Effect of Early Educational Intervention on Younger Siblings

The Infant Health and Development Program

Marie C. McCormick, MD, ScD; Stephen Buka, ScD; Jeanne Brooks-Gunn, PhD; Mikhail Salganik, PhD; Wenyang Mao, MS

Object: To assess whether younger siblings of participants in an early (preschool) educational program would benefit in terms of developmental and educational outcomes.

Design: Assessment of a cohort of siblings of intervention participants at a mean age of 13.5 years.

Setting: The Infant Health and Development Program (IHDP), an 8-site randomized trial of 3 years of early education for premature low-birth-weight infants who were followed up through 18 years of age.

Participants: Siblings born within 5 years of the IHDP study participants.

Main Exposure: A sibling born no more than 5 years earlier who participated in the IHDP.

Main Outcome Measures: Observed IQ; youth report of behavioral problems, their expectations of future success, and their relationship with their parents; and the caregiver's report on the youth's school progress and their expectations of the youth's educational attainment.

Results: Of 878 IHDP participants who were followed up, 466 (53.1%) had an eligible younger sibling, and 229 of those siblings (49.1%) agreed to participate. No differences were seen between the siblings of those who did and did not receive the IHDP intervention on any of the outcome measures. Adjusting for maternal race/ethnicity, age, and educational attainment at the birth of the study participant; study site; sex of the sibling; and losses to the cohort did not alter the results.

Conclusion: Participation in an early educational program confers no apparent benefit on younger siblings in their early adolescent years.


Educational intervention in the preschool years leads to improved cognitive functioning and school achievement and to better behavior early in school,1-3 with potential long-term benefits with respect to economic productivity, higher education, and less criminal behavior.4-7 Most of the evidence comes from randomized trials of intensive center-based education, but comparable results have occurred in one home-visiting program8 and a quasi experiment that used center care and a parenting intervention at several sites in one city.9,10 Although most studies involve disadvantaged groups, these findings have been extended in a study involving a population heterogeneous for socioeconomic status and potential neurodevelopmental disability in the Infant Health and Development Program (IHDP).11 The results support the argument that early educational intervention in high-risk preschool children conveys substantial benefits outweighing the initial investment.5,5,12

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Cost-benefit discussions have focused on direct benefits to the children who received the intervention3,5 or to their mothers, also considered targets of intervention strategies.12 However, many of these interventions, such as IHDP11 and its antecedent Abecedarian Project,5,7 include components designed to provide specific information and modeling of behavior for fostering children's cognitive and behavioral development that might influence the care of younger children.13

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The evidence for such spillover effects is limited, however. Studies of family-based interventions for children with or at risk of significant behavioral disorders have noted improved behavior in older and younger nontargeted siblings. Gray and Klaus reported higher IQs among younger siblings closest in age to those who participated in the Early Training Project, a randomized trial of a preschool early-educational intervention. Garces et al noted small positive, insignificant effects on educational attainment of the younger siblings of Head Start participants but a significant reduction of 11% in the risk of being charged with a crime among the younger siblings of African American participants. If such effects were seen more broadly, they would provide additional justification for early childhood educational programs, especially those with a parenting component. To address this issue, we examined outcomes for younger siblings born after the intervention child in IHDP by obtaining interviews and developmental observations during the age 18-year follow-up of the IHDP sample.

**METHODS**

**STUDY SAMPLE**

The IHDP was a multisite randomized controlled trial of an educational intervention until 3 years of age for low-birth-weight pre-term infants at 8 sites. Infants were sampled from 2 birth-weight strata (<2000 g [lighter low-birth-weight (LLBW) group] and 2001-2499 g [heavier low-birth-weight (HLBW) group]) to ensure an oversample of those at higher developmental risk (LLBW group) and continuity with studies of poor, normal-birth-weight children (HLBW group). Random assignment to the arms of the study resulted in balance by sociodemographic and health variables known to affect child development (see the “Baseline Variables” subsection). The intervention (INT) consisted of home visits weekly for the first year and every other week in the second and third years and daily center-based education beginning at 12 months and continuing until 36 months of age (both corrected for duration of gestation). At all sites, both components followed structured protocols and a common curriculum designed to enhance parental abilities to anticipate and foster child development and to address other issues affecting parents’ lives. All children received intensive pediatric follow-up care, which for the other arm of the study was the only service provided (follow-up only [FUO]). The program and its results have been described in detail elsewhere.

In summary, at the end of the intervention period (3 years of age), all participants in the INT group averaged higher IQ and lower behavioral problem scores than those in the FUO group. In addition, measures of the home environment and parenting behaviors favored the INT group.

At subsequent ages, no differences in IQ, achievement testing, or behavior were seen for the LLBW children. In the HLBW group, the INT group had persistently higher IQ scores compared with the FUO group, but the differences were smaller than at the end of the intervention. In addition, the HLBW group had higher achievement scores and exhibited less risky behavior. Subsequent childbearing among the IHDP mothers was equivalent in both arms of the study at the 36-month assessment.

As part of the preparation for the assessment at 18 years of age, personnel at the study sites were asked to identify younger siblings born within 5 years of the study child based on records held at the study sites from the follow-up at 8 years of age. Five siblings and to compare younger siblings who did and did not participate in the INT phase according to a prespecified protocol. Of new family formation. In instances of multiple eligible siblings, we selected the sibling closest in age to the IHDP child of the same biological mother. Twin siblings of the IHDP child were not eligible for assessment because they participated in the INT phase according to a prespecified protocol.

**ASSESSMENT AND OUTCOME VARIABLES**

The assessment of younger siblings included psychological observations and interviews with the sibling and primary caregiver. Cognitive performance was assessed using the Wechsler Abbreviated Scale of Intelligence. The Wechsler scale provides IQ information and includes total, verbal, and performance IQ scores referenced to a mean (SD) of 100 (15). The youth were asked to report on their own behavior, expectations of future success, and relationship with the primary caregiver. The first relied on the Behavior Problem Index. 28 items scored on a 3-point scale (not true, sometimes true, and often true), with higher values indicative of worse behavior. Future expectations were ascertained using 9 questions selected from a previously used scale to ascertain the likelihood of higher education, a good paying job, a happy family life, friends, and good health. Each item was answered along a 5-point Likert scale from very low to very high likelihood, with higher scores indicating higher expectations of success. Finally, the youth were asked 12 items from the Conflict Tactics Scale for Parent and Child selected from the version fielded in the third wave of the Project on Human Development in Chicago Neighborhoods. Items were selected to reflect a range of parenting disciplinary strategies but not those that might require a report to child welfare agencies. The items are scored on a 6-point scale from never happened to happened more than 20 times in the past year; items were scored as written if reported as single-digits or in the middle of those reported as ranges. The scores ranged from 0 to 231, with a mean (SD) of 64.1 (44.2).

Primary caregivers provided information on attendance at school, grade and school difficulties (classification for special education or repetition of a grade), and expectations for how far they thought the sibling would go in school. They also provided the sibling’s birth weight and sex.

**BASELINE VARIABLES**

A standard set of variables obtained at the beginning of the study before randomization was used to compare participants and nonparticipants in this assessment and to adjust the outcomes for differences across sites. These included maternal age in years at the time of the birth of the IHDP participant; maternal race/ethnicity (African American, Hispanic, and white/other as self-declared by the mother at the time of recruitment into the study); maternal educational attainment at the time of the birth of the IHDP participant (<high school graduate, high school graduate, and > high school graduate); and study site: Arkansas (Little Rock), Einstein (South Bronx, New York), Harvard (Boston, Massachusetts), Miami (Miami, Florida), Pennsylvania (Philadelphia), Texas (Dallas), Washington (Seattle), and Yale (New Haven, Connecticut). In addition, they included the birth weight stratum (LLBW or HLBW) and the arm of the study of the IHDP participant (INT or FUO).

**STATISTICAL ANALYSIS**

Distributions by the baseline variables were used to compare study participants at 18 years of age with and without younger siblings and to compare younger siblings who did and did not participate (ie, completed an interview and/or psychological assessment). Comparisons of scores on IQ tests, the Behavior Problem Index, future expectations, and the Conflict Tactics Scale...
RESULTS

Of the original 978 infants enrolled in the analysis group of IHDP, 878 were eligible for follow-up by virtue of not having died or refused previous assessments by age 8 years. Of these, 466 (53.1%) had a potentially eligible younger sibling born within 5 years. As seen in Table 1, IHDP participants with and without younger siblings did not differ on any of the baseline variables except study site and maternal age. Participants at the Einstein and Yale sites were slightly less likely to have a younger sibling, whereas those in Miami and Seattle were more likely. Mothers who were younger on enrollment into the study were more likely to have a child after the IHDP participant.

Of the 466 younger siblings identified, 229 (49.1%) agreed to be interviewed and assessed. As seen in Table 2, no differences between those completing and not completing the assessment were seen for the baseline vari-

Table 1. Demographic Features of IHDP Participants With and Without Younger Siblings (Within 5 Years of Age)

<table>
<thead>
<tr>
<th>Younger Sibling</th>
<th>No (n = 412)</th>
<th>Yes (n = 466)</th>
<th>Total (n = 878)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race/ethnicity of study participant, %</td>
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<tr>
<td>Black</td>
<td>52.9</td>
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<td>52.6</td>
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<tr>
<td>White/other</td>
<td>37.1</td>
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<td>37.7</td>
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<td>Hispanic</td>
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<td>9.7</td>
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<td>Birth weight stratum of study participant, %</td>
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<td>Heavier low birth weight</td>
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<td>Lighter low birth weight</td>
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<td>Maternal educational level at birth of study child, %</td>
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<td>25.5 (6.4)</td>
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Table 2. Demographic Features of Eligible Younger Siblings of IHDP Participants Who Did and Did Not Participate in Outcome Assessment

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<th>Sibling Assessment</th>
<th>No (n = 237)</th>
<th>Yes (n = 229)</th>
<th>Total (n = 466)</th>
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**HUMAN SUBJECTS**

The study was approved by the institutional review boards of all participating institutions. A certification of confidentiality was also obtained. Written informed consent was obtained from the caregivers for the assessment of the siblings and written assent from the younger sibling.

relied on mean differences and 95% CIs; for categorical variables, odds ratios and 95% CIs were calculated. As done previously, the effect of the losses to the cohorts on the outcomes was assessed using separate linear (analysis of covariance) models for each outcome variable derived from the S-plus software. These models controlled for the baseline variables measured at enrollment to estimate the differences between INT and FUO groups. The linear models provided population marginal mean values and differences (INT vs FUO) for each outcome by substituting into the linear model the average values of the covariates. Nominal P values derived from the linear models were used for primary outcome comparisons. Under the modeling assumptions, this method removes nonresponse bias.

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**RESULTS**

Of the original 978 infants enrolled in the analysis group of IHDP, 878 were eligible for follow-up by virtue of not having died or refused previous assessments by age 8 years. Of these, 466 (53.1%) had a potentially eligible younger sibling born within 5 years. As seen in Table 1, IHDP participants with and without younger siblings did not differ on any of the baseline variables except study site and maternal age. Participants at the Einstein and Yale sites were slightly less likely to have a younger sibling, whereas those in Miami and Seattle were more likely. Mothers who were younger on enrollment into the study were more likely to have a child after the IHDP participant.

Of the 466 younger siblings identified, 229 (49.1%) agreed to be interviewed and assessed. As seen in Table 2, no differences between those completing and not completing the assessment were seen for the baseline vari-
The younger siblings of participants in the IHDP intervention were not different in adolescence from the siblings of those in the FUO group in terms of IQ, self-reported behavioral problems, expectations of future achievements, parental disciplinary strategies, or caregiver reports on their current and anticipated educational progress. When analyses were restricted to groups who benefited the most from IHDP (the HLBW group and study participants whose mothers had a high school education or less), again no differences were seen.

The mean age at assessment of the sibling was 13.5 years. The youth were equally likely to be born weighing less than 2500 g: approximately 31% of both groups. Examination of outcomes for siblings revealed no significant differences for any of the IQ, self-reported Behavior Problem Index, future expectation, or Conflict Tactics Scale scores (Table 3). Adjusting for maternal age and educational attainment at enrollment in the study, maternal race/ethnicity, study site, and sex of the study child did not alter the results. For example, the difference in verbal IQs between INT and FUO group siblings adjusted for these variables was a mean (SD) of 90.0 (15.0) vs 93.5 (16.4) (P = .09), which is virtually identical to the results in Table 3. Because persistent results of the intervention were seen primarily in study participants who weighed 2000 to 2500 g at birth and in whom effects of the intervention were seen primarily in study participants of minority race/ethnicity, with a sizable proportion of mothers having an educational attainment less than high school graduation, the results were further examined by the birth-weight stratum of the study subject and the educational attainment of the mother. No differences were seen between the INT and FUO groups. For example, the mean (SD) verbal IQ for the INT siblings of study children born weighing 2000 to 2500 g was 90.5 (15.4) vs 91.5 (19.1) for the FUO group (P = .80). Similarly, the verbal IQ for those whose mothers had a high school education or less on enrollment in the study was 85.8 (13.9) for the INT group and 87.7 (15.3) for the FUO group (P = .41).

As seen in Table 4, virtually all the siblings were still in high school (99%) in 9th and 10th grades. Most received grades of C or higher, and less than 25% had been classified as needing special education or repeated a grade. Most caregivers in both groups (62.7%) of the combined groups) anticipated that the sibling would graduate from college or go further. No group differences were seen for any of these variables.

Table 3. Comparison of Outcomes Among Younger Siblings of IHDP Participants According to Intervention Status

<table>
<thead>
<tr>
<th>Score, Mean (SD)</th>
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<th>FUO (n = 137)</th>
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<td>92.7 (14.5)</td>
<td>2.94 (−6.90 to 1.01)</td>
</tr>
<tr>
<td>Verbal</td>
<td>89.7 (15.0)</td>
<td>93.5 (16.4)</td>
<td>−3.57 (−7.89 to −0.66)</td>
</tr>
<tr>
<td>Performance</td>
<td>91.1 (13.7)</td>
<td>93.1 (13.8)</td>
<td>−1.99 (−5.60 to 1.62)</td>
</tr>
<tr>
<td>Behavior Problem Index</td>
<td>42.5 (7.7)</td>
<td>43.0 (7.7)</td>
<td>−0.58 (−2.65 to 1.48)</td>
</tr>
<tr>
<td>Future expectations</td>
<td>36.8 (4.2)</td>
<td>37.4 (4.4)</td>
<td>−0.81 (−1.97 to −0.25)</td>
</tr>
<tr>
<td>Conflict Tactics Scale</td>
<td>64.1 (44.2)</td>
<td>65.0 (48.0)</td>
<td>−0.84 (−13.28 to 11.60)</td>
</tr>
</tbody>
</table>

Table 4. Comparison of Maternal Report of Outcomes Among Younger Siblings of IHDP Participants According to Intervention Status

<table>
<thead>
<tr>
<th>IHDP Participant Study Status</th>
<th>INT (n=91)</th>
<th>FUO (n=137)</th>
<th>P Value or Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current grade in school, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9th</td>
<td>33.3</td>
<td>26.5</td>
<td></td>
</tr>
<tr>
<td>10th</td>
<td>18.9</td>
<td>28.7</td>
<td></td>
</tr>
<tr>
<td>11th</td>
<td>15.6</td>
<td>14.7</td>
<td>.54</td>
</tr>
<tr>
<td>12th</td>
<td>4.4</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>26.6</td>
<td>25.7</td>
<td></td>
</tr>
<tr>
<td>Academic grades in past year, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mostly A</td>
<td>19.1</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>Mostly B</td>
<td>46.3</td>
<td>37.8</td>
<td></td>
</tr>
<tr>
<td>Mostly C</td>
<td>25.0</td>
<td>33.3</td>
<td>.53</td>
</tr>
<tr>
<td>Mostly D</td>
<td>8.1</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td>Mostly Es</td>
<td>1.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>School difficulties, %b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever repeated a grade</td>
<td>24.4</td>
<td>26.3</td>
<td>.91 (0.49-1.68)</td>
</tr>
<tr>
<td>Ever classified as needing special education</td>
<td>18.0</td>
<td>16.2</td>
<td>1.14 (0.56-2.30)</td>
</tr>
<tr>
<td>How far in school this child will go, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not graduate</td>
<td>0.0</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Graduate high school</td>
<td>12.2</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Some college</td>
<td>18.9</td>
<td>18.4</td>
<td>.72</td>
</tr>
<tr>
<td>Graduate college</td>
<td>44.4</td>
<td>30.0</td>
<td></td>
</tr>
<tr>
<td>More</td>
<td>24.4</td>
<td>28.7</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: FUO, follow-up only; IHDP, Infant Health and Development Program; INT, intervention.

a Column percentages may not total 100 because of missing data.

b Categories are not mutually exclusive.

The mean age at assessment of the sibling was 13.5 years. The youth were equally likely to be born weighing less than 2500 g: approximately 31% of both groups. Examination of outcomes for siblings revealed no significant differences for any of the IQ, self-reported Behavior Problem Index, future expectation, or Conflict Tactics Scale scores (Table 3). Adjusting for maternal age and educational attainment at enrollment in the study, maternal race/ethnicity, study site, and sex of the study child did not alter the results. For example, the difference in verbal IQs between INT and FUO group siblings adjusted for these variables was a mean (SD) of 90.0 (15.0) vs 93.5 (16.4) (P = .09), which is virtually identical to the results in Table 3. Because persistent results of the intervention were seen primarily in study participants who weighed 2000 to 2500 g at birth and in whom effects of the intervention were seen primarily in study participants of minority race/ethnicity, with a sizable proportion of mothers having an educational attainment less than high school graduation, the results were further examined by the birth-weight stratum of the study subject and the educational attainment of the mother. No differences were seen between the INT and FUO groups. For example, the mean (SD) verbal IQ for the INT siblings of study children born weighing 2000 to 2500 g was 90.5 (15.4) vs 91.5 (19.1) for the FUO group (P = .80). Similarly, the verbal IQ for those whose mothers had a high school education or less on enrollment in the study was 85.8 (13.9) for the INT group and 87.7 (15.3) for the FUO group (P = .41).

As seen in Table 4, virtually all the siblings were still in school (99%) in 9th and 10th grades. Most received grades of C or higher, and less than 25% had been classified as needing special education or repeated a grade. Most caregivers in both groups (62.7%) of the combined groups) anticipated that the sibling would graduate from college or go further. No group differences were seen for any of these variables.

The younger siblings of participants in the IHDP intervention were not different in adolescence from the siblings of those in the FUO group in terms of IQ, self-reported behavioral problems, expectations of future achievements, parental disciplinary strategies, or caregiver reports on their current and anticipated educational progress. When analyses were restricted to groups who benefited the most from IHDP (the HLBW group and study participants whose mothers had a high school education or less), again no differences were seen.
These results are somewhat unexpected given that IHDP provided explicit approaches to enhancing parental abilities to address problems and improve coping skills and relied on a developmentally oriented curriculum with play materials. As predicted, the home environments and parenting skills were rated as more likely to be associated with better child development. Despite these positive changes at 36 months favoring the intervention, no long-term changes were seen.

One explanation for the lack of sibling effect is that the parenting components of early childhood education programs may contribute to the differences shortly after the intervention period but not account for a significant portion of the sustained effects seen in some programs, which may directly influence the child. This hypothesis has been experimentally tested in only 1 evaluation comparing a strategy of home visits only in which most of the intervention would be through the parents, with a strategy of home visits plus high-quality early childhood education and using the curriculum from which the IHDP program was developed. In comparison with the control participants, significant differences in child outcomes were seen with the strategy of home visits plus high-quality early childhood education but not with the home-visits-only program. Other suggestive evidence is derived from observations that effect sizes for parenting outcomes across numerous studies are smaller than those for child outcomes, including the lack of overall differences in maternal outcomes by study arm in IHDP at age 18 years.

Several factors may account for the lack of a sibling effect in IHDP compared with other studies and include the sociodemographic characteristics of participating families, the nature of the parental tasks for supporting development, and changes or differences in families who received early intervention programs. The IHDP is not a study solely of disadvantaged families, and many of our participants would have had the resources to support the development of their children as suggested by the lack of effect in the original trial in more advantaged sites or families and by the higher IQs among the IHDP siblings compared with those for the siblings in the Early Training Program (≤85). We continued to see no difference when the analyses were restricted to less-educated mothers, but the power for this analysis was limited.

Where sibling effects have been observed more frequently are studies of serious behavioral problems. Providing parents with standard ways of fostering positive behaviors and extinguishing negative ones may be more generally applicable across children than the observation and tailoring of developmental tasks used in IHDP. Moreover, in some studies, the siblings were clearly involved in the intervention. Finally, many of these studies relied on parental report of behavioral problems as the outcome, with the suggestion that the intervention may not diminish the behavioral problems but rather the parental distress in response to them.

Where sibling effects have been seen in developmental studies, they occur in the context of profound changes in the families with greater maternal educational attainment, limitations in family size, and greater economic well-being. Alternatively, families may differ at baseline, such as those who seek out educational opportunities for their children (as in Head Start) in unknown ways that would lead to better developmental and school outcomes, thus accounting for better outcomes among younger siblings. In IHDP, the 2 study arms were carefully balanced for significant predictors of child outcomes and differ very little in maternal workforce participation, further maternal educational attainment, or subsequent childbearing at the end of the intervention phase, and showed no long-term differences in a variety of maternal attitudes or behaviors at 18 years of age. Thus, our results differ from studies of disadvantaged populations in an earlier era.

Our results should be considered in the light of some of the limitations of the study. One limitation is the lack of early childhood data on the younger siblings. We did not, for example, have information on birth or early health events that might affect school performance and later outcomes or on the child care arrangements and early educational experiences of these youth. In addition, although we attempted to account statistically for siblings not assessed, cohort attrition may have affected the results. Likewise, the youth were still in school; therefore, we were unable to assess their long-term outcomes, such as school completion and criminal behavior, which is in contrast to the study by Garces et al, who reported differences.

Despite these limitations, this study adds to the literature on the effects of early childhood education. In particular, it raises questions about the potential for effects other than those seen among the primary targets of an educational intervention.