing policy as causes of health and illness.

The Moving to Opportunity (MTO) for Fair Housing Demonstration Project was a randomized housing mobility experiment designed to understand how relocation from high- to lower-poverty neighborhoods influences families. Families in public housing were randomly allocated an offer of a rental subsidy/housing voucher to rent private apartments in lower-poverty neighborhoods. Their outcomes were compared with control members who remained in public housing. Although MTO treatment predicted improvements in neighborhoods, housing, and safety, as well as better mental health for mothers, it had little impact on employment and earnings of adults (Orr et al., 2003).

Regarding outcomes among youth, previous MTO studies have documented beneficial effects on adolescent girls but null (Kling et al., 2007; Orr et al., 2003; Sanbonmatsu et al., 2011) or harmful (Osypuk et al., 2012a; Osypuk et al., 2012b) effects in several mental health domains among boys. These striking opposite gender effects of MTO may be better understood in light of other effect modification co-occurring with the gender effect modification. For example, recently researchers found that benefits to girls' psychological distress and behavior problems were concentrated among those in families without recent violent victimization (Osypuk et al., 2012a) or health/developmental vulnerabilities at baseline (Osypuk et al., 2012b). Additionally, the adverse treatment effects for boys for these outcomes were concentrated among those in families with baseline violent victimization or health vulnerabilities. These studies illustrate the crosscutting set of adversities facing youth, and suggest that although MTO intervened to address housing, its effects may depend upon the presence of multiple vulnerabilities across other domains of the child, including health, development, and prior trauma.

Identifying subgroups who are likely to benefit most from social interventions may also allow us to target the intervention more effectively. Moreover, if some subgroups are potentially harmed by the intervention, it is critical to identify such subgroups and modify the intervention appropriately. Other investigations have examined heterogeneity in MTO treatment effects by age for academic achievement (Sanbonmatsu et al., 2006) and adolescent outcomes in New York three years after randomization (Leventhal and Brooks-Gunn, 2003). Notably, though MTO generated mental health effects for youth, it had little impact on youth physical health overall. For example, there was some suggestion of adverse effects on asthma and self-rated health for younger adolescents aged 11–15, but effects were null for those aged 16–20 at the interim survey (Fortson and Sanbonmatsu, 2010).

To date, no published studies have examined whether family SES or household structure alter the impact of the MTO experiment on youth mental health, despite observational research documenting a link between family SES and adolescent mental health. Lower family SES and having a single parent are each associated with higher odds of DSM-IV disorders (Kessler et al., 2011), psychiatric symptoms (Barrett and Turner, 2005) and problem behaviors (Hoffmann, 2006; Miech et al., 1999) among adolescents. These processes may be mediated by lower economic resources, differences in family processes

(e.g., family cohesion, perceived support), chronic strains, and traumatic life events that vary by family SES and household structure (Barrett and Turner, 2005). Furthermore, lower family SES correlates with lower adolescent physical health (Goodman, 1999)—which may negatively impact adolescent mental health. Although residential mobility may have benefits, it is also a stressor for children, involving challenges such as breaking or straining existing social ties, forming new relationships, and adapting to new cultural norms (Adam, 2004; Adam and Chase-Lansdale, 2002; Anderson, 2000). Families with fewer resources may already face more stressors to their mental health, making the new challenges associated with relocation more difficult to manage (Simmons et al., 1987). For example, some studies have shown that residential mobility adversely affects school progress only among children whose parents had lower education (Straits, 1987), or for families without two biological parents (Tucker et al., 1998).

Family characteristics may influence actual use of the offered housing voucher, for instance, if lower SES families were less able to use the voucher to find an appropriate apartment to rent. Since there are many steps involved in actually using a rental voucher, more vulnerable families might have less time to navigate a move, or it may have been more difficult for them to comply with program rules. Family characteristics like SES or marital status may also influence the types of neighborhoods families consider and/or select as destinations. For instance, using the Panel Study of Income Dynamics, South and Crowder found that conditional on moving, among blacks, being married and having more years of schooling increased the likelihood of moving into predominantly white census tracts. Among whites, higher SES was also linked to moving to census tracts with greater proportions of whites (South and Crowder, 1998). Indeed, the choice sets that parents construct, from which they will select a destination for a move, may be substantially different by family SES (Bell, 2009). Differences in destination neighborhoods may, in turn, produce differences in adolescent outcomes, especially since families with lower SES already face stressors to their health (Lynch and Kaplan, 2000) and may have fewer resources to adapt to new neighborhoods. Thus, family SES may be an important effect modifier for MTO for a variety of reasons.

The MTO population is among the most disadvantaged in the United States (US); these are primarily minority, very-low income, single-headed families receiving housing support, and are recruited from some of the highest-poverty neighborhoods in the US. Nonetheless, at baseline, there was meaningful variation in baseline socioeconomic and household structure characteristics. More than half of household heads had a high school diploma or greater, about a quarter were employed, about 1 in 7 were in school, and three-fifths had never been married (Orr et al., 2003). The investigation of treatment heterogeneity in the MTO population is valuable given that low-income families are the targets of current policies such as the Housing Choice Vouchers program that assists families in affording rental housing (U.S. Department of Housing and Urban Development, 2012).

Study aims and hypotheses

No published studies have examined whether baseline family SES or household structure alter the impact of the MTO housing voucher experiment on youth outcomes. Therefore, the aim of this study is to test whether the MTO treatment effect on adolescent mental health differed by family SES or household structure. Even though prior studies have established opposite MTO effects on mental health by gender (Kling et al., 2007; Osypuk et al., 2012a; Osypuk et al., 2012b), we hypothesize that family vulnerability assessed by socioeconomic status and household structure will reduce benefits (or enhance the harm) of the treatment effects for both boys and girls. Nonetheless, the size of the treatment effect modification may differ by gender and/or the family characteristics under consideration.

METHODS

MTO was a \$70 million federally-funded housing mobility experiment carried out by the U.S. Department of Housing and Urban Development (U.S. Department of Housing and Urban Development, 1996) in 5 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 high poverty neighborhoods. 5301 families volunteered and 4610 families were eligible and randomized (Orr et al., 2003).

Treatment assignment—Families were randomized to one of three groups in 1994–1998. The “low-poverty-neighborhood” treatment group was offered Section 8 housing vouchers that they could use to subsidize renting an apartment in the private market, with the restriction that these vouchers were redeemable only in neighborhoods where <10% of households in the census tract were poor. Housing counseling was available to this group to assist in relocation. The low neighborhood poverty restriction expired one year after relocating—after which families in this treatment group could move to another apartment regardless of the poverty level of its census tract and retain their housing voucher. The “regular section 8” treatment group was offered traditional Section 8 housing vouchers with no neighborhood poverty constraints or housing counseling. Finally, the control group was given no further assistance, but could remain in public housing (Goering et al., 1999).

Assessments—Our data includes surveys completed at baseline (1994–1998) and during the interim follow-up 4–7 years after randomization (2001–2002) among household heads and their children. At randomization, 92% of household heads were female. Up to two children were randomly selected from each household for the interim survey. Interviews were conducted in person via computer-assisted interviewing technology. We focus on adolescents ($n=3537$ aged 12–19 years as of May 31, 2001) randomized through December 31, 1997 in MTO Tier 1 Restricted Access Data; the effective response rate is 89.3% (Orr et al., 2003). Adults provided informed written consent for themselves and their children (Goering et al., 1999; Orr et al., 2003). Our study was approved by Northeastern University’s Institutional Review Board. Because MTO was a housing intervention with no explicit clinical or health-care intervention components, it was not registered in clinical trial databases (International Committee of Medical Journal Editors, 2012).

Variables

Mental health outcomes—*Past-month psychological distress* was assessed via the K6 scale, a six-item Likert scale with responses including all, most, some, a little, or none of the time to the following self-reported items: so depressed nothing could cheer you up; nervous; restless or fidgety; hopeless; everything was an effort; worthless. We scored the K6 with two-parameter binary Item Response Theory (IRT) latent variable methods (Kessler et al., 2002; Osypuk et al., 2012a; Osypuk et al., 2012b) to obtain standardized distress factor scores (Cronbach’s $\alpha=0.80$, mean (SD) = $-0.04(1.1)$). The *Behavior problems index (BPI)* was a summary of 11 self-reported items including “I lie or cheat” and “I have a hot temper” (Zill, 1990). Responses ranged from 0 (not true) to 2 (often true). We used two-parameter binary IRT methods to obtain standardized BPI scores (Cronbach’s $\alpha=0.80$, mean (SD) = $-0.03(1.1)$). Higher values indicate worse mental health for both measures. These measures capture potentially different manifestations of mental health problems expressed by gender, where girls are more likely to exhibit internalizing symptoms such as distress, while boys are more likely to exhibit externalizing symptoms such as behavioral problems (Rosenfield, 1999; Schwartz and Meyer, 2010). Although diagnostic mental health measures, including major depression, were measured in the MTO protocols, very low

prevalence severely limited power. Effects of social context may also be nonspecific, to affect more than one disorder, so using dimensional measures of symptomatology may be helpful for population or community assessment (Aneshensel, 2005; McMahon et al., 2003).

Treatment effect modifiers measured at baseline—Modification of the effect of the MTO intervention on adolescent mental health outcomes was evaluated using available *pre-randomization* covariates indicating family socioeconomic status, parental marital status, and teen parent status measured by household head's (usually the mother's) survey responses. Specifically, the examined treatment modifiers included that the head-of-household 1) had no high school degree or GED; 2) was unemployed; 3) was receiving welfare (Aid to Families with Dependent Children, AFDC, or Temporary Assistance for Needy Families, TANF); 4) was in school; 5) owned a car; 6) had household size of two; 7) had household size less than or equal to three; 8) was never married; 9) was a teen parent at birth of first child. We included household size as a rough indicator of household composition and resources. Because the vast majority of MTO families were female-headed single households, a household size of two indicates one parent and one child. Adolescents in small families may have greater ease with neighborhood relocation because the available housing stock to rent for small families is greater than for large families (Shroder, 2002). We included teen parent status as a treatment modifier along with other indicators of family SES status because teen parenthood is a predictor of low economic and social resources. For instance, a recent study utilizing instrumental variable methods found that teen pregnancy was associated with a lower probability of receiving a high school diploma, lower annual income, and lower wages (Fletcher and Wolfe, 2009).

Treatment group assignment was indicated with one binary variable: treatment group vs. control group. Although MTO was designed with 2 experimental treatment groups, effects on adolescent mental health were similar for both treatment groups (vs. controls) and formal statistical tests provided no evidence of effect heterogeneity for psychological distress ($p=0.94$) or for behavior problems index ($p=0.40$) in pooled models or in gender-stratified models. We therefore combined experimental groups to improve statistical power and to simplify analyses.

Treatment adherence—For the two original treatment groups assigned to receive a rental housing voucher, treatment adherence was defined as utilizing the MTO-offered housing voucher to relocate within 90 days of receipt of that voucher (after which the voucher expired). Approximately 51% of treatment group families utilized MTO-offered housing vouchers to relocate (Orr et al., 2003). The control group was not given housing vouchers and hence under this definition, all participants in the control group were classified as having fully adhered.

Covariates—We controlled for baseline covariates to adjust for potential covariate imbalances across treatment groups that occurred by chance, and to improve efficiency of estimates (Gail et al., 1984; Rosenblum and Van Der Laan, 2009). Covariates included site and other pre-randomization characteristics: youth age, race/ethnicity, giftedness, and schoolwork or behavior problems; household head marital status, employment, education, tenure in neighborhood, relationships with baseline neighbors, presence of family/friends in baseline neighborhood, and prior application for section 8 (Table 1). Addition of these covariates had little effect on regression results. Gender was controlled by stratification.

Analytic Approach

ITT—Primary analyses included intention-to-treat (ITT) estimates derived from covariate-adjusted linear regression models, modeled separately for each outcome (psychological

distress, BPI). We then tested the primary hypothesis: whether family socioeconomic status or household structure modified MTO treatment effects on adolescent mental health, using treatment-by-family characteristic interaction terms. All models were gender-stratified (given prior evidence of gender effect modification of MTO treatment) (Kling et al., 2007; Orr et al., 2003). Models collapsed on gender (modeling additional gender-treatment interactions) achieved comparable results as gender stratified models. Outcomes were modeled as standardized scores with an approximate mean of zero and standard deviation (SD) of one. Thus, treatment effects are in units of a SD (e.g., a treatment effect of 0.20 indicates 0.20 of a SD difference in the outcome between treatment and control members).

Adherence-Adjusted Instrumental Variable (IV) Treatment-On-Treated (TOT)

Models—ITT effect estimates are likely attenuated compared to effect estimates of actually using the housing voucher to move, because about half of treatment group families offered housing vouchers did not utilize them. Yet MTO families that utilized housing vouchers differed substantially from those who did not. For example, adherence rates were higher among families with heads who were enrolled in school at baseline, younger parents, never married parents, those dissatisfied with their neighborhoods, those with fewer social interactions with neighbors, those with a household member who had been victimized, and those hopeful about being able to find an apartment in another area of the city (Sanbonmatsu et al., 2006). Notably, other unmeasured factors may also have predicted moving with the voucher. Thus, directly comparing voucher movers to non-movers may bias results (Angrist et al., 1996; Newhouse and McClellan, 1998). Instrumental variable methods produce valid adherence-adjusted treatment effect estimates because these methods do not directly compare compliers with non-compliers. Under the assumption that the MTO treatment assignment impacts the mental health of participants only indirectly by influencing residential moves with the voucher, the MTO treatment is a valid instrument to estimate the effect on mental health of actually using the housing voucher to move (Gennetian et al., 2002). Therefore, to rule out differences in adherence rates (e.g., use of the housing vouchers) by family characteristics as an explanation for observed MTO treatment heterogeneity in ITT models, we implemented adherence-adjusted effect estimates using IV analysis, implemented via two-stage least squares (2SLS) regression (Kling et al., 2007). Comparing ITT estimates with adherence-adjusted TOT estimates allows us to assess whether any observed effect modification of treatment was driven by adherence (use of the voucher) among subgroups defined by family socioeconomic status and household structure. For instance, the MTO treatment may appear less effective for low SES families in ITT models because these families may have been less likely to use the offered MTO housing vouchers, in which case, we expect to see significant effect modification in ITT models, but not in TOT models. But if ITT and TOT patterns are similar, this implies that adherence rates do not account for observed ITT treatment heterogeneity.

All analyses accounted for household clustering, given that up to two children were sampled per household, and were weighted to account for attrition and varying random assignment ratios across time. We report robust standard errors. For baseline variables with less than 5% missing observations, values were imputed by the original investigators to means conditional on site (for adults), and site, age and gender of respondent (for youth). For variables missing for more than 5%, an indicator variable for “missing” was used (Orr et al., 2003). Child giftedness and parental education were missing for 7% of respondents, and thus indicators for missing on these covariates were included in regressions. For the few observations with missing outcome values (<1%), values were imputed by taking the average of the mean response for that person across all non-missing items and the item mean for the sample. We used M-Plus 6.11 for IRT analyses and STATA 11.0 for all other analyses. To conserve space, we report crude relationships between parent/family characteristics and outcomes under investigation in online appendices. These do not address

our primary aim of investigating treatment heterogeneity but are important for describing the associations of these factors with adolescent mental health. In addition, because TOT analyses generated similar results as ITT estimates, they are presented in the appendices.

RESULTS

The MTO sample lived in extremely high-poverty neighborhoods at baseline (with 1990 census tract poverty rate approximately 50%). Treatment group compliers relocated to substantially lower poverty neighborhoods as a result of the treatment, with mean poverty rates of 7.5% and 26.9% among low-poverty experimental group and Section 8 movers respectively after their first move using the housing voucher (Orr et al., 2003). Neighborhood poverty rates for control group members decreased over time as well, (Orr et al., 2003) since many MTO families were living in distressed public housing developments that were marked for demolition under the HOPE VI program, and other control members moved of their own volition. Table 1 displays baseline characteristics for the analytic sample restricted to adolescents aged 12–19 present at the interim survey. No statistically significant ($p < .05$) differences in baseline characteristics among treatment groups were observed. At baseline, almost half (47.1%) of household heads had less than a high school education; a quarter were employed (25.8%); a quarter had been teen parents (25.9%), and average age of household heads at enrollment was 35 years. Most were receiving AFDC/TANF (76.0%).

Baseline family characteristics were associated with distress and BPI at the interim survey. Appendix A displays mean distress and BPI associations with family characteristics. Parental unemployment was marginally linked with higher psychological distress for girls ($p = 0.07$). Additionally, for girls, parental unemployment, welfare receipt, and never married status were associated with higher levels of behavior problems ($p < 0.05$). For boys, parental unemployment ($p = 0.003$) and teen parent status ($p = 0.07$) were linked to higher psychological distress. Parent-in-school status was associated with marginally fewer behavior problems ($p = 0.08$) for boys. Moreover, for boys, family size of two was related to marginally lower psychological distress ($p = 0.10$) and fewer behavior problems ($p = 0.05$) (Appendix A).

The overall MTO ITT intervention effects for boys were harmful for psychological distress ($B = 0.14$; $p = 0.03$) and BPI ($B = 0.18$; $p = 0.003$) vs. controls, but the overall MTO intervention effects for girls were beneficial for distress ($B = -0.12$; $p = 0.05$) and null for BPI ($B = -0.03$; $p = 0.60$). Table 2 displays the gender-stratified ITT estimates for the modification of treatment effects on mental health by family characteristics. Very similar conclusions were drawn with gender-pooled models (not shown) in that the majority of treatment effect estimates were homogeneous by family SES and household structure characteristics. In gender-stratified models, few variables were significant treatment modifiers; only 2 out of 36 tests demonstrated a statistically significant interaction ($p < 0.05$) between family characteristics and treatment on mental health, and then only for girls (Table 2). Table 3 presents subgroup-specific ITT estimates by the modifier subgroup and gender, calculated from the regression results presented in Table 2.

Low parental education, unemployment, receiving AFDC/TANF, household size, and never being married were not significant treatment modifiers on adolescent mental health. However, parental enrollment in school adversely modified the effect of the MTO treatment on psychological distress for girls (treatment*parent-in-school interaction term $p = 0.04$); the treatment effect for girls with a parent in school was 0.20 (an adverse effect) compared to -0.17 for girls with a parent not in school (a beneficial effect). Additionally, teen parent was an adverse treatment modifier for girls for BPI (treatment*teen parent $p = 0.03$); the treatment effect for girls with a parent who had been a teen parent was 0.19 compared to -0.10 for

girls whose parent had not been a teen parent. Although statistically non-significant, parental enrollment in school was an adverse modifier of treatment effects for boys and girls for BPI. Parental ownership of a car was a marginally significant adverse treatment modifier for BPI for girls (treatment*teen parent $B = 0.23$; $p = 0.08$).

Adherence-adjusted treatment heterogeneity was also investigated using instrumental variable methods. Appendix Tables B–C present complementary TOT estimates for the ITT estimates presented in Tables 2 and 3 of the main text. The patterns observed in the ITT analyses were similar with TOT analyses; non-significant interaction terms in ITT analyses remained non-significant in TOT analyses but TOT estimates were approximately double those of ITT—which is not surprising given that about half of families in the treatment group actually used the MTO voucher to move. Adherence-adjusted effect estimates are presented in Figure 1 for parent-in-school as a treatment modifier. These similar patterns between ITT and TOT models suggest that differential treatment adherence rates across different SES and other family characteristic subgroups do not account for the observed effect modification.

DISCUSSION

This is the first study to examine MTO treatment modification by family socioeconomic characteristics and household structure, not only for health, but for any outcome. We hypothesized that more economic resources may enable families to select better neighborhoods or housing units with a given housing subsidy, and/or to adjust or assimilate better after residential relocation. However, we did not find that MTO affected adolescent mental health differently among vulnerable families (defined by low parental education, welfare receipt, unemployment, or never-married status) compared to more resourced families. Nonetheless, the documentation of treatment homogeneity is valuable given the very limited MTO literature on modification of treatment effects and the policy relevance of the results of MTO for the large federally funded Housing Choice Vouchers Program (U.S. Department of Housing and Urban Development, 2012).

Although we did not detect modification of treatment effects for the majority of family characteristics examined, treatment heterogeneity was documented for a few measures. Parental enrollment in school appeared to significantly adversely modify MTO treatment effects on girls' psychological distress. The adherence-adjusted beneficial effects on psychological distress for girls whose parent was not enrolled in school at baseline were moderate (Cohen, 1969), at approximately -0.33 , and of comparable magnitude to that of non-behavioral psychotherapy (Weisz et al., 1995). Parent-in-school also marginally adversely modified treatment effects on boys' BPI. Parental enrollment in school concurrent with neighborhood relocation may exert detrimental impacts on adolescent mental health—at least in the relative short-term—and may suggest reduced availability of time a parent has to spend with her children. It is unclear why car ownership was marginally associated with adverse treatment effects for girls' BPI, opposite our hypothesis. Like parental enrollment in school, it may also indicate competing responsibilities outside the home, and signal reduced parental monitoring.

Teen parent status was also an adverse treatment modifier of girl's BPI; compared to controls, MTO treatment girls with older mothers had fewer behavior problems, while girls of teen parents exhibited more behavior problems in the treatment group. Previous research has found children of teenage mothers had higher rates of grade failure, delinquency, and early sexual debut than children of older mothers (Coley and Chase-Lansdale, 1998). Thus, teen parenthood seems to be one vulnerability that inhibits MTO treatment, suggesting perhaps that the parenting style of young parents may have combined with stressors of MTO

treatment to adversely influence girls' behavior. Our detection of greater treatment heterogeneity among girls by family characteristics aligns with previous literature suggesting girls' greater sensitivity to the caregiving environment on the development of emotional and behavioral problems (Keenan et al., 1999). Yet, overall, we find little heterogeneity in treatment effects by family socioeconomic position.

Study findings in context

Although this study did not identify much heterogeneity in treatment effects by family SES and household structure, newly published MTO studies document heterogeneity by baseline health and violent victimization. Benefits to girls' psychological distress and BPI were concentrated among those in families without history of recent violent victimization at baseline (Osypuk et al., 2012a) or without health vulnerabilities at baseline (Osypuk et al., 2012b). Moreover, adverse treatment effects for boys were concentrated among those in families with baseline history of violent victimization or health vulnerabilities. Thus, while SES may not modify MTO treatment effects on adolescent mental health, other vulnerabilities do, suggesting that health especially might be a particularly relevant domain of adolescent life that both impedes and is affected by housing mobility.

Recently released results from the MTO final evaluation 10–15 years after randomization suggest that experimental treatment girls aged 13–20 had lower psychological distress and fewer emotional and behavior problems compared to control members. For adolescent boys, estimates were non-significant but adverse for mental health disorders (Sanbonmatsu et al., 2011). Thus patterns documented in our data at the interim evaluation 4–7 years post randomization were reflected again at the final evaluation. The final evaluation additionally documented beneficial physical health effects for MTO adult heads of households including lower prevalence of class II/III obesity (body mass index ≥ 35), diabetes, lower levels of c-reactive protein (an inflammatory marker related to cardiovascular disease), as well as lower self-reported physical limitations (an indicator of disability). Beneficial mental health effects for MTO adult heads included lower levels of psychological distress and lower prevalence of depression and anxiety. However, MTO treatment was also related to higher self-reported dependence on drugs and alcohol among MTO adult heads (Sanbonmatsu et al., 2011). In line with earlier evaluations, there were few effects on adult labor market or economic outcomes which were the main outcomes of the original MTO study (Ludwig et al., 2012; Ludwig et al., 2011; Sanbonmatsu et al., 2012). So although the MTO social experiment was not designed with health in mind, either as an outcome or as a vulnerability that might affect program impact, health emerged as a prominent domain of investigation. As such, health within the MTO study likely deserves more attention, so we can better understand why it was so affected, in order to maximize health benefits from future housing mobility and neighborhood relocation policies.

Study strengths and limitations

MTO is one of the only social experiments of housing mobility, so its strong design may inform contextual causes of mental health. This study contributes to the sparse literature on treatment heterogeneity of the MTO experiment and, thus, to a further understanding of who may be benefiting, and who may not, from housing mobility among low-income families. MTO was a \$70 million investment for understanding effects of housing vouchers on various life domains of low-income families. Housing vouchers remain the major affordable housing federal investment in the U.S., providing housing assistance for more than 2.2 million low-income households (DeLuca et al., 2012; U.S. Department of Housing and Urban Development, 2012). Therefore MTO's study population of families living in distressed public housing was the relevant population for targeting neighborhood relocation. However, this means that MTO participants were highly disadvantaged in terms of income,

employment, and education and most MTO households were headed by single mothers. MTO results may not be generalizable therefore to other, less disadvantaged populations. Neighborhood relocation by a different population, e.g. among higher SES populations, or among populations with larger variation in socioeconomic SES status, may still theoretically produce heterogeneous intervention effects by baseline socioeconomic status.

Our investigation of treatment heterogeneity was constrained by available baseline measures, which were often dichotomized in the restricted access dataset to protect the identities of respondents. For instance, for marital status, we were only able to compare “never married” versus “other”—although the “other” category contains adults who were married, divorced, widowed and separated. Also, a teen parent in this study was defined as ever having been a teen parent—the sampled parent was not necessarily a teen parent at baseline. Of the respondents who indicated they had been a teen parent (n=1029), only 61 were below age 20 at randomization, limiting power to examine the effects of neighborhood relocation among teen parents at baseline. Therefore ever having been a teen parent may be capturing a legacy of teen parenthood (e.g. parenting style or experience) rather than a more immediate effect. Future investigations that include more comprehensive and refined measures of family socioeconomic status than those available in this study are needed to confirm the absence of treatment heterogeneity by family SES. Moreover, to improve power to test associations among subgroups, future research examining heterogeneity of assisted housing mobility might explore a stratified design, within which random assignment occurs, thus helping to ensure sufficient sample size for internally valid treatment effects within subgroups (Kernan et al., 1999).

In addition to the variables that we examined, other factors, such as level of parental monitoring at baseline, may be important effect modifiers of the MTO program on adolescent mental health. Yet many such variables were not measured in the MTO data at baseline. For example, less intense parental monitoring has been strongly linked to the development of adolescent problem behaviors both directly and indirectly as mediated by adolescent involvement with deviant peers (Ary et al., 1999; Dishion and McMahon, 1998). Parental monitoring is also higher for girls than boys (Dishion and McMahon, 1998), which may disadvantage boys in housing relocation interventions if monitoring is important for successful adaptation to the new neighborhood. Other potentially important modifiers include residential instability, household composition (beyond household size), availability and stability of adult caregivers, and presence and involvement of a father figure, given that the vast majority of MTO families were single female-headed households. A qualitative study utilizing in-depth interviews with MTO teens in Baltimore and Chicago found that while girls in the treatment and control group did not differ in their reporting of a father figure in their lives (about 25% in each group), control boys were nearly twice as likely as experimental boys (63% vs. 33%) to describe a relationship with a close, caring male other than a biological father (Clampet-Lundquist et al., 2011). Neighborhood relocation may have disrupted boys’ relationships with father figures which may also account for some of the adverse treatment effects seen for boys. Lastly, we did not have baseline mental health measures. Although we believe differences in mental health were balanced across treatment groups (given the experimental design of MTO and balance across other covariates), having baseline mental health would have allowed its examination as a modifier.

Study implications and conclusions

Investigation of heterogeneity in MTO impacts has thus far been highly limited. Future studies would benefit from including more comprehensive baseline measures such as those on health, socioeconomic status, and household structure, so we can better assess treatment heterogeneity and program effectiveness, which can ultimately inform more tailored program design. Examining heterogeneity of program effects is important because it allows

us to better understand to what extent *and* for which groups mobility interventions can aid low-income families. MTO treatment effects on adolescent mental health were homogenous over most family SES characteristics—suggesting that in the population of disadvantaged families in public housing, tailoring neighborhood mobility interventions by family SES may not be necessary to alter the intervention’s impact on adolescent mental health. However, because parental enrollment in school and teen parent status adversely modified MTO, post-move services accompanying neighborhood relocation may be necessary to ease adjustment to new neighborhoods. For instance, leveraging school and community resources in the form of after-school enrichment programs, sport teams, school groups, and adult mentors may support supervision and guidance of adolescents (Ary et al., 1999; Dishion and McMahon, 1998). Such resources may therefore, help assure that more low-income youth benefit from housing mobility programs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

- Adam EK. Beyond Quality. *Current Directions in Psychological Science*. 2004; 13:210–213.
- Adam EK, Chase-Lansdale PL. Home sweet home(s): Parental separations, residential moves, and adjustment problems in low-income adolescent girls. *Developmental Psychology*. 2002; 38:792–805. [PubMed: 12220056]
- Anderson, E. *Code of the Street: Decency, Violence, and the Moral Life of the Inner City*. W. W. Norton & Company; New York, New York: 2000.
- Aneshensel CS. Research in Mental Health: Social Etiology versus Social Consequences. *Journal of Health and Social Behavior*. 2005; 46:221–228. [PubMed: 16259145]
- Angrist JD, Imbens GW, Rubin DB. Identification of causal effects using instrumental variables. *Journal of the American Statistical Association*. 1996; 91:444–455.
- Ary DV, Duncan TE, Biglan A, Metzler CW, Noell JW, Smolkowski K. Development of Adolescent Problem Behavior. *Journal of Abnormal Child Psychology*. 1999; 27:141–150. [PubMed: 10400060]
- Barrett AE, Turner RJ. Family Structure and Mental Health: The Mediating Effects of Socioeconomic Status, Family Process, and Social Stress. *Journal of Health and Social Behavior*. 2005; 46:156–169. [PubMed: 16028455]
- Bell CA. All Choices Created Equal? The Role of Choice Sets in the Selection of Schools. *Peabody Journal of Education*. 2009; 84:191–208.
- Clampet-Lundquist S, Edin K, Kling JR, Duncan GJ. Moving Teenagers Out of High-Risk Neighborhoods: How Girls Fare Better than Boys. *American Journal of Sociology*. 2011; 116:1154–1189.
- Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*. Academic Press; New York, New York: 1969.
- Coley RL, Chase-Lansdale PL. Adolescent pregnancy and parenthood: Recent evidence and future directions. *American Psychologist*. 1998; 53:152–166. [PubMed: 9491745]
- DeLuca, S.; Duncan, G.; Mendenhall, R.; Keels, M. The Notable and the Null: Using Mixed Methods to Understand the Diverse Impacts of Residential Mobility Programs. In: Van Ham, M.; Manley,

- D.; Bailey, N.; Simpson, L.; MacLennan, D., editors. *Neighborhood Effects Research: New Perspectives*. Springer; Dordrecht: 2012. p. 195-223.
- Dishion TJ, McMahon RJ. Parental Monitoring and the Prevention of Child and Adolescent Problem Behavior: A Conceptual and Empirical Formulation. *Clinical Child and Family Psychology Review*. 1998; 1:61–75. [PubMed: 11324078]
- Fletcher JM, Wolfe BL. Education and Labor Market Consequences of Teenage Childbearing. *Journal of Human Resources*. 2009; 44:303–325.
- Fortson JG, Sanbonmatsu L. Child Health and Neighborhood Conditions: Results from a Randomized Housing Voucher Program. *Journal of Human Resources*. 2010; 45:840–864.
- Gail M, Wieand S, Piantadosi S. Biased estimates of treatment effect in randomized experiments with nonlinear regressions and omitted covariates. *Biometrika*. 1984; 71:431–444.
- Gennetian, LA.; Bos, JM.; Morris, PA. *Using Instrumental Variables Analysis to Learn More from Social Policy Experiments*. Manpower Demonstration Research Corporation; New York: 2002.
- Goering, J.; Kraft, J.; Feins, J.; McInnis, D.; Holin, MJ.; Elhassan, H. *Moving to Opportunity for Fair Housing Demonstration Program: Current Status and Initial Findings*. US Department of Housing & Urban Development, Office of Policy Development and Research; Washington, DC: 1999.
- Goodman E. The role of socioeconomic status gradients in explaining differences in US adolescents' health. *American Journal of Public Health*. 1999; 89:1522–1528. [PubMed: 10511834]
- Hoffmann J. Family Structure, Community Context, and Adolescent Problem Behaviors. *Journal of Youth and Adolescence*. 2006; 35:867–880.
- International Committee of Medical Journal Editors. *Frequently Asked Questions: Questions about Clinical Trials Registration*. 2012.
- Keenan K, Loeber R, Green S. Conduct Disorder in Girls: A Review of the Literature. *Clinical Child and Family Psychology Review*. 1999; 2:3–19. [PubMed: 11324095]
- Kernan WN, Viscoli CM, Makuch RW, Brass LM, Horwitz RI. Stratified Randomization for Clinical Trials. *Journal of Clinical Epidemiology*. 1999; 52:19–26. [PubMed: 9973070]
- Kessler R, Andrews G, Colpe L, Hiripi E, Mroczek D, Normand S, Walters E, Zaslavsky A. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine*. 2002; 32:959–976. [PubMed: 12214795]
- Kessler RC, Avenevoli S, Costello EJ, Georgiades K, Green JG, Gruber MJ, He J-p, Koretz D, McLaughlin KA, Petukhova M, Sampson NA, Zaslavsky AM, Merikangas KR. Prevalence, Persistence, and Sociodemographic Correlates of DSM-IV Disorders in the National Comorbidity Survey Replication Adolescent Supplement. *Archives of General Psychiatry*. 2012; 69:372–380. [PubMed: 22147808]
- Kim D. Blues from the Neighborhood? Neighborhood Characteristics and Depression. *Epidemiologic Reviews*. 2008; 30:101–117. [PubMed: 18753674]
- Kling JR, Liebman JB, Katz LF. Experimental analysis of neighborhood effects. *Econometrica*. 2007; 75:83–119.
- Leventhal T, Brooks-Gunn J. The Neighborhoods They Live In: The Effects of Neighborhood Residence on Child and Adolescent Outcomes. *Psychological Bulletin*. 2000; 126:309–337. [PubMed: 10748645]
- Leventhal T, Brooks-Gunn J. Moving to Opportunity: an Experimental Study of Neighborhood Effects on Mental Health. *American Journal of Public Health*. 2003; 93:1576–1582. [PubMed: 12948983]
- Ludwig J, Duncan GJ, Gennetian LA, Katz LF, Kessler RC, Kling JR, Sanbonmatsu L. Neighborhood effects on the long-term well-being of low-income adults. *Science*. 2012; 337:1505–1510. [PubMed: 22997331]
- Ludwig J, Sanbonmatsu L, Gennetian L, Adam E, Duncan GJ, Katz LF, Kessler RC, Kling JR, Lindau ST, Whitaker RC, McDade TW. Neighborhoods, Obesity, and Diabetes--A Randomized Social Experiment. *New England Journal of Medicine*. 2011; 365:1509–1519. [PubMed: 22010917]
- Lynch, J.; Kaplan, G. *Socioeconomic Position*. In: Berkman, L.; Kawachi, I., editors. *Social Epidemiology*. Oxford; New York: 2000. p. 13-35.
- Mair C, Diez Roux AV, Galea S. Are neighbourhood characteristics associated with depressive symptoms? A review of evidence. *Journal of Epidemiology & Community Health*. 2008; 62:940–946. [PubMed: 18775943]

- McMahon SD, Grant KE, Compas BE, Thurm AE, Ey S. Stress and psychopathology in children and adolescents: is there evidence of specificity? *Journal of Child Psychology and Psychiatry*. 2003; 44:107–133. [PubMed: 12553415]
- Miech RA, Caspi A, Moffitt TE, Wright BRE, Silva PA. Low Socioeconomic Status and Mental Disorders: A Longitudinal Study of Selection and Causation during Young Adulthood. *American Journal of Sociology*. 1999; 104:1096–1131.
- Newhouse JP, McClellan M. Econometrics in outcome research: The use of instrumental variables. *Annual Reviews of Public Health*. 1998; 19:17–34.
- Oakes JM. The (mis)estimation of neighborhood effects: causal inference for a practicable social epidemiology. *Social Science & Medicine*. 2004; 58:1929–1952. [PubMed: 15020009]
- Orr, L.; Feins, JD.; Jacob, R.; Beecroft, E.; Sanbonmatsu, L.; Katz, LF.; Liebman, JB.; Kling, JR. Moving to Opportunity for Fair Housing Demonstration Program: Interim Impacts Evaluation. U.S. Department of Housing and Urban Development; Washington, DC: 2003.
- Osypuk TL, Schmidt NM, Bates LM, Tchetgen-Tchetgen EJ, Earls FJ, Glymour MM. Gender and Crime Victimization Modify Neighborhood Effects on Adolescent Mental Health. *Pediatrics*. 2012a; 130:472–481. [PubMed: 22908105]
- Osypuk TL, Tchetgen-Tchetgen EJ, Acevedo-Garcia D, Earls FJ, Lincoln A, Schmidt NM. Differential Mental Health Effects of Neighborhood Relocation Among Youth in Vulnerable Families. *Archives of General Psychiatry*. 2012b; 69:1284–1294. [PubMed: 23045214]
- Pickett KE, Pearl M. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *Journal of Epidemiology & Community Health*. 2001; 55:111–122. [PubMed: 11154250]
- Rosenblum M, Van Der Laan MJ. Using Regression Models to Analyze Randomized Trials: Asymptotically Valid Hypothesis Tests Despite Incorrectly Specified Models. *Biometrics*. 2009; 65:937–945. [PubMed: 19210739]
- Rosenfield, S. Gender and mental health, do women have more psychopathology, men more, or both the same (and why)?. In: Horwitz, AV.; Scheid, TL., editors. *A handbook for the study of mental health, social contexts, theories, and systems*. Cambridge university press; Cambridge: 1999. p. 348–360.
- Sampson RJ, Morenoff JD, Gannon-Rowley T. Assessing “Neighborhood Effects”: Social Processes and New Directions in Research. *Annual Review of Sociology*. 2002; 28:443–478.
- Sanbonmatsu L, Kling JR, Duncan GJ, Brooks-Gunn J. Neighborhoods and Academic Achievement: Results from the Moving to Opportunity Experiment. *The Journal of Human Resources*. 2006; 41:649–691.
- Sanbonmatsu, L.; Ludwig, J.; Katz, LF.; Gennetian, LA.; Duncan, GJ.; Kessler, RC.; Adam, E.; McDade, TW.; Lindau, ST. Moving to Opportunity for Fair Housing Demonstration Program Final Impacts Evaluation. U.S. Department of Housing and Urban Development Office of Policy and Development and Research; 2011.
- Sanbonmatsu L, Marvokov J, Porter N, Yang F, Adam E, Congdon WJ, Duncan GJ, Gennetian LA, Katz LF, Kling JR, Kessler RC, Lindau ST, Ludwig J, McDade TW. The Long-Term Effects of Moving to Opportunity on Adult Health and Economic Self-Sufficiency. *Citiescape*. 2012; 14:109–136.
- Schwartz S, Meyer IH. Mental health disparities research: The impact of within and between group analyses on tests of social stress hypotheses. *Social Science & Medicine*. 2010; 70:1111–1118. [PubMed: 20100631]
- Shroder M. Locational Constraint, Housing Counseling, and Successful Lease-up in a Randomized Housing Voucher Experiment. *Journal of Urban Economics*. 2002; 51:315–338.
- Simmons RG, Burgeson R, Carlton-Ford S, Blyth DA. The Impact of Cumulative Change in Early Adolescence. *Child Development*. 1987; 58:1220–1234. [PubMed: 3665641]
- South SJ, Crowder KD. Leaving the ‘Hood: Residential Mobility between Black, White, and Integrated Neighborhoods. *American Sociological Review*. 1998; 63:17–26.
- Straits BC. Residence, Migration, and School Progress. *Sociology of Education*. 1987; 60:34–43.
- Tucker CJ, Marx J, Long L. “Moving On”: Residential Mobility and Children’s School Lives. *Sociology of Education*. 1998; 71:111–129.

- U.S. Department of Housing and Urban Development. Expanding Housing Choices For HUD-Assisted Families: Moving to Opportunity. First Biennial Report to Congress, Moving to Opportunity for Fair Housing Demonstration Program. 1996
- U.S. Department of Housing and Urban Development. Housing Choice Vouchers Fact Sheet. 2012.
- Weisz JR, Weiss B, Han SS, Granger DA, Morton T. Effects of Psychotherapy with Children and Adolescents Revisited: A Meta-Analysis of Treatment Outcome Studies. *Psychological Bulletin*. 1995; 117:450–468. [PubMed: 7777649]
- Zill, N. Behavior Problems Index Based on Parent-Report. Child Trends; Washington, DC: 1990.

Highlights

- Although heterogeneous health effects for the Moving to Opportunity (MTO) Experiment have been identified by age and gender, little is known about differences in treatment effects by other characteristics.
- The effects of MTO on psychological distress and externalizing behavioral problems did not vary across indicators of family socioeconomic status, for either boys or girls.
- In the population of disadvantaged families in public housing, tailoring neighborhood mobility interventions by family socioeconomic status may not be necessary to alter the program's impact on youth mental health.
- However, because parental enrollment in school and teen parent status adversely modified MTO, post-move services accompanying neighborhood relocation that increase guidance and supervision of adolescents may help support post-move adjustment.

Figure 1. Adherence-adjusted (TOT) Treatment Effects by Parent In-School Status
 Estimates were derived using Instrumental Variables analysis with two-stage least squares regression; gender stratified models (1426 girls, 1403 boys). **P-value < 0.01; * P-value < 0.05; † P-value < 0.10

Table 1

Moving to Opportunity Youth, Baseline Variables, Overall and by Treatment Group.

Construct	Variable	Overall	Treatment Group	
			Treatment Group	Controls
Total in Interim Survey in 2002	N	2829	1950	879
Baseline mean poverty rate	Percent poverty rate in the 1990 census tract	49.8%	49.5%	50.5%
Interim follow-up mean poverty rate	Percent poverty rate in the 1990 census tract	34.0%	31.7%	39.2%
Site ^b	Baltimore	15.5%	16.0%	14.2%
	Boston	18.9%	18.1%	20.7%
	Chicago	22.4%	23.3%	20.4%
	Los Angeles	18.6%	17.5%	21.2%
	New York	24.6%	25.1%	23.5%
Youth Characteristics				
Age (in years) ^b		9.94	9.96	9.88
Gender ^b	Male	49.9%	49.5%	51.0%
	Female	50.1%	50.5%	49.0%
Race/ethnicity ^b	African American	62.8%	63.2%	62.1%
	Hispanic ethnicity, any race	30.0%	30.3%	29.5%
	White	1.1%	1.0%	1.2%
	Other race	2.2%	2.4%	1.9%
	Missing race	3.8%	3.2%	5.3%
Gifted ^b	Special class for gifted students or did advanced work	15.4%	14.7%	16.8%
Developmental Problems	School asked to talk about problems child having with schoolwork or behavior in past 2 years ^b	26.3%	26.7%	25.4%
Family/Household Head Characteristics				
Family Structure	Never married ^b	55.9%	55.2%	57.5%
	Teen parent	25.9%	26.4%	25.0%
Household size	2 people	7.3%	6.9%	8.3%
	3 people	22.3%	22.1%	22.9%
	4 people	25.4%	26.2%	23.4%
	5 or more people	45.0%	44.8%	45.4%
Socioeconomic Status	Employed ^b	25.8%	26.1%	25.3%
	On AFDC (welfare)	76.0%	75.5%	76.9%
Education ^b	Less than high school	47.1%	47.2%	46.7%
	High school diploma	36.2%	36.6%	35.3%
	GED	16.7%	16.1%	17.9%
	In School	13.9%	14.4%	12.6%
Owned car		19.1%	19.2%	18.9%
Neighborhood/Mobility Variables ^b	Lived in neighborhood 5 or more years	65.7%	65.8%	65.5%
	No family living in neigh	64.1%	63.1%	66.3%
	No friends living in neigh	37.3%	36.8%	38.5%
	Had applied for section 8 voucher before	44.3%	43.6%	45.8%

Construct	Variable	Overall	Treatment Group	
			Treatment Group	Controls
Neighbor Relationships ^b	Chats with neighbors at least once a week	51.9%	51.3%	53.2%
	Respondent very likely to tell neighbor if saw neighbor's child getting into trouble	56.7%	56.8%	56.4%

*
p<.05

NOTE: All variables range between 0 & 1 except baseline age (5–16) and mean poverty rate, so means represent proportions. Analysis weighted for varying treatment random assignment ratios across time, and for attrition. Test of treatment group differences calculated from Wald chi-square tests outputted from logistic regression for dichotomous baseline characteristics and multinomial logistic regression for categorical characteristics. F-tests were used with linear regression for continuous variables. All tests were adjusted for clustering at the family level; the null hypothesis was that none of the 3 treatment group proportions or means differed. Treatment group proportions differed significantly at p<.05 only for special school/class/help for behavioral/emotional problems

^aP-value from chi-square test for all variables except age, which was tested by ANOVA; the null hypothesis as that the treatment and control group proportions or means differed.

^bUsed as a covariate in regression analyses. Missing baseline covariate data were imputed to site specific means (<5% missing)⁷ or modeled with missing indicators (7% missing for gifted and parent education).

Table 2

Modification of Treatment Effects for Psychological Distress and Behavior Problems Index among Adolescents Aged 12–19; Gender-stratified ITT Models, 2002 MTO Interim Survey

Panel A: Females (n=1426)										
Psychological Distress					Behavior Problems Index					
OLS beta coefficients					OLS beta coefficient					
Treatment Modifiers ^a	Modifier		Treatment*modifier		Modifier		Treatment*modifier		Treatment*modifier	
	B (95% CI)	P-value	B (95% CI)	P-value	B (95% CI)	P-value	B (95% CI)	P-value	B (95% CI)	P-value
<i>Parent/family characteristics</i>										
Low parental education	0.01 (−0.19, 0.21)	0.94	0.03 (−0.21, 0.26)	0.83	−0.10 (−0.29, 0.10)	0.34	0.13 (−0.10, 0.35)	0.27		
Unemployed	0.12 (−0.11, 0.35)	0.30	−0.08 (−0.36, 0.19)	0.55	0.20 (−0.02, 0.43)	0.08	−0.08 (−0.34, 0.19)	0.56		
Receiving AFDC/TANF	0.11 (−0.12, 0.34)	0.35	−0.07 (−0.35, 0.20)	0.61	0.11 (−0.11, 0.32)	0.33	0.00 (−0.25, 0.26)	0.98		
In School	−0.43 (−0.71, −0.16)	0.002	0.37 (0.02, 0.71)	0.04	−0.29 (−0.62, 0.04)	0.09	0.24 (−0.15, 0.62)	0.23		
Owned car	−0.15 (−0.38, 0.09)	0.23	0.18 (−0.10, 0.46)	0.22	−0.18 (−0.40, 0.04)	0.11	0.23 (−0.03, 0.49)	0.08		
Family size = 2	0.08 (−0.22, 0.38)	0.61	−0.08 (−0.46, 0.29)	0.67	0.02 (−0.26, 0.30)	0.88	−0.07 (−0.42, 0.27)	0.67		
Family size = 3	0.06 (−0.13, 0.25)	0.53	−0.05 (−0.29, 0.19)	0.67	−0.08 (−0.28, 0.11)	0.40	0.05 (−0.18, 0.28)	0.66		
Never married	0.13 (−0.07, 0.33)	0.21	0.01 (−0.23, 0.25)	0.96	0.10 (−0.10, 0.30)	0.32	0.03 (−0.20, 0.26)	0.80		
Teen parent	−0.06 (−0.30, 0.18)	0.64	0.02 (−0.28, 0.31)	0.91	−0.29 (−0.52, −0.07)	0.01	0.29 (0.03, 0.55)	0.03		
Panel B: Males (n=1403)										
Psychological Distress					Behavior Problems Index					
OLS beta coefficients					OLS beta coefficient					
Treatment Modifiers ^a	Modifier		Treatment*modifier		Modifier		Treatment*modifier		Treatment*modifier	
	B (95% CI)	P-value	B (95% CI)	P-value	B (95% CI)	P-value	B (95% CI)	P-value	B (95% CI)	P-value
<i>Parent/family characteristics</i>										
Low parental education	0.09 (−0.11, 0.29)	0.39	−0.15 (−0.40, 0.10)	0.24	0.04 (−0.15, 0.24)	0.67	−0.13 (−0.36, 0.10)	0.28		
Unemployed	0.21 (0.00, 0.42)	0.05	0.00 (−0.26, 0.26)	0.99	0.25 (0.04, 0.46)	0.02	−0.18 (−0.43, 0.07)	0.16		
Receiving AFDC/TANF	−0.09 (−0.32, 0.14)	0.44	0.07 (−0.20, 0.34)	0.59	−0.04 (−0.28, 0.19)	0.72	0.08 (−0.19, 0.35)	0.57		
In School	−0.02 (−0.34, 0.30)	0.89	0.09 (−0.29, 0.47)	0.64	−0.41 (−0.67, −0.15)	0.002	0.26 (−0.08, 0.60)	0.14		
Owned car	−0.17 (−0.44, 0.11)	0.23	0.19 (−0.13, 0.51)	0.24	0.02 (−0.24, 0.29)	0.867	−0.02 (−0.32, 0.27)	0.88		

Panel A: Females (n=1426)									
Treatment Modifiers ^a	Psychological Distress					Behavior Problems Index			
	OLS beta coefficients					OLS beta coefficient			
	Modifier	Treatment*modifier			Modifier	Treatment*modifier			
	B (95% CI)	P-value	B (95% CI)	P-value	B (95% CI)	P-value	B (95% CI)	P-value	P-value
<i>Parent/family characteristics</i>									
Family size = 2	-0.19 (-0.51, 0.12)	0.22	0.05 (-0.34, 0.44)	0.80	-0.19 (-0.46, 0.09)	0.18	0.00 (-0.39, 0.40)	1.00	
Family size = 3	0.09 (-0.13, 0.30)	0.43	-0.02 (-0.29, 0.24)	0.85	-0.08 (-0.28, 0.13)	0.45	0.07 (-0.18, 0.32)	0.56	
Never married	0.06 (-0.14, 0.26)	0.54	-0.03 (-0.27, 0.22)	0.82	0.02 (-0.18, 0.22)	0.82	0.03 (-0.21, 0.27)	0.80	
Teen parent	0.21 (-0.04, 0.45)	0.10	-0.05 (-0.36, 0.25)	0.73	0.05 (-0.16, 0.26)	0.66	0.05 (-0.20, 0.31)	0.69	

^a All modifiers are dichotomous (Yes, No)

^b Gender-stratified treatment effects estimated in linear regression models controlling for treatment, modifier, treatment*modifier interaction, age, race, giftedness, and schoolwork or behavior problems; household head marital status, employment, education, tenure in neighborhood, relationships with baseline neighbors, presence of family/friends in baseline neighborhood, and prior application for section 8

Table 3

Subgroup-specific Treatment Effects for Psychological Distress and Behavior Problems Index among adolescents aged 12–19 years, 2002 MTO Interim Survey

Treatment Modifiers ^a	Panel A: Females (n=1426)			
	Psychological distress		Behavior Problems Index	
	Modifier = No	Modifier = Yes	Modifier = No	Modifier = Yes
	ITT Treatment effects (95% CI) ^b	ITT Treatment effects (95% CI) ^b	ITT Treatment effects (95% CI) ^b	ITT Treatment effects (95% CI) ^b
<i>Parent/family characteristics</i>				
Low parental education	−0.13 (−0.30, 0.03)	−0.11 (−0.28, 0.06)	−0.10 (−0.27, 0.07)	0.03 (−0.13, 0.18)
Unemployed	−0.05 (−0.29, 0.19)	−0.14 (−0.27, 0.00) [*]	0.03 (−0.20, 0.25)	−0.05 (−0.19, 0.08)
Receiving AFDC/TANF	−0.06 (−0.30, 0.18)	−0.13 (−0.27, 0.00) [†]	−0.03 (−0.25, 0.19)	−0.03 (−0.16, 0.11)
In School	−0.17 (−0.30, −0.04) [*]	0.20 (−0.12, 0.52)	−0.06 (−0.19, 0.06)	0.17 (−0.19, 0.53)
Owned car	−0.15 (−0.28, −0.02) [*]	0.03 (−0.22, 0.27)	−0.08 (−0.21, 0.06)	0.16 (−0.07, 0.38)
Family size = 2	−0.11 (−0.23, 0.02)	−0.19 (−0.54, 0.17)	−0.02 (−0.15, 0.10)	−0.10 (−0.42, 0.22)
Family size = 3	−0.10 (−0.24, 0.04)	−0.15 (−0.35, 0.04)	−0.04 (−0.18, 0.10)	0.01 (−0.17, 0.19)
Never married	−0.12 (−0.30, 0.06)	−0.11 (−0.27, 0.05)	−0.05 (−0.22, 0.12)	−0.02 (−0.18, 0.14)
Teen parent	−0.12 (−0.25, 0.02) [†]	−0.10 (−0.36, 0.16)	−0.10 (−0.23, 0.04)	0.19 (−0.03, 0.41) [†]
Panel B: Males (n=1403)				
Treatment Modifiers ^a	Psychological distress		Behavior Problems Index	
	Modifier = No	Modifier = Yes	Modifier = No	Modifier = Yes
	ITT Treatment effects (95% CI) ^b	ITT Treatment effects (95% CI) ^b	ITT Treatment effects (95% CI) ^b	ITT Treatment effects (95% CI) ^b
	ITT Treatment effects (95% CI) ^b	ITT Treatment effects (95% CI) ^b	ITT Treatment effects (95% CI) ^b	ITT Treatment effects (95% CI) ^b
<i>Parent/family characteristics</i>				
Low parental education	0.22 (0.04, 0.39) [*]	0.07 (−0.11, 0.24)	0.25 (0.08, 0.41) ^{**}	0.12 (−0.05, 0.29)
Unemployed	0.15 (−0.06, 0.35)	0.14 (−0.01, 0.30) [†]	0.31 (0.10, 0.52) ^{**}	0.13 (−0.01, 0.27) [†]
Receiving AFDC/TANF	0.09 (−0.14, 0.31)	0.16 (0.01, 0.31) [*]	0.12 (−0.11, 0.36)	0.20 (0.07, 0.34) ^{**}
In School	0.13 (0.00, 0.27) [†]	0.22 (−0.13, 0.58)	0.15 (0.02, 0.28) [*]	0.41 (0.10, 0.72) [*]
Owned car	0.11 (−0.03, 0.25)	0.30 (0.01, 0.59) [*]	0.19 (0.05, 0.32) ^{**}	0.16 (−0.10, 0.42)
Family size = 2	0.14 (0.01, 0.27) [*]	0.19 (−0.18, 0.56)	0.18 (0.06, 0.30) ^{**}	0.18 (−0.19, 0.55)
Family size = 3	0.15 (0.00, 0.30) [*]	0.12 (−0.09, 0.34)	0.17 (0.03, 0.30) [*]	0.24 (0.03, 0.45) [*]
Never married	0.16 (−0.02, 0.34) [†]	0.13 (−0.04, 0.30)	0.16 (−0.02, 0.35) [†]	0.20 (0.04, 0.35) [*]
Teen parent	0.16 (0.02, 0.30) [*]	0.11 (−0.16, 0.37)	0.17 (0.03, 0.31) [*]	0.22 (0.01, 0.44) [*]

^{**} P-value < 0.01;

^{*} P-value < 0.05;

[†] P-value < 0.10

^a All modifiers are dichotomous (Yes, No)

^b Gender-stratified treatment effects estimated in linear regression models controlling for treatment, modifier, treatment*modifier interaction, age, race, giftedness, and schoolwork or behavior problems; household head marital status, employment, education, tenure in neighborhood, relationships with baseline neighbors, presence of family/friends in baseline neighborhood, and prior application for section 8