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Associations of housing mobility interventions for children in high poverty neighborhoods with subsequent mental disorders during adolescence

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Abstract

Importance—Youth in poor neighborhoods have high emotional problem rates. Understanding neighborhood influences on these rates is crucial for designing neighborhood-level interventions.

Objective—To do exploratory analysis of associations between housing mobility interventions for children in high-poverty neighborhoods and subsequent mental disorders during adolescence.

Design, Setting, and Participants—The Moving to Opportunity (MTO) demonstration in 1994-1998 randomized 4,604 volunteer public housing families with children in high-poverty neighborhoods into Low-poverty voucher (LPV) or Traditional voucher (TRV) interventions to encourage moving to lower-poverty neighborhoods or a Control group. An evaluation 10-15 years later (June 2008-April 2010) interviewed (blinded to assignment) participants aged 0-8 at randomization and 13-19 at follow-up. Response rates were 86.9-92.9%.

Interventions—LPV (n=1,430) received vouchers to move to low-poverty neighborhoods with enhanced mobility counseling. TRV (n=1,081) received geographically unrestricted vouchers. Controls (n=1,178) received no intervention.

Main Outcomes and Measures—Twelve-month DSM-IV major depressive, panic, post-traumatic stress (PTSD), oppositional-defiant, intermittent explosive, and conduct disorders assessed *post hoc* with a validated research diagnostic interview.

Results—3,689 children were randomized and 2,872 interviewed (1,407 boys, median age 16 range: 13-19; 1,465 girls, median age 16, range 13-19). Boys had significantly *elevated* rates of major depression in LPV (7.1% [95% CI, 4.1-10.1%]; OR, 2.2 [95% CI, 1.2-3.9]) versus Controls (3.5% [95% CI, 2.3-4.6%]), PTSD in LPV (6.2% [95% CI, 4.7-7.7%]; OR, 3.4 [95% CI, 1.6-7.4]) and TRV (4.9% [95% CI, 3.0-6.8%]; OR, 2.7 [95% CI, 1.2-5.8]) versus Controls (1.9% [95% CI, 0.9-2.9%]), and conduct disorder in LPV (6.4% [95% CI, 4.7-8.1%]; OR, 3.1 [95% CI, 1.7-5.8]) versus Controls (2.1% [95% CI, 1.1-3.2%]). TRV girls had *reduced* rates of major depression (6.5% [95% CI, 4.5-8.4%]; OR, 0.6 [95% CI, 0.3-0.9]) versus Controls (10.9% [95% CI, 8.4-13.4%]) and conduct disorder (0.3% [95% CI, 0.0-0.7%]; OR, 0.1 [95% CI, 0.0-0.4]) versus Controls (2.9% [95% CI, 1.1-4.7%]).

Conclusions and Relevance—Interventions to encourage moving from high-poverty neighborhoods were associated with elevated depression, PTSD, and conduct disorder among boys and reduced depression and conduct disorder among girls. Better understanding of interactions

among individual, family, and neighborhood risk factors is needed to guide future public housing policy changes.

Observational studies consistently find youth in poor neighborhoods have high rates of emotional problems even after controlling individual-level risk factors,¹ raising the possibilities that neighborhood characteristics affect emotional functioning² and that neighborhood-level interventions might reduce these problems. Available data are unclear on these possibilities, though, because observational studies are subject to selection bias (i.e., families with emotional problems selecting into poorer neighborhoods). Despite this uncertainty, available data have been presumptively characterized as documenting neighborhood *effects*,³ causal pathways have been hypothesized,⁴ and interventions have been implemented.⁵

It is important to evaluate causal claims regarding neighborhood effects experimentally. The U.S. Department of Housing and Urban Development (HUD) attempted to do this in a housing-mobility experiment known as the Moving to Opportunity for Fair Housing Demonstration (MTO) in 1994-1998 by randomizing volunteer low-income public housing families with children to receive vouchers to move to lower-poverty neighborhoods.^{6,7} An interim evaluation 4-7 years after randomization showed that the intervention caused families to move to better neighborhoods (e.g., lower poverty and crime rates, social ties with more affluent people).⁸ Significant reductions in psychological distress and depression were also found among intervention versus control adolescent girls but increased behavior problems were found among intervention versus control adolescent boys.⁹⁻¹¹ Given the importance of these sex differences, clinically significant mental disorders were included in a long-term (10-15 years after randomization) evaluation survey. We present here the first data regarding associations of MTO randomization with these disorders among adolescents. Prior long-term evaluation reports documented effects on improved neighborhood characteristics,^{12,13} reduced adult extreme obesity and diabetes,¹⁴ and improved adult subjective well-being.¹³ The long-term evaluation found significantly reduced psychological distress among female youth,¹⁵ but measures of mental disorders were not examined in previous reports. The intervention had no detectable effects on economic self-sufficiency.¹³

Methods

Objectives

The primary MTO objectives were to move families to lower-poverty neighborhoods and increase educational achievement and economic self-sufficiency. Mental disorders were *post hoc* outcomes. The current report presents exploratory analyses evaluating long-term associations of intervention randomization with 12-month mental disorders among participants who were in early childhood (ages 0-8) at randomization and adolescence (ages 13-19) at long-term follow-up (June 2008-April 2010).

Study Design

MTO families (n= 4,604) were recruited by public housing authorities in 1994-1998 for a randomized rent-subsidy voucher lottery.¹⁶ Volunteer families were assigned an identification number and randomized using a computerized random-number generator.

Families had to reside in public or project-based assisted housing in high-poverty census tracts (>40% families in poverty) in Baltimore, Boston, Chicago, Los Angeles, or New York; be eligible for Section 8 housing; and have 1+ children age <18. Housing authorities sent recruitment letters, held information sessions, and asked families to complete pre-applications within a short recruitment time window (within 4 weeks of invitation). Signed consents and baseline questionnaires were obtained in intake sessions prior to randomization. Families were then randomized into 1 of 3 groups. In the *Low-poverty voucher group*, families were offered a standard rent-subsidy voucher but with the restriction on use to low-poverty census tracts (<10% residents poor in 1990). Census tracts contain 2,500-8,000 people and are defined by the Census Bureau to be “homogeneous with respect to population characteristics, economic status, and living conditions.”¹⁷ Vouchers provided subsidies for private-market housing equal to the difference between a rent threshold and the family's rent contribution (30% of income, identical to public housing).¹⁸ Families remained eligible for vouchers so long as they met income and other criteria. Families also received short-term housing counseling for their initial housing search.^{6,7} After 1 year, families in the Low-poverty voucher intervention group could use their voucher to relocate to a different tract, including those with higher poverty rates, or could remain in the tract where they originally moved even if the poverty rate of that tract fell out of the “low-poverty” range. In the *Traditional voucher group*, families were offered a standard rent-subsidy voucher without restriction on location and standard mobility counseling.^{6,7} In the *Control group*, families were offered no new assistance. Enhanced mobility counseling was offered to Low-poverty voucher group families because of restrictions on where they could move. The protocol was approved by the Office of Management and Budget and HUD. Twenty-three percent of invited families applied.⁶ Forty-eight percent of Low-poverty and 63% of Traditional voucher group families used their vouchers to move.⁷

Interim (4-7 years after randomization) and long-term (10-15 years after randomization) evaluation surveys were carried out with baseline household heads and residents who were children at baseline randomization and adolescents at follow-up. Most interim evaluation adolescents were in middle childhood or early adolescence (ages 9-16) at randomization. The 3,689 long-term evaluation adolescents, in comparison, were ages 0-8 at randomization. Long-term evaluation adolescents were selected December, 2007 and interviewed June 2008-April 2010. Interviewers were blinded to group assignment. We targeted 3,501 of the 3,689 long-term evaluation adolescents for interview, including all those from households with 1-3 baseline children and 3 randomly selected adolescents from households with 4+ baseline children (median number of children in these households 1; Range 1-5). Large households were under-sampled to reduce household burden.

Long-term recruitment began with telephone contacts followed by online tracking and telephone networking to locate hard-to-recruit cases. Potential respondents were offered \$50 for completing interviews. Although most interviews were face-to-face, some were by telephone for logistical reasons. A random 35% of hard-to-recruit non-respondents were selected near the ending of fieldwork for final intensive recruitment with increased financial incentives.^{19(P64)} Written informed parent consent and adolescent assent were obtained

before interviews. These procedures were approved by the Office of Management and Budget, HUD, and the Institutional Review Boards of the National Bureau of Economic Research, University of Chicago, University of Michigan, and Northwestern University.

Measures

Baseline household head questionnaires focused largely on socio-demographics and neighborhood experiences (e.g., social networks, crime victimization). Mental disorders were not assessed (either for heads or for children). Item-level missing data on the variables assessed was <5% for all but 5 variables (youth low birth weight; hospitalization before first birthday; baseline health problems that restricted normal activities; parent education; whether someone read to the child more than once daily during his/her early childhood; 5.5-11.2% missing). Item-level missing data were imputed using the multiple imputation (MI) method²⁰ and 20 MI pseudo-samples. The MI imputations were generated using SAS.²¹ There were no missing values on the intervention variable.

The long-term evaluation interview included the Composite International Diagnostic Interview (CIDI),²² a widely-used psychiatric diagnostic evaluation known to have good concordance with blinded clinical diagnoses of the disorders considered here.²³ Diagnoses were made for DSM-IV disorders present in the 12 months before interview. CIDI questions were read word-for-word and responses recorded in pre-specified (mostly yes-no) format. Diagnoses were generated by CIDI algorithms operationalizing DSM-IV inclusion criteria. Item-level missing data were <1% for each symptom question and were recoded conservatively to assume the symptom was absent. We focused on 6 DSM-IV/CIDI mood (major depression), anxiety (panic, post-traumatic stress [PTSD]), and disruptive behavior (oppositional-defiant, intermittent explosive, conduct) disorders. Bipolar disorder was also assessed, but was not analyzed due to low prevalence and insufficient statistical power to detect meaningful associations with the individual interventions. (eTable 1 available at <http://www.jama.com>.)

Statistical Analysis

HUD determined sample size based on MTO budget (\$70 million Congressional authorization, additional vouchers from local housing authorities, and nonprofit agencies donating counseling). Randomization was designed to yield equal numbers of families within cities using vouchers in each Intervention group. The number of Control group families invited was set to equal the mean number invited in the 2 Intervention groups. As voucher use percentages were determined only after randomization, proportions randomized across groups were modified during the study to adjust for observed rates of voucher use. HUD determined that this design would yield 0.80 power to detect intervention effects of \$2,000 increased earnings in each intervention group with .05-level 1-sided tests.^{6(pE-4, Exhibit E4)} *Post hoc* power calculations showed that the long-term adolescent sample had at least 0.80 power to detect odds-ratios (ORs) of each of the 2 interventions with each of the 6 disorders considered here of 1.4-1.8 for boys and girls combined. (eTable 1 available at <http://www.jama.com>.)

Intention-to-treat²⁴ logistic regression analysis²⁵ was used to estimate associations of the Interventions with the outcomes. A weight corrected for across-time variation (the random assignment period was from 1994-1998) in Intervention-versus-Control group selection ratios. Case-level MI based on 20 pseudo-samples was used to adjust for the fact that not all baseline participants completed follow-up interviews. The Taylor series method²⁶ implemented in SUDAAN²⁷ was used to adjust for weighting and clustering (cities, housing projects, families). The significance of sex differences was assessed by estimating a logistic regression equation to predict each disorder that included dummy variables for each intervention, a dummy variable for sex, and 2 dummy variables for the interactions of interventions with sex. A 2 degree of freedom χ^2 test was used to evaluate the significance of the interactions. In cases where the test was significant, associations of the interventions with the disorder were considered separately for boys and girls. The evaluation of sex differences was carried out because significant sex differences had been found in previous interim evaluations⁹⁻¹¹ and because a qualitative component of the interim evaluation found that low income girls were more likely than boys to profit from the intervention due to differences both in neighborhood experiences and in social skills needed to capitalize on the opportunities created by moving to a better neighborhood.²⁸⁻³⁰ The 6 mental disorders were considered separately based on evidence that risk factors vary across these disorders.^{31,32} The Benjamini-Hochberg method³³ implemented in SAS²¹ was used to adjust significance tests across outcomes for the false discovery rate (FDR).

Logistic regression coefficients and standard errors were exponentiated to create ORs and 95% confidence intervals. Mental disorder prevalence estimates in intervention and control groups were used to calculate absolute risk (AR) and absolute risk reduction (ARR). The jack-knife repeated replications method²⁶ implemented in SAS²¹ was used to generate confidence intervals for the estimates of AR and ARR. Statistical significance was consistently evaluated using .05 level 2-sided tests.

Results

Response Rates

The 3,689 long-term evaluation adolescents were ages 0-8 (median age 4) at baseline and ages 13-19 (median age 16) at the time of the long-term follow-up interviews. A total of 2,872 adolescents were interviewed (1,407 boys and 1,465 girls from 2,134 families; including 1,165 in the Low-poverty voucher intervention group [843 families], 799 in the Traditional voucher intervention group [615 families], and 908 in the Control group [676 families]) from the 3,689 eligible in the baseline sample (a 77.8% participation rate). An additional 643 adolescents were randomly selected for exclusion (188 in families with 4+ eligible respondents; 455 hard-to-recruit) and 174 lost to follow-up (including 18 known to be deceased). (Figure) The weighted response rates were 92.9% (Low-poverty voucher group), 86.9% (Traditional voucher group), and 89.4% (Control group) using the American Association of Public Opinion Research RR1w definition.^{34(P51)} Respondents were more likely to be girls (50.4% [95% CI, 48.3-52.6%] respondents; 38.4% [95% CI, 29.4-47.1%] non-respondents) and Non-Hispanic Black (64.5% [95% CI, 55.9-73.1%] respondents; 51.8% [95% CI, 42.4-61.3%] non-respondents) but did not differ significantly from non-

respondents on numerous other baseline personal, family, and neighborhood characteristics. (eTable 2 available at <http://www.jama.com>.) 22.2% of baseline participants did not complete follow-up interviews. The 18 baseline participants known to be deceased (6 in the Low-poverty voucher group, 7 in the Traditional voucher group, and 5 in the Control group) were excluded from the analysis sample and MI was used to generate 20 pseudo-samples from the remaining 3,671 long-term evaluation adolescent participants (1,424 in the Low-poverty voucher group, 1,074 in the Traditional voucher group, and 1,173 in the Control group). These MI samples were the basis of the analyses reported below.

Sample Characteristics

Baseline socio-demographic characteristics of adolescents were largely comparable across the Low-poverty voucher, Traditional voucher, and Control groups for both boys (Table 1) and girls (Table 2). Most respondents were Non-Hispanic Black (61.8-66.2%) or Hispanic (27.7-33.2%). The vast majority of respondents were ages 0-5 years of age at baseline (82.2-87.9%), with mean age of 3.6 in each group and range of 0-7 in the Low-poverty voucher group, 0-8 in Traditional voucher and Control groups. The vast majority of baseline families received Aid to Families with Dependent Children (79.1-85.1%). Mean baseline neighborhood poverty rates were 53.6-54.9%.

Twelve-month Mental Disorder Prevalence

The most prevalent 12-month mental disorders were intermittent explosive disorder (14.2-16.0% prevalence among boys and girls, respectively) and oppositional-defiant disorder (6.8-8.4%) followed by major depressive disorder (5.5-7.9%), PTSD (4.4-6.6%), conduct disorder (4.3-1.6%), and panic disorder (4.1-3.7%). (eTable 3 available at <http://www.jama.com>.)

Associations of Interventions with DSM-IV/CIDI Disorders for Boys and Girls Combined

Adjusting for FDR, respondents in the Low-poverty voucher group had significantly *elevated* prevalence of PTSD (7.2% [95% CI, 5.7-8.6%]; OR, 1.8 [95% CI, 1.2-2.7]) compared to the Control group (4.2% [95% CI, 3.2-5.2%]). (Table 3) None of the other 11 comparisons of Low-poverty or Traditional voucher groups with the Control group was significant. ORs comparing the Low-poverty voucher group with the Control group were in the range 0.7-1.6 ($P=0.13-0.84$). ORs comparing the Traditional voucher group with the Control group were in the range 0.9-1.1 ($P=0.70$).

The ORs comparing the Low-poverty and Traditional voucher groups with the Control group varied significantly by respondent sex for 3 of the 6 outcomes after adjusting for FDR: major depression ($\chi^2_2=14.1$, $P=0.007$), PTSD ($\chi^2_2=9.0$, $P=0.028$), and conduct disorder ($\chi^2_2=11.7$, $P=0.011$). Sex differences in these ORs were not significant, in comparison, for panic disorder ($\chi^2_2=6.2$, $P=0.08$), oppositional-defiant disorder ($\chi^2_2=4.4$, $P=0.16$), or intermittent explosive disorder ($\chi^2_2=1.3$, $P=0.60$). Based on these results, the remaining analyses focused on major depression, PTSD, and conduct disorder separately for boys and girls.

Associations of Interventions with DSM-IV/CIDI Disorders Among Boys

Adjusting for FDR, boys had significantly *elevated* rates of major depression in the Low-poverty voucher group (7.1% [95% CI, 4.1-10.1%]; OR, 2.2 [95% CI, 1.2-3.9]) compared to the Control group (3.5% [95% CI, 2.3-4.6%]), of PTSD in both the Low-poverty voucher group (6.2% [95% CI, 4.7-7.7%]; OR, 3.4 [95% CI, 1.6-7.4]) and the Traditional voucher group (4.9% [95% CI, 3.0-6.8%]; OR, 2.7 [95% CI, 1.2-5.8]) compared to the Control Group (1.9% [95% CI, 0.9-2.9%]), and of conduct disorder in the Low-poverty voucher group (6.4% [95% CI, 4.7-8.1%]; OR, 3.1 [95% CI, 1.7-5.8]) compared to the Control group (2.1% [95% CI, 1.1-3.2%]).(Table 4) Neither of the other 2 comparisons between Intervention and Control groups was significant, with ORs in the range 1.7-2.0 ($P=0.23$).

Associations of Interventions with DSM-IV/CIDI Disorders Among Girls

Adjusting for FDR, girls in the Traditional voucher intervention group had significantly *reduced* rates of major depression (6.5% [95% CI, 4.5-8.4%]; OR, 0.6 [95% CI, 0.3-0.9]) compared to the Control group (10.9% [95% CI, 8.4-13.4%]) and of conduct disorder in the Traditional voucher group (0.3% [95% CI, 0.0-0.7%]; OR, 0.1 [95% CI, 0.0-0.4]) compared to the Control group (2.9% [95% CI, 1.1-4.7%]). (Table 4) Number needed to treat among girls (NNT=the inverse of ARR) was 23 for major depression and 38 for conduct disorder. None of the other 4 comparisons between Intervention and Control groups was significant, with ORs in the range 0.5-1.2 ($P=0.06-0.40$).

Comment

Our *post hoc* exploratory analysis found that interventions to encourage moving from high-poverty neighborhoods were associated with increased depression, PTSD and conduct disorder among adolescent boys and reduced depression and conduct disorder among adolescent girls who were randomized at ages 0-8. These sex differences were broadly consistent with interim MTO results,^{8,9,11} which qualitative evidence suggested were due to girls profiting more than boys from moving to better neighborhoods because of sex differences in both neighborhood experiences and in the social skills needed to capitalize on the new opportunities presented by their improved neighborhoods.²⁸⁻³⁰ The magnitudes of the protective associations of the interventions with 12-month DSM-IV/CIDI disorders among girls were modest in intention-to-treat comparisons (NNT=23-38), although these estimates would, of course, be larger if restricted to movers. It is noteworthy, though, that the ORs were comparable in size to those published in studies of risk factors considered to be of high policy significance in accounting for the outcomes considered here. For example, the elevated ORs of the MTO interventions with PTSD among boys were comparable to the ORs found between combat exposure and PTSD in epidemiological studies of the military,³⁵ while the reduced OR of the MTO interventions with major depression among girls was comparable to the inverse of the OR found in previous research between sexual assault and major depression in epidemiological studies of young women.³⁶ Furthermore, it is important to recognize that these associations were evaluated 10-15 years after randomization. It is not clear if the magnitudes of the associations were stable over this entire time period, but, if so, they would be substantial despite the relatively high levels of NNT. For example, ARR for

major depression among girls would be 58.3 person-years per 100 respondents over 15 years if ORs were temporally stable over that entire time period.

That only 23% of eligible families volunteered for MTO reduced external validity. However, it is important to recognize that the public housing population is large and that even this small fraction represents a very large number (over 300,000) of low-income U.S. children,³⁷ making the volunteer families significant from a policy perspective even though they are only a minority of all public housing families. A question might be raised in this regard whether the added costs of developing a special housing intervention for such a small proportion of public housing recipients could be justified by the small proportion accepting the offer, but this concern is mitigated by the fact that many housing economists believe the true costs of housing vouchers are actually lower than those of conventional public housing because of the greater efficiency of the open housing market.¹⁸

It is nonetheless difficult to draw policy implications from these results because of the finding that associations have different signs among boys and girls, suggesting that the interventions might have had harmful effects on boys but protective effects on girls. Future government decisions regarding widespread implementation of MTO-like changes in public housing policy will have to grapple with this complexity based on the realization that no policy decision will have benign effects on both boys and girls. The most realistic way to grapple with this complexity might be to attempt to develop more nuanced assignment rules than currently exist or additional intervention elements to mitigate the adverse effects of the intervention on boys while maintaining the protective effects on girls.

Development of such refinements would require a better understanding than we currently have of interacting influences among individual, family, and neighborhood characteristics in leading to child and adolescent mental disorders. While MTO was not designed to produce this kind of understanding, the results reported here should create an impetus to do so by documenting that neighborhoods matter. The challenge for future research is to increase understanding enough to guide allocation of the substantial amount of money spent on public housing in the U.S. each year (more than \$36 billion in fiscal year 2012³⁸) to maximize the health and well-being of all family members rather than to maximize value for some family members at the expense of other family members.

MTO had several strengths, including an experimental design, large sample size, and long (10-15 year) follow-up. It also had several noteworthy limitations: that only 23% of eligible families volunteered and that the experiment was implemented when unemployment was much lower than today,³⁹ both of which reduce generalizability of results;⁴⁰ that families offered vouchers had rather severe time limits on enrollment and practical constraints on finding new housing that might have artificially reduced uptake;⁴¹ that non-respondents might have differed systematically from respondents; that the CIDI and other mental health measures were not administered at baseline; and that, as with all policy experiments, the MTO design made it impossible to trace out intervening processes that account for aggregate intervention effects. In addition, MTO was under-powered to detect effects of the 2 separate intervention arms on uncommon adolescent mental disorders. Despite these limitations, we found significant associations of the MTO interventions to reduce neighborhood-level

poverty with several important adolescent mental disorders, providing rigorous evidence that experimental manipulation of incentives to move is associated with adolescent emotional functioning. However, as the interventions were also associated with changes in many other aspects of neighborhoods and participant experiences, pathways accounting for the associations of the interventions with adolescent mental disorders remain unclear, creating a challenge for future research to develop nuanced decision rules for matching public housing families with neighborhoods to maximize the health and well-being of all family members.

Conclusions

Interventions to encourage moving from high-poverty neighborhoods were associated with elevated major depression, PTSD, and conduct disorder among boys and reduced major depression and conduct disorder among girls. Better understanding of interactions among individual, family, and neighborhood risk factors is needed to guide future public housing policy changes in light of these sex differences.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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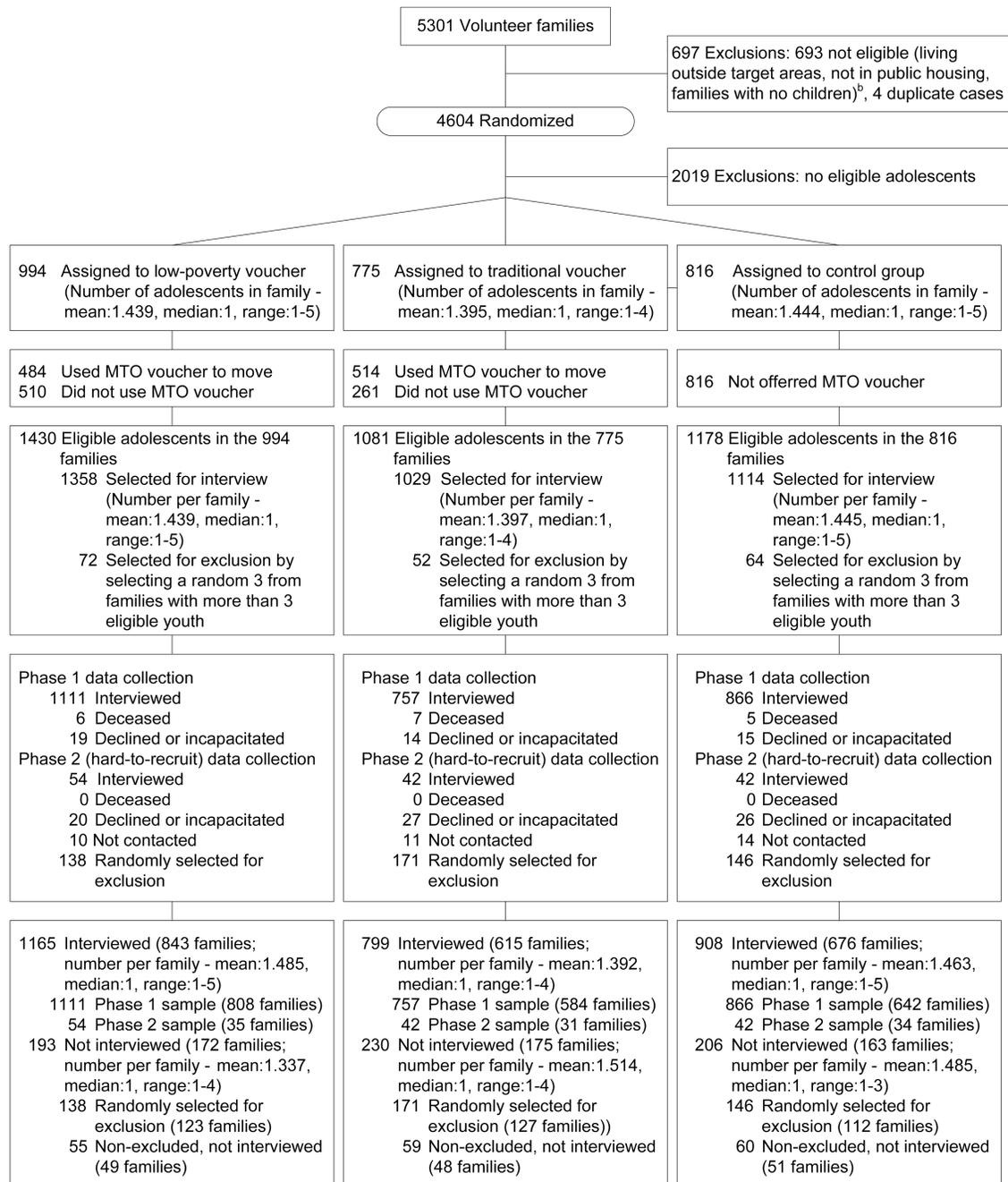


Figure. Study flow of the long-term MTO adolescent sample evaluation^a

^aTarget respondents for the adolescent long-term evaluation included all baseline residents of randomized MTO households who were ages 0-8 at randomization between 1994-1998, 13-17 at selection in December 2007, and 13-19 at interview between June 2008 and April 2010. All adolescents in the eligible age range who lived at baseline in households containing three or fewer youth ages 10 to 20 were targeted for follow-up, while a random three youth were targeted from baseline households with four or more youth. A weight of $n/3$, where n = the number of eligible youths in the baseline household, was used to adjust

for the under-sampling of youths from baseline households containing more than three eligible youth. The term “Phase 1” data collection refers to the efforts made to contact and interview all target respondents until the end of the field period, at which point a random 35% of target respondents who had not yet either been interviewed, were deceased, declined to participate, or were incapacitated (incarcerated or unable to be interviewed due to a barrier related to health or language) were selected for a more intensive “Phase 2” data collection effort that included expanded tracing efforts (e.g., using private investigators to trace target respondents who had not yet been located) and increased financial incentives to obtain interviews from hard-to-recruit youths. A weight of 1/.35 was used to adjust for the under-sampling of the hard-to-recruit youths who were interviewed.

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Table 1
Baseline characteristics of the MTO adolescent boy long-term evaluation sample in the Low-poverty voucher intervention group, the Traditional voucher intervention group, and the Control group^a

	Low-poverty Voucher Group (n=713)			Traditional Voucher Group (n=533)			Control Group (n=604)					
	n ^b	Est	(95% CI)	P value ^c	n ^b	Est	(95% CI)	P value ^c	n ^b	Est	(95% CI)	P value ^d
I. Respondent characteristics												
Age at baseline ^e												
0-5 (%)	602	82.2	(77.9-86.5)	0.72	421	82.9	(79.0-86.8)	0.99	502	83.0	(78.4-87.5)	0.81
Mean	--	3.6	(3.4-3.9)	0.82	--	3.6	(3.4-3.9)	0.95	--	3.6	(3.5-3.9)	0.91
Median (Range)	--	4.0	(0-7)	--	--	4.0	(0-8)	--	--	4.0	(0-8)	--
Required special medicine/equipment	69	9.8	(7.0-12.7)	0.97	64	11.2	(8.4-13.9)	0.40	57	9.7	(7.2-12.3)	0.68
Race/ethnicity (%)												
Hispanic (Any race)	184	27.7	(19.7-35.7)	0.34	178	30.3	(21.5-39.1)	0.83	197	31.0	(23.9-38.0)	0.45
White (Non-Hispanic)	14	2.0	(-0.2-4.1)	0.85	9	1.8	(-0.2-3.7)	0.97	12	1.8	(0.4-3.2)	0.90
African-American (Non-Hispanic)	483	66.2	(56.7-75.6)	0.59	322	63.3	(53.2-73.4)	0.99	372	64.3	(56.3-72.3)	0.83
Other race (Non-Hispanic)	31	4.2	(2.0-6.4)	0.26	23	4.6	(1.4-7.9)	0.18	21	3.0	(1.4-4.6)	0.17
II. Baseline characteristics of the sample adult												
High school diploma (% yes)	297	40.8	(36.9-44.8)	0.95	207	40.5	(34.3-46.6)	0.96	248	40.6	(35.6-45.7)	0.99
Currently in school (% yes)	111	15.5	(12.1-18.9)	0.15	102	18.3	(14.9-21.8)	0.98	108	18.4	(14.4-22.4)	0.37
Employed (% yes)	156	22.0	(17.6-26.3)	0.79	114	20.1	(15.5-24.7)	0.69	127	21.3	(16.8-25.7)	0.97
Never married (% yes)	485	67.4	(61.7-73.2)	0.40	354	67.6	(60.4-74.8)	0.46	416	70.4	(65.1-75.6)	0.38
Younger than 18 at birth of first child (% yes)	217	29.6	(24.1-35.1)	0.35	165	31.7	(25.5-37.8)	0.12	160	26.3	(20.1-32.5)	0.17
Single mother (% yes)	613	85.5	(81.2-89.8)	0.49	463	86.9	(82.2-91.6)	0.95	521	87.1	(83.7-90.4)	0.64
III. Baseline household characteristics												
Income (%)												
\$7,000	130	17.0	(11.5-22.6)	0.85	83	16.6	(10.1-23.2)	0.73	96	17.5	(11.1-24.0)	0.76
\$7,001-9,000	117	16.5	(12.3-20.6)	0.90	107	19.6	(15.5-23.8)	0.31	102	16.8	(13.2-20.4)	0.70
\$9,001-12,000	148	20.6	(16.3-24.9)	0.33	147	27.5	(20.9-34.1)	0.26	143	23.1	(18.9-27.4)	0.87
\$12,001-17,000	164	23.5	(19.0-28.0)	0.05	84	15.8	(11.7-19.8)	0.28	119	18.2	(14.2-22.1)	0.36
\$17,001+	152	22.4	(17.8-27.0)	0.43	109	20.5	(15.9-25.1)	0.20	142	24.3	(19.8-28.8)	0.21

	Low-poverty Voucher Group (n=713)			Traditional Voucher Group (n=533)			Control Group (n=604)					
	n ^b	Est	(95% CI)	P value ^c	n ^b	Est	(95% CI)	P value ^c	n ^b	Est	(95% CI)	P value ^d
Receives AFDC (% yes)	596	83.5	(79.8-87.3)	0.08	435	82.3	(77.5-87.1)	0.24	476	79.1	(74.8-83.5)	0.08
Household size (%)												
1-2	67	9.9	(6.9-13.0)	0.50	55	8.7	(5.8-11.6)	0.90	54	8.4	(5.7-11.2)	0.61
3	153	21.7	(18.0-25.3)	0.01	139	25.1	(20.6-29.6)	0.31	166	27.9	(23.6-32.3)	0.03
4	196	28.0	(24.0-32.0)	0.05	131	25.2	(20.3-30.1)	0.36	135	22.6	(19.0-26.1)	0.07
5+	297	40.4	(35.4-45.5)	0.85	208	41.0	(36.2-45.7)	0.98	249	41.1	(36.6-45.5)	0.90
IV. Baseline neighborhood characteristics												
Family member victimized past 6 months (% yes)	293	40.8	(36.9-44.7)	0.13	235	44.0	(37.8-50.1)	0.81	264	44.8	(40.2-49.4)	0.29
Lived in neighborhood 5 or more years (% yes)	383	52.4	(47.2-57.6)	0.57	307	57.4	(52.1-62.7)	0.30	325	54.3	(49.2-59.4)	0.91
Moved more than 3 times in the 5 years (% yes)	75	10.9	(7.9-13.9)	0.19	51	10.0	(6.8-13.3)	0.10	90	14.6	(10.5-18.7)	0.10
Family in neighborhood (% yes)	447	64.9	(57.4-72.4)	0.38	321	59.9	(54.3-65.4)	0.68	377	61.7	(54.8-68.6)	0.75
Mean poverty rate in census tract ^f	--	53.8	(49.3-58.4)	0.79	--	54.9	(50.1-59.7)	0.67	--	54.2	(49.7-58.7)	0.94
V. City (%)												
Baltimore	78	11.9	(5.5-18.3)	0.84	71	13.3	(6.0-20.6)	0.61	76	12.5	(6.2-18.9)	0.99
Boston	125	17.4	(9.7-25.2)	0.50	103	20.1	(11.0-29.1)	0.77	128	19.2	(11.1-27.4)	0.74
Chicago	215	23.2	(9.9-36.5)	0.78	109	25.4	(10.9-39.8)	0.49	108	22.2	(10.8-33.5)	0.62
Los Angeles	148	24.8	(12.4-37.2)	0.61	126	23.0	(12.2-33.7)	0.85	170	23.4	(11.3-35.5)	0.78
New York City	147	22.6	(15.0-30.2)	0.99	124	18.3	(11.8-24.8)	0.15	122	22.7	(14.7-30.6)	0.47

Abbreviation: MTO, Moving to Opportunity; AFDC, Aid to Families with Dependent Children.

^aBased on multiply-imputed data (described in the text) to adjust for the fact that 22.2% of eligible baseline respondents did not participate in the long-term evaluation survey.

^bThe n's are the mean number of respondents in the group with the outcome averaged across the 20 multiply imputed pseudo-samples.

^cCompared to controls.

^dCompared to both intervention groups combined.

^eAge at long-term follow-up interview had a median age of 16 for both the Low-poverty Voucher Group and Traditional Voucher Group, and a median age of 17 in the control group. The range was 13-19 for all three groups.

^fThe mean poverty rate in census tract is the fraction of residents living below the poverty threshold in the household's baseline census tract. The poverty rate is linearly interpolated from the 1990 and 2000 decennial censuses. See <http://www.census.gov/hhes/www/poverty/about/overview/measure.html> for information on how the Census Bureau defines the poverty threshold.

Table 2
Baseline characteristics of the MTO adolescent girl long-term evaluation sample in the Low-poverty voucher intervention group, the Traditional voucher intervention group, and the Control group^a

	Low-poverty Voucher Group (n=711)			Traditional Voucher Group (n=541)			Control Group (n=569)					
	n ^b	%	(95% CI)	P value ^c	n ^b	%	(95% CI)	P value ^c	n ^b	%	(95% CI)	P value ^d
I. Respondent characteristics												
Age at baseline ^e												
0-5 (%)	613	83.8	(79.8-87.9)	0.86	457	87.9	(84.4-91.4)	0.02	479	83.5	(79.6-87.3)	0.20
Mean	--	3.6	(3.4-3.9)	0.76	--	3.5	(3.2-3.7)	0.06	--	3.7	(3.4-3.9)	0.22
Median (Range)	--	4.0	(0-8)	--	--	4.0	(0-8)	--	--	4.0	(0-8)	--
Required special medicine/equipment	60	8.1	(5.7-10.4)	0.53	38	6.6	(3.9-9.4)	0.89	39	6.9	(3.7-10.1)	0.75
Race/ethnicity (%)												
Hispanic (Any race)	215	33.2	(24.7-41.7)	0.74	163	28.2	(20.7-35.6)	0.25	194	32.0	(24.6-39.4)	0.75
White (Non-Hispanic)	11	2.2	(-0.4-4.7)	0.66	12	2.0	(-0.3-4.2)	0.48	15	2.8	(0.9-4.6)	0.57
African-American (Non-Hispanic)	464	61.8	(51.9-71.6)	0.89	341	65.7	(56.6-74.8)	0.32	341	62.3	(53.8-70.8)	0.72
Other race (Non-Hispanic)	19	2.9	(0.8-4.9)	0.94	24	4.2	(1.7-6.6)	0.32	19.0	2.9	(1.2-4.7)	0.62
II. Baseline characteristics of the sample adult												
High school diploma (% yes)	278	38.4	(32.2-44.7)	0.63	195	35.8	(29.0-42.5)	0.82	212	36.7	(32.1-41.2)	0.86
Currently in school (% yes)	135	19.4	(15.2-23.6)	0.48	93	16.8	(13.0-20.7)	0.79	94	17.6	(13.7-21.4)	0.75
Employed (% yes)	151	22.3	(18.6-25.9)	0.93	109	18.8	(15.3-22.3)	0.19	127	22.1	(18.3-25.9)	0.49
Never married (% yes)	483	67.3	(62.6-72.0)	0.33	370	69.5	(64.2-74.8)	0.86	390	70.2	(64.4-75.9)	0.51
Younger than 18 at birth of first child (% yes)	216	28.0	(22.9-33.1)	0.19	164	31.1	(25.3-36.9)	0.90	177	31.5	(26.7-36.2)	0.35
Single mother (% yes)	633	87.8	(84.2-91.5)	0.48	470	87.1	(83.3-91.0)	0.28	504	89.3	(86.2-92.4)	0.32
III. Baseline household characteristics												
Income												
\$7,000	143	17.6	(12.0-23.2)	0.22	74	14.9	(8.3-21.5)	0.80	79	15.7	(9.9-21.5)	0.68
\$7,001-9,000	134	19.5	(15.4-23.7)	0.31	125	22.9	(17.3-28.5)	0.09	99	16.9	(13.7-20.1)	0.13
\$9,001-12,000	174	25.3	(20.2-30.3)	0.98	138	25.7	(20.1-31.3)	0.91	150	25.4	(20.5-30.2)	0.96
\$12,001-17,000	144	20.3	(15.5-25.2)	0.55	109	19.4	(15.6-23.2)	0.31	127	22.3	(17.8-26.7)	0.38
\$17,001+	113	17.2	(13.5-20.9)	0.31	93	17.0	(12.9-21.1)	0.25	112	19.8	(16.0-23.5)	0.21

	Low-poverty Voucher Group (n=711)				Traditional Voucher Group (n=541)				Control Group (n=569)			
	n ^b	%	(95% CI)	P value ^c	n ^b	%	(95% CI)	P value ^c	n ^b	%	(95% CI)	P value ^d
Receives AFDC (% yes)	598	82.9	(78.9-86.9)	0.23	453	85.1	(81.3-89.0)	0.07	449	80.2	(76.4-83.9)	0.08
Household size (%)												
1-2	72	10.8	(7.8-13.9)	0.16	54	9.6	(6.8-12.4)	0.62	54	8.7	(6.7-10.7)	0.22
3	186	27.4	(23.3-31.4)	0.52	132	24.3	(19.5-29.2)	0.70	150	25.6	(21.4-29.9)	0.87
4	191	26.4	(22.7-30.1)	0.75	128	22.9	(18.6-27.3)	0.38	144	25.4	(21.6-29.2)	0.81
5+	262	35.4	(30.1-40.8)	0.20	227	43.1	(36.6-49.6)	0.50	221	40.2	(34.6-45.8)	0.67
IV. Baseline neighborhood characteristics												
Family member victimized past 6 months (% yes)	324	45.8	(40.3-51.2)	0.26	207	37.9	(32.3-43.5)	0.44	232	41.5	(34.9-48.1)	0.84
Lived in neighborhood 5 or more years (% yes)	359	49.3	(44.8-53.8)	0.04	287	51.2	(44.6-57.8)	0.21	310	55.7	(51.1-60.4)	0.05
Moved more than 3 times in the 5 years (% yes)	66	9.3	(7.0-11.6)	0.12	62	12.9	(8.7-17.2)	0.68	70	11.9	(9.1-14.8)	0.52
Family in neighborhood (% yes)	435	64.6	(58.6-70.6)	0.65	354	65.6	(60.5-70.8)	0.47	364	63.1	(56.5-69.7)	0.52
Mean poverty rate in census tract ^f	--	53.7	(49.0-58.3)	0.93	--	53.7	(49.4-57.9)	0.94	--	53.6	(49.4-57.7)	0.93
V. City (%)												
Baltimore	74	10.9	(3.5-18.3)	0.59	79	14.3	(5.8-22.9)	0.02	58	10.1	(2.9-17.3)	0.12
Boston	146	21.7	(13.2-30.3)	0.47	92	17.7	(10.1-25.3)	0.46	125	19.9	(12.0-27.8)	0.97
Chicago	219	23.7	(11.7-35.8)	0.56	110	24.7	(13.7-35.7)	0.35	102	22.3	(11.8-32.9)	0.40
Los Angeles	140	23.5	(12.5-34.5)	0.92	121	21.6	(10.4-32.9)	0.47	161	23.2	(11.3-35.1)	0.80
New York City	132	20.1	(13.6-26.7)	0.09	139	21.6	(15.2-28.0)	0.36	123	24.5	(16.7-32.3)	0.13

Abbreviation: MTO, Moving to Opportunity, AFDC; Aid to Families with Dependent Children.

^aBased on multiply-imputed data (described in the text) to adjust for the fact that 22.2% of eligible baseline respondents did not participate in the long-term evaluation survey.

^bThe n's are the mean number of respondents in the group with the outcome averaged across the 20 multiply imputed pseudo-samples.

^cCompared to controls.

^dCompared to both intervention groups combined.

^eAge at long-term follow-up interview had a median age of 16 for both the Low-poverty Voucher Group and Traditional Voucher Group, and a median age of 17 in the control group. The range was 13-19 for all three groups.

^fThe mean poverty rate in census tract is the fraction of residents living below the poverty threshold in the household's baseline census tract. The poverty rate is linearly interpolated from the 1990 and 2000 decennial censuses. See <http://www.census.gov/hhes/www/poverty/about/overview/measure.html> for information on how the Census Bureau defines the poverty threshold.

Associations of the MTO interventions with 12-month DSM-IV/CIDI disorders among long-term evaluation sample adolescent boys and girls combined^a

Table 3

	Low-poverty Voucher Group (n=1,424)		Traditional Voucher Group (n=1,074)		Control Group (n=1,173)	
	Est	(95% CI)	Est	(95% CI)	Est	(95% CI)
I. Major Depressive Disorder						
Absolute Risk (%)	6.8	(-12.0-25.6)	6.1	(-20.1-32.4)	7.1	(-21.8-35.9)
Absolute Risk Reduction (%)	0.3	(-27.0-27.6)	1.0	(-30.7-32.7)		
Odds Ratio	1.0	(0.6-1.4)	0.9	(0.6-1.3)	1.0	--
<i>P</i> value ^b	0.70					
(n) ^c	(98)		(66)		(84)	
II. Panic Disorder						
Absolute Risk (%)	3.1	(2.2-4.1)	4.1	(2.8-5.3)	4.7	(3.2-6.1)
Absolute Risk Reduction (%)	1.5	(-0.2-3.3)	0.6	(-1.6-2.8)		
Odds Ratio	0.7	(0.4-1.1)	0.9	(0.5-1.5)	1.0	--
<i>P</i> value ^b	0.17					
(n) ^c	(52)		(44)		(58)	
III. Posttraumatic stress disorder						
Absolute Risk (%)	7.2	(5.7-8.6)	4.7	(3.6-5.8)	4.2	(3.2-5.2)
Absolute Risk Reduction (%)	-3.0	(-4.5- -1.5)	-0.5	(-1.9-1.0)		
Odds Ratio	1.8	(1.2-2.7)	1.1	(0.7-1.8)	1.0	--
<i>P</i> value ^b	0.03					
(n) ^c	(105)		(54)		(48)	
IV. Oppositional-defiant disorder						
Absolute Risk (%)	6.2	(4.8-7.6)	8.8	(7.5-10.0)	8.2	(6.3-10.1)
Absolute Risk Reduction (%)	1.9	(-0.1-4.0)	-0.6	(-2.8-1.6)		
Odds Ratio	0.7	(0.5-1.1)	1.1	(0.8-1.5)	1.0	--
<i>P</i> value ^b	0.17					
(n) ^c	(97)		(89)		(98)	

	Low-poverty Voucher Group (n=1,424)		Traditional Voucher Group (n=1,074)		Control Group (n=1,173)	
	Est	(95% CI)	Est	(95% CI)	Est	(95% CI)
V. Intermittent explosive disorder						
Absolute Risk (%)	13.6	(11.5-15.8)	15.4	(13.4-17.3)	16.7	(14.9-18.6)
Absolute Risk Reduction (%)	3.1	(-0.2-6.4)	1.3	(-1.3-4.0)		
Odds Ratio	0.8	(0.6-1.0)	0.9	(0.7-1.2)	1.0	--
<i>P</i> value ^b	0.13		0.70			
(n) ^c	(202)		(161)		(196)	
VI. Conduct Disorder						
Absolute Risk (%)	3.9	(3.0-4.9)	2.2	(1.0-3.4)	2.5	(1.5-3.5)
Absolute Risk Reduction (%)	-1.4	(-2.7--0.1)	0.3	(-1.2-1.8)		
Odds Ratio	1.6	(1.0-2.6)	0.9	(0.5-1.7)	1.0	--
<i>P</i> value ^b	0.13		0.70			
(n) ^c	(55)		(21)		(28)	

Abbreviations: MTO, Moving to Opportunity; DSM, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; CIDI, Composite International Diagnostic Interview.

^aBased on a series of logistic regression equations comparing respondents in the Low-poverty and Traditional voucher intervention groups with respondents in the Control group ignoring whether or not intervention families used their vouchers. The equations are based on multiply-imputed data (described in the text) to adjust for the fact that 22.2% of eligible baseline respondents did not participate in the long-term evaluation survey.

^bThe *P* values evaluate the significance of odds-ratios using the Benjamini-Hochberg method³³ to adjust for the false discovery rate. These *P* values are higher than those implied by the 95% CIs, as the latter are based on models for separate outcomes.

^cThe n's are the mean number of respondents in the group with the outcome averaged across the 20 multiply imputed pseudo-samples.

Associations of the MTO interventions with 12-month DSM-IV/CIDI disorders among long-term evaluation sample adolescent s[†]

Table 4

	Low-poverty Voucher Group (n boys = 713, n girls = 711)		Traditional Voucher Group (n boys = 533, n girls = 541)		Control Group (n boys = 604, n girls = 569)	
	Est	(95% CI)	Est	(95% CI)	Est	(95% CI)
I. Boys						
Major depressive disorder						
Absolute Risk (%)	7.1	(4.1-10.1)	5.7	(3.8-7.7)	3.5	(2.3-4.6)
Absolute Risk Reduction (%)	-3.7	(-6.9--0.4)	-2.3	(-4.5--0.1)		
Odds Ratio	2.2	(1.2-3.9)	1.7	(0.9-3.4)	1.0	--
<i>P</i> value ^b	0.03		0.23			--
(n) ^c	(52)		(30)		(22)	
Posttraumatic stress disorder						
Absolute Risk (%)	6.2	(4.7-7.7)	4.9	(3.0-6.8)	1.9	(0.9-2.9)
Absolute Risk Reduction (%)	-4.3	(-6.1--2.5)	-3.0	(-5.0--1.0)		
Odds Ratio	3.4	(1.6-7.4)	2.7	(1.2-5.8)	1.0	--
<i>P</i> value ^b	0.007		0.05			--
(n) ^c	(44)		(26)		(10)	
Conduct Disorder						
Absolute Risk (%)	6.4	(4.7-8.1)	4.2	(1.9-6.5)	2.1	(1.1-3.2)
Absolute Risk Reduction (%)	-4.2	(-6.4--2.1)	-2.1	(-4.5-0.4)		
Odds Ratio	3.1	(1.7-5.8)	2.0	(0.8-5.1)	1.0	--
<i>P</i> value ^b	< .001		0.23			--
(n) ^c	(42)		(19)		(13)	
II. Girls						
Major depressive disorder						
Absolute Risk (%)	6.5	(4.7-8.3)	6.5	(4.5-8.4)	10.9	(8.4-13.4)
Absolute Risk Reduction (%)	4.4	(1.5-7.3)	4.4	(1.3-7.5)		
Odds Ratio	0.6	(0.3-1.0)	0.6	(0.3-0.9)	1.0	--
<i>P</i> value ^b	0.06		0.04			--

	Low-poverty Voucher Group (n boys = 713, n girls = 711)		Traditional Voucher Group (n boys = 533, n girls = 541)		Control Group (n boys = 604, n girls = 569)	
	Est	(95% CI)	Est	(95% CI)	Est	(95% CI)
(n) ^c		(46)		(35)		(61)
Posttraumatic stress disorder						
Absolute Risk (%)	8.2	(6.1-10.2)	4.5	(3.2-5.7)	6.7	(4.8-8.5)
Absolute Risk Reduction (%)	-1.5	(-3.8-0.9)	2.2	(0.0-4.4)		
Odds Ratio	1.2	(0.8-2.1)	0.7	(0.3-1.2)	1.0	--
<i>P</i> value ^b	0.40		0.33		--	
(n) ^c		(60)		(28)		(38)
Conduct Disorder						
Absolute Risk (%)	1.5	(0.8-2.1)	0.3	(0.0-0.7)	2.9	(1.1-4.7)
Absolute Risk Reduction (%)	1.4	(-0.5-3.3)	2.6	(0.7-4.5)		
Odds Ratio	0.5	(0.2-1.4)	0.1	(0.0-0.4)	1.0	--
<i>P</i> value ^b	0.20		0.02		--	
(n) ^c		(11)		(2)		(15)

Abbreviations: MTO, Moving to Opportunity; DSM, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; CIDI, Composite International Diagnostic Interview.

^aBased on a series of logistic regression equations comparing respondents in the Low-poverty and Traditional voucher intervention groups with respondents in the Control group ignoring whether or not intervention families used their vouchers. The equations are based on multiply-imputed data (described in the text) to adjust for the fact that 22.2% of eligible baseline respondents did not participate in the long-term evaluation survey.

^bThe *P* values evaluate the significance of odds-ratios using the Benjamini-Hochberg method³³ to adjust for the false discovery rate. These *P* values are higher than those implied by the 95% CIs, as the latter are based on models for separate outcomes.

^cThe n's are the mean number of respondents in the group with the outcome averaged across the 20 multiply imputed pseudo-samples.