

## Supplemental Information

### PROPSENSITY SCORE MATCHING PROCEDURE

In this analysis, we use PSM as a means of achieving greater balance between the characteristics of the treatment group (children whose families volunteered to participate in MM) and characteristics of the comparison group (children whose parents either did not have the option of participating or chose not to participate in MM). PSM works to limit bias that occurs when effects on the outcome may be caused by a factor that predicts likelihood of treatment rather than treatment itself. This is accomplished by accounting for the covariates that predict whether a treatment was received and creating a probability of group membership (treated versus untreated) on the basis of those observed characteristics. PSM is an ideal methodology for investigating the effects of MM participation because of the voluntary nature of the program and the likelihood that selection bias will explain some differences in outcomes between treated and untreated groups. PSM helps to account for this by ensuring that the untreated group does not differ considerably from the treated group on a long list of demographic characteristics and risk factors that may otherwise predict MM participation.

The propensity score was estimated by using the `pscore` command and the matching was performed across treatment sites by using `psmatch2` in Stata. To produce correct SEs from regression performed on the matched sample, we used 1:1 nearest neighbor with replacement.<sup>14,15</sup> Using 1:1 matching reduces bias between the treatment and comparison groups by only matching treated individuals with the most similar comparison-group individual. Matching with replacement is preferred in this procedure because treated individuals outnumber untreated individuals by a

5:1 margin, which makes it difficult to successfully provide a single match per treated individual. Matching with replacement allows multiple untreated individuals to be matched with a single treated individual. Finally, common support ensures that there is sufficient overlap in the characteristics of treated and untreated individuals to find adequate matches. We use a caliper of 0.020, which was generated from the log of the propensity score.<sup>16</sup> We also include sensitivity testing for this model, wherein we decrease the caliper to 0.001 (See Sensitivity Testing below, Supplemental Tables 11 and 12). In total, 100% of individuals from the untreated group ( $n = 440$ ) and 99% of individuals from the treated group ( $n = 2589$ ) were used for the match. Additionally, we conduct regression adjustment using covariates from the matching model to reduce any residual bias that may remain after matching.

In generating propensity scores, as well as the subsequent regression adjustment, we are aided in efforts to eliminate bias by a substantial list of control variables. These procedures draw on standard demographic features (ie, household income, child age in months, race, ethnicity, sex, disability status, and home language), as well as a list of 16 risk factors collected from families as a means of determining eligibility for enrollment (Supplemental Table 9). Additionally, our models control for programmatic features related to program dosage (ie, child is in first or second year of ECEAP enrollment), classroom model (ie, part, full, or extended day), site years of operation, and population density relative to site location.

In our models, we exclude certain variables known to be related to spring TSG outcomes but are collected after fall enrollment (yearly duration of enrollment and fall TSG

baseline scores). Although related to the spring TSG outcome, these variables are not collected until after families decide whether to participate in MM and, thus, cannot be used to predict likelihood of participation.

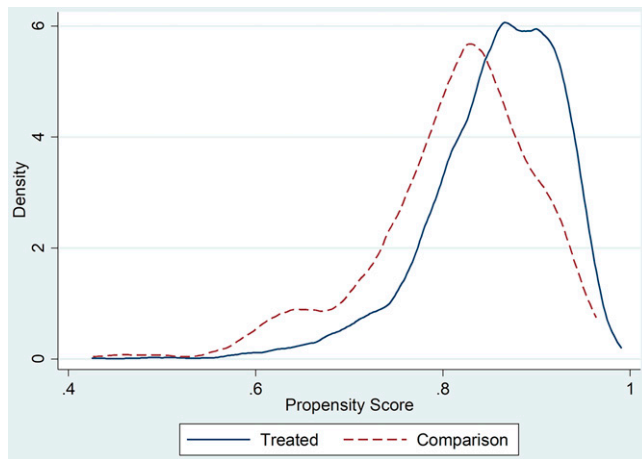
### ASSESSING QUALITY OF THE MATCH

We begin by testing whether the propensity-score match results in improved alignment of propensity-score distributions between the treated and untreated groups (Supplemental Figs 3 and 4). Matching led to almost identical propensity-score distributions, indicating treated and untreated individuals were similarly likely to participate in MM relative to the vector of observed predictor variables that were included in the model.

We also examine the match by calculating the standardized difference in means of our matching variables, before and after conducting the propensity scores. Before matching, the means of many of the covariates used in the model were significantly different across the treated and untreated groups. After the match, almost all mean differences in covariates were reduced and none remained significantly different across groups (Supplemental Table 10).

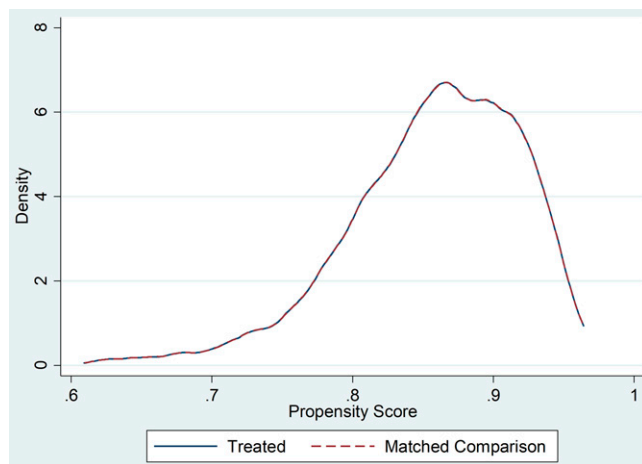
### SENSITIVITY TESTING

Sensitivity testing was used to test the robustness of these findings. This test helps us to identify the extent to which findings are sensitive to changes in sample specification, or likelihood of participation in the MM intervention. Specifically, a .001 caliper adjustment was used in PSM as a means of substantially limiting the tolerated “nonperfect” matching threshold. We found that our results were robust to this alternative model specification (Supplemental Tables 11 and 12).



**SUPPLEMENTAL FIGURE 3**

Comparison of propensity-score distributions between treated and untreated groups before matching.



**SUPPLEMENTAL FIGURE 4**

Comparison of propensity-score distributions between treated and untreated groups after matching.

**SUPPLEMENTAL TABLE 8** Full List of Characteristics of Children and Families Within Sites Who Did or Did Not Receive MM

| Variable  | MM Children ( <i>n</i> = 2609) | Non-MM Children ( <i>n</i> = 440) | <i>P</i> |
|---|--------------------------------|-----------------------------------|----------|
| Average federal poverty level   | 74.20                          | 80.05                             | .06      |
| Proportion of children enrolled previous year                               | 0.30                           | 0.31                              | .54      |
| Proportion of male sex  | 0.51                           | 0.50                              | .60      |
| Average age at fall entry, mo   | 49.80                          | 49.09                             | .03      |
| Proportion American Indian or Alaskan Native                                | 0.02                           | 0.01                              | .11      |
| Proportion Asian American   | 0.02                           | 0.01                              | .15      |
| Proportion Pacific Islander   | 0.00                           | 0.01                              | .13      |
| Proportion White  | 0.34                           | 0.40                              | .01      |
| Proportion multiracial  | 0.10                           | 0.15                              | .003     |
| Proportion Hispanic   | 0.48                           | 0.39                              | .001     |
| Proportion with individualized education plan                               | 0.12                           | 0.10                              | .28      |
| Proportion with suspected delay   | 0.11                           | 0.10                              | .49      |
| Proportion with English as first language                                   | 0.67                           | 0.80                              | <.001    |
| Proportion with low birth wt  | 0.07                           | 0.13                              | <.001    |
| Proportion with single parent   | 0.44                           | 0.43                              | .90      |
| Proportion with teenaged parent   | 0.03                           | 0.03                              | .60      |
| Proportion with parent sixth grade or less education                        | 0.11                           | 0.11                              | .95      |
| Proportion with parent interpreter needed                                   | 0.21                           | 0.14                              | .002     |
| Proportion with incarcerated parent   | 0.06                           | 0.08                              | .09      |
| Proportion with domestic violence   | 0.13                           | 0.19                              | .001     |
| Proportion with substance abuse   | 0.10                           | 0.18                              | <.001    |
| Proportion with parent mental illness                                       | 0.18                           | 0.26                              | <.001    |
| Proportion with foster care   | 0.02                           | 0.04                              | .02      |
| Proportion with child protective services involvement (previous or current) | 0.12                           | 0.19                              | <.001    |
| Proportion with homeless (previous or current)                              | 0.11                           | 0.13                              | .22      |
| Proportion with migrant parent  | 0.09                           | 0.07                              | .29      |
| Proportion with disabled parent   | 0.07                           | 0.10                              | .02      |
| Proportion with isolated residence  | 0.15                           | 0.12                              | .05      |
| Proportion with kinship guardian  | 0.03                           | 0.04                              | .56      |
| Proportion in part-day ECEAP  | 0.80                           | 0.78                              | .38      |
| Proportion in first-year ECEAP site   | 0.22                           | 0.24                              | .28      |
| Proportion in small rural community   | 0.05                           | 0.07                              | .02      |
| Proportion in large rural community   | 0.05                           | 0.03                              | .05      |
| Proportion in suburban community  | 0.31                           | 0.26                              | .03      |
| Average days between fall and spring assessment                             | 194.86                         | 196.20                            | .07      |

**SUPPLEMENTAL TABLE 9** Full List of Characteristics of Children and Families Between Sites That Did and Did Not Offer MM

| Variable  | Children in MM Sites ( <i>n</i> = 3049) | Children in Non-MM Sites ( <i>n</i> = 7216) | <i>P</i> |
|---|---|---|----------|
| Average federal poverty level, %  | 75.040                                  | 73.84                                       | .36      |
| Proportion children enrolled previous year                                  | 0.30                                    | 0.30  | .81      |
| Proportion of male sex  | 0.51                                    | 0.51  | .76      |
| Average age in fall, mo   | 49.70                                   | 49.75                                       | .72      |
| Proportion American Indian or Alaskan Native                                | 0.02                                    | 0.02  | .38      |
| Proportion Asian American   | 0.02                                    | 0.04  | <.001    |
| Proportion Pacific Islander   | 0.00                                    | 0.02  | <.001    |
| Proportion White  | 0.35                                    | 0.32  | .02      |
| Proportion multiracial  | 0.11                                    | 0.11  | .94      |
| Proportion Hispanic   | 0.47                                    | 0.39  | <.001    |
| Proportion with individualized education plan                               | 0.12                                    | 0.12  | .70      |
| Proportion with suspected delay   | 0.11                                    | 0.11  | .65      |
| Proportion with English language  | 0.69                                    | 0.67  | .11      |
| Proportion with low birth wt  | 0.08                                    | 0.06  | .003     |
| Proportion with single parent   | 0.44                                    | 0.40  | .002     |
| Proportion with teenaged parent   | 0.03                                    | 0.02  | .007     |
| Proportion with parent sixth grade or less ed                               | 0.11                                    | 0.09  | <.001    |
| Proportion with parent interpreter needed                                   | 0.20                                    | 0.20  | .78      |
| Proportion with incarcerated parent   | 0.06                                    | 0.04  | <.001    |
| Proportion with domestic violence   | 0.14                                    | 0.10  | <.001    |
| Proportion with substance abuse   | 0.11                                    | 0.08  | <.001    |
| Proportion with parent mental illness                                       | 0.20                                    | 0.15  | <.001    |
| Proportion foster care  | 0.02                                    | 0.03  | .31      |
| Proportion with child protective services involvement (previous or current) | 0.13                                    | 0.09  | <.001    |
| Proportion homeless (previous or current)                                   | 0.12                                    | 0.11  | .64      |
| Proportion with migrant parent  | 0.09                                    | 0.07  | .004     |
| Proportion with disabled parent   | 0.08                                    | 0.07  | .50      |
| Proportion with isolated residence  | 0.15                                    | 0.08  | <.001    |
| Proportion with kinship guardian  | 0.03                                    | 0.03  | .004     |
| Proportion in part-day ECEAP  | 0.80                                    | 0.79  | <.001    |
| Proportion in first-year ECEAP site   | 0.22                                    | 0.06  | .53      |
| Proportion in small rural community   | 0.05                                    | 0.05  | <.001    |
| Proportion in large rural community   | 0.05                                    | 0.08  | .64      |
| Proportion in suburban community  | 0.30                                    | 0.13  | <.001    |
| Average days between fall and spring assessment                             | 195.05                                  | 184.89                                      | <.001    |

**SUPPLEMENTAL TABLE 10** Treated Versus Untreated Comparison Within Treatment Sites: Study Group Characteristics Before and After Matching

|   | Before Match |                |          | After Match  |                |          |
|---|--------------|----------------|----------|--------------|----------------|----------|
|   | Mean Treated | Mean Untreated | <i>P</i> | Mean Treated | Mean Untreated | <i>P</i> |
| Federal poverty level                                       | 74.200       | 80.05          | .06      | 74.39        | 74.65          | .95      |
| Child enrolled previous year                                | 0.30         | 0.31           | .54      | 0.30         | 0.29           | .76      |
| Male sex  | 0.51         | 0.50           | .60      | 0.51         | 0.49           | .64      |
| Age in fall, mo   | 49.80        | 49.09          | .03      | 49.77        | 49.80          | .94      |
| American Indian or Alaskan Native                           | 0.02         | 0.01           | .12      | 0.02         | 0.02           | .72      |
| Asian American  | 0.02         | 0.01           | .15      | 0.02         | 0.02           | .74      |
| Pacific Islander  | 0.00         | 0.01           | .13      | 0.00         | 0.00           | .84      |
| White   | 0.34         | 0.40           | .01      | 0.34         | 0.33           | .73      |
| Multiracial   | 0.10         | 0.15           | .003     | 0.10         | 0.12           | .45      |
| Hispanic  | 0.48         | 0.39           | .001     | 0.48         | 0.47           | .86      |
| Black   | 0.04         | 0.03           | .46      | 0.04         | 0.04           | .93      |
| Suspected delay   | 0.12         | 0.10           | .28      | 0.12         | 0.13           | .68      |
| English language  | 0.67         | 0.80           | <.001    | 0.68         | 0.66           | .66      |
| Low birth wt  | 0.07         | 0.13           | <.001    | 0.07         | 0.07           | .74      |
| Single parent   | 0.44         | 0.43           | .90      | 0.44         | 0.42           | .57      |
| Teenaged parent   | 0.03         | 0.03           | .60      | 0.03         | 0.04           | .63      |
| Parent sixth grade or less education                        | 0.11         | 0.11           | .95      | 0.12         | 0.14           | .45      |
| Parent interpreter needed                                   | 0.21         | 0.14           | .002     | 0.21         | 0.21           | .98      |
| Incarcerated parent   | 0.06         | 0.08           | .09      | 0.06         | 0.05           | .86      |
| Domestic violence   | 0.13         | 0.19           | .001     | 0.13         | 0.12           | .77      |
| Substance abuse   | 0.10         | 0.18           | <.001    | 0.10         | 0.11           | .81      |
| Parent mental illness                                       | 0.18         | 0.26           | <.001    | 0.19         | 0.17           | .53      |
| Foster care   | 0.02         | 0.04           | .02      | 0.02         | 0.03           | .65      |
| Child protective services involvement (previous or current) | 0.12         | 0.19           | <.001    | 0.12         | 0.12           | .85      |
| Homeless (previous or current)                              | 0.11         | 0.13           | .22      | 0.11         | 0.12           | .83      |
| Migrant parent  | 0.09         | 0.07           | .29      | 0.09         | 0.08           | .48      |
| Disabled parent   | 0.07         | 0.10           | .02      | 0.07         | 0.09           | .28      |
| Isolated  | 0.15         | 0.12           | .05      | 0.15         | 0.10           | .02      |
| Kinship guardian  | 0.03         | 0.04           | .56      | 0.03         | 0.04           | .54      |
| Part day  | 0.80         | 0.78           | .38      | 0.80         | 0.82           | .48      |
| Site first year ECEAP                                       | 0.22         | 0.24           | .23      | 0.22         | 0.20           | .49      |
| Small rural   | 0.05         | 0.07           | .02      | 0.05         | 0.05           | .99      |
| Large rural   | 0.05         | 0.03           | .05      | 0.05         | 0.05           | .98      |
| Suburban  | 0.31         | 0.26           | .03      | 0.31         | 0.32           | .66      |
| Site MM 2016–2017   | 0.74         | 0.70           | .14      | 0.74         | 0.75           | .80      |
| Propensity score  | 1.96         | 1.60           | <.001    | 0.86         | 0.86           | .62      |

**SUPPLEMENTAL TABLE 11** Sensitivity Test: Effects of Treatment on Spring TSG Assessment Scale Scores, Children Within Treatment Sites Only

| Domain           | Coefficient | 95% CI         | <i>P</i> |
|------------------|-------------|----------------|----------|
| Cognitive        | 10.49       | −1.90 to 22.88 | .10      |
| Language         | 4.67        | −6.62 to 15.95 | .42      |
| Literacy         | 13.47       | 3.85 to 23.09  | .006     |
| Math             | 10.95       | 3.32 to 18.59  | .005     |
| Physical         | 5.12        | −7.40 to 17.64 | .42      |
| Social-emotional | 6.94        | −0.85 to 14.74 | .08      |

**SUPPLEMENTAL TABLE 12** Sensitivity Test: Adjusted OR of Meeting or Exceeding WHE on the Fall TSG Assessment, Children Within Treatment Sites Only

| Domain                               | OR   | 95% CI       | <i>P</i> |
|--------------------------------------|------|--------------|----------|
| Meet or exceed WHE on 6 of 6 domains | 1.66 | 1.08 to 2.56 | .02      |