Outcomes of Childhood Preventive Intervention Across 2 Generations
A Nonrandomized Controlled Trial

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IMPORTANCE Trials of preventive interventions for children that were implemented in the 1980s have reported sustained positive outcomes on behavioral and health outcomes into adulthood, years after the end of the intervention. This present study examines whether intervention in childhood may show sustained benefits across generations.

OBJECTIVE To examine possible intervention outcomes on the offspring of individuals (now parents) who participated in the Raising Healthy Children preventive intervention as children in the elementary grades.

DESIGN, SETTING, AND PARTICIPANTS This nonrandomized controlled trial was conducted in public elementary schools serving high-crime areas in Seattle, Washington. The panel originated in Seattle but was followed up locally and in out-of-state locations over time. Data analyzed in this study were collected from September 1980 to June 2011, with follow-up of the firstborn offspring (aged 1 through 22 years) of 182 parents who had been in the full intervention vs control conditions in childhood. Their children were assessed across 7 waves in 2 blocks (2002-2006 and 2009-2011). Data were analyzed for this article from September 2018 through January 2019.

INTERVENTIONS In grades 1 through 6, the Raising Healthy Children intervention provided elementary school teachers with methods of classroom management and instruction, first-generation (G1) parents with skills to promote opportunities for children’s active involvement in the classroom and family, and second-generation (G2) child with social and emotional skills training.

MAIN OUTCOMES AND MEASURES Outcomes examined in the third-generation (G3) offspring were self-regulation (emotion, attention, and behavioral regulation), cognitive capabilities, and social capabilities. Risk behaviors, including substance use and delinquency, were examined from age 6 years to study completion. Early onset of sexual activity was examined from age 13 years to study completion. Intent-to-treat analyses controlled for potential confounding factors.

RESULTS A total of 182 G3 children were included in this analysis (72 in the full intervention and 110 in the control condition; mean age at first wave of data collection, 7 [range, 1-13] years). Significant differences in the offspring of intervention parents were observed across 4 domains: improved early child developmental functioning (ages 1-5 years; significant standardized β range, 0.45-0.56), lower teacher-rated behavioral problems (ages 6-18 years; significant standardized β range, -0.39 to -0.46), higher teacher-rated academic skills and performance (ages 6-18 years; significant standardized β range, 0.34-0.49), and lower child-reported risk behavior (ages 6-18 years; odds ratio for any drug use [alcohol, cigarettes, or marijuana], 0.27 [95% CI, 0.10-0.73]).

CONCLUSIONS AND RELEVANCE To our knowledge, this is the first study to report significant intervention differences in the offspring of participants in a universal childhood preventive intervention. Cost-benefit analyses have examined the benefits of childhood intervention in the target generation. The present study suggests that additional benefits can be realized in the next generation as well.

TRIAL REGISTRATION ClinicalTrials.gov Identifier: NCT04075019

Published online June 8, 2020.

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Trials of preventive interventions for children implemented in the 1980s have reported sustained benefits on behavioral and health outcomes into adulthood, years after the end of the intervention. These include the Nurse-Family Partnership,1 the Good Behavior Game,2 the Chicago Longitudinal Study,3 the Montreal Longitudinal-Experimental Study,4 and the New Beginnings Project.5

The Seattle Social Development Project (SSDP; ClinicalTrials.gov identifier: NCT04075019) is a study of a preventive intervention delivered in the elementary grades called Raising Healthy Children (RHC). Participants were followed up longitudinally. Guided theoretically by the social development model,6 RHC provides elementary school teachers with methods of classroom management and instruction and parents with skills to promote opportunities for children’s active involvement in the classroom and family, develop children’s skills for participation, and reinforce children’s efforts, improvements, and accomplishments.

Analyses examining efficacy of RHC have identified intervention effects into adulthood. By age 18 years (6 years post-intervention), compared with control participants, youths in the full intervention condition had significantly reduced school misbehavior, lifetime violence, and heavy alcohol use and had improved school commitment, attachment, and achievement.7 By age 21 years, the full intervention group, compared with control participants, showed significantly better outcomes with respect to education, employment, mental health, and reduced crime rates.8 By ages 24 to 27 years, the full intervention group, compared with control participants, showed significantly better socioeconomic attainment and mental health. Effect sizes (Cohen d) at ages 24 to 27 years ranged from 0.27 (educational attainment) to 0.46 (mental health disorder).9

This study examines whether intervention differences are sustained across generations. It examines intervention outcomes in the offspring of parents who, as children in elementary school, had participated in RHC. Developmental cascade theory10 suggests the possibility of outcomes that cross over to the next generation. Studies have identified negative developmental cascades stemming from childhood adversity and psychopathology into adulthood and across generations.11,12 Cascade theory also asserts the potential of positive developmental cascades. Early strengths in one domain become a scaffold onto which later competencies in newly emerging domains develop.13 The long-term outcomes of preventive interventions provided in childhood, as noted earlier, indicate that positive cascades can be stimulated through participation in a childhood preventive intervention. This article examines the possibility that participation in preventive intervention during childhood could also affect the behavioral health and development of one’s own children.

Starting in 2002, when participants in SSDP were aged 27 years, those who were actively parenting a biological child were invited to participate in the SSDP Intergenerational Study. This article examines whether the RHC intervention experienced by their grandparents (the first generation [G1]) and parents (the second generation [G2]) when the G2 participants were in grades 1 through 6 resulted in benefits in the third generation (G3) 20 years later. The outcomes examined for G3 participants are guided by the Institute of Medicine’s Committee on Early Childhood Development,14 which emphasized 3 capabilities as foundations for development: self-regulation (emotion, attention, and behavioral regulation), cognitive capabilities that undergird communication and learning, and social capabilities to relate well to others and form friendships. In addition, from adolescence onwards, G3 risk behaviors, including substance use, delinquency, and early onset of sex, are examined. These outcomes constitute the primary outcomes of this study.

Methods

Data analyses and reporting follow the recommendations of the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) group.15 A Consolidated Standards of Reporting Trials (CONSORT) diagram describing the flow of participants is provided in the Figure. A list of all items in each construct across all years are available from the first author (K.G.H.). Data are available through a shared collaborative agreement with the second author (J.A.B.). The project received University of Washington institutional review board human subjects review and approval continuously since its inception. A full description of the trial protocol is available through ClinicalTrials.gov. Written consent was obtained from all participants 18 years and older, and written assent was obtained from their participating children (ages 6-18 years).

Sample

This article examines the offspring of individuals from the 2 primary conditions (full intervention and control groups) from a larger nonrandomized controlled trial of the RHC intervention. Data analyzed in this study were collected from September 1980 to June 2011. The trial was constituted in 1985, when 808 youths (77% of the 1053 eligible youths) in 18 Seattle, Washington, elementary schools entered the fifth grade.9 The sample was balanced by sex (51% male) and racial/ethnically diverse. About 47.2% (n = 381) were white, 25.6% (n = 207) were African American, 21.9% (n = 177) were Asian American, and 5.3% (n = 43) were Native American. Of these, 5.4% (n = 44) were Hispanic. About 52.3% of the panel members (n = 423) were from low-income families, as evidenced by participation in the National School

Key Points

Question  Might a universal social-developmental intervention in childhood show sustained benefits across generations?

Findings  In this nonrandomized controlled trial, significant differences in the offspring of individuals (now parents) who had received the intervention in childhood were observed across 4 domains: improved early-childhood developmental functioning, lower teacher-rated behavioral problems, higher teacher-rated academic skills and performance, and lower child-reported risk behaviors.

Meaning  These findings emphasize the importance of childhood preventive intervention not only for later adult functioning but also for improved functioning in the next generation.
Lunch/School Breakfast Program between the ages of 10 and 12 years. Second-generation (G2) participants were followed up from the fifth grade (age 10 years) to age 39 years (in 2014).

The original nonrandomized trial begun in the G2’s fifth grade year recruited 156 full-intervention youths who had previously received the RHC intervention annually from the first through fourth grades in an earlier randomized clinical trial and were provided 2 more years of intervention (thus, first through sixth grades in total), as well as 124 children from the previous control group of the randomized clinical trial. In addition, 96 new control students from 5 schools were added in the fifth grade, randomly by school, for a total of 220 control participants. This is considered a nonrandomized controlled trial because it recruited youths (both intervention and control) who had participated in an earlier randomized clinical trial test of this intervention that had started in the first grade (in 1980), along with additional youths (randomized at the school level) in the fifth grade. Two conditions not tested in this analysis consisted of 141 students in a group offered parent training only and 267 students who received late treatment (grades 5 and 6) only. Finally, 24 of 808 participants moved between intervention and control schools more than once and thus could not be classified and were excluded from the analysis. Thus, the participants in the full intervention and control conditions whose children were tested in the current study came from 13 of the original 18 fifth-grade schools. In fall 1985, participants in the full intervention condition did not differ significantly from all other participants in the sample on demographic variables of race/ethnicity, sex, age, or socioeconomic status, as indicated by eligibility for the federal free lunch program.7

As seen in the CONSORT diagram (Figure), these 376 G2 full intervention (n = 156) and control (n = 220) youths were then followed up longitudinally into adulthood. At age 27 years, the intergenerational follow-up study was established by recruiting those individuals who were actively parenting a biological child. A total of 241 (93 intervention and 148 control) individuals were eligible for the intergenerational follow-up. Of those eligible, 182 (72 intervention and 110 control) individuals participated in the study and were analyzed in this article. Consistent with all prior articles examining the outcomes of this intervention,7-9,16,17 the 24 participants who could not be classified to a condition were excluded from the analyses. Prior analyses on G2 outcomes in adolescence and adulthood have consistently found significant RHC intervention outcomes between the full intervention group and control group, but the late intervention group and the parent training only group have not consistently differed significantly from the control group.7,9 Therefore, this study examines only 2 conditions: full intervention and control. However, sensitivity analyses for validity checks (eg, eligibility, recruitment, retention) and outcomes were conducted with excluded participants classified as having received full treatment. Twelve excluded participants were recruited into the intergenerational study. While some coefficients were slightly larger and some smaller in the second decimal place in sensitivity analyses, none of the significances were changed in any analysis. Results from
These sensitivity analyses are presented in eTable 2 in Supplement 1.

The intergenerational project (TIP) following up with the offspring of the original study participants began data collection in 2002 and included those participants who had become parents (G2) and the oldest biological child (G3) with whom they had had face-to-face contact at least once a month. The oldest child was selected to minimize potential confounds attributable to birth order and family size. A second caregiver nominated by the participant was also included when relevant (usually the other biological parent). New families were included in the sample as participants became parents for the first time. Seven waves of data were collected in 2 blocks (2002-2006 and 2009-2011) from participating TIP families, with follow-up occurring locally and in out-of-state locations over time. Data used in the present analyses were collected from a median of 5 waves across all children.

The RHC Intervention

The preventive intervention RHC was a multicomponent package that sought to improve opportunities, involvement, rewards, and life skills for children in elementary school. Every year, as the panel moved through grades 1 through 6, teachers of intervention students received 5 days of in-service training in a package of instructional methods with 3 major components: proactive classroom management, interactive teaching, and cooperative learning. Parents of children in the intervention were offered training in child-behavior management skills, strengthening their skills for supporting their children's academic development, and strengthening their skills to maintain strong bonds as their children entered the teenage years and reduce their children's risks for drug use. Given the nature of the intervention delivery, G1 parents were aware of the intervention condition, but it is unlikely that their G2 children or the G3 grandchildren examined here were aware of the intervention condition. All intervention components of RHC are presented in the Box. Intervention components are described more fully in previously published articles.

Potential Confounding Factors

To ensure internal validity of tests of the intervention in G3, analyses were conducted to ascertain the equivalence of the G3 offspring of the full intervention and control groups on factors that might influence G3 outcomes. Additional threats to internal validity could arise from differential rates of consent to participate in TIP, so further analyses examined these patterns.

Outcome Measures

Child Developmental Functioning

Using the Ages and Stages Questionnaire and in collaboration with a trained interviewer, primary caregivers (G2 parents) reported on their G3 child’s on-time developmental functioning (at ages 1-5 years) across 5 developmental domains: communication, gross motor functioning, fine motor functioning, problem solving, personal/social skills, and an overall functioning composite across all areas. Potential scores range from 0 to 60 points. Following Ages and Stages Questionnaire protocols, responses were summed at each age for each
developmental domain and across all domains to construct a global developmental competence score. A mean of scores was then calculated across all ages. Higher values indicated greater on-time development. The Ages and Stages Questionnaire has been shown to have strong scale reliability and validity.21

Child Problem Behaviors
As G3 children attended school (ages 6-18 years), teachers completed the Teacher Report Form of the Child Behavior Checklist.22 Typically, teachers across 3 grades provided problem behavior and academic skills ratings. Eight problem behavior subscales were used: oppositional defiance, conduct problems, attention-deficit/hyperactivity disorder, social problems, anxiety, affective problems, and externalizing and internalizing behavior composites. Problem behavior measures were based on Lengua and colleagues’ subscales,23 which have demonstrated better sensitivity, predictive power, and discriminate validity than the original Child Behavior Checklist subscales. Past research indicates that behavior problems change as children age,24 and participating children spanned a wide age range, so items were standardized within age group ranges (ages 6-7 years, 8-9 years, 10-13 years, and 14-18 years), and then a mean was calculated to create the scale. Children’s behavior problems were thus scored relative to their same-aged peers. Scale reliabilities ranged from 0.78 to 0.90 (by Cronbach α).

Child Skills and Performance
Teachers rated 5 items from the Peer-Preferred Social Behavior subscale of the Walker-McConnell Scale of Social Competence and School Adjustment for G3 children aged 6 to 18 years. Items measured cognitive skills, academic skills, relative performance, grades, and emotional skills.25 Means were calculated of teacher responses across items to create the reported scales, and means were then calculated across waves. Scale reliabilities ranged from 0.84 to 0.94 (by Cronbach α).

Child Risk Behaviors
The G3 children self-reported their own behaviors of sex, substance use, and delinquency from age 6 to 18 years. Specific items were whether they had engaged in sex at 16 years or younger, ever drunk alcohol, ever smoked cigarettes, ever used cannabis, ever used any drug, ever committed violent behavior, and ever committed nonviolent crimes (theft or drug sales). Children were asked these questions as they became age eligible, and they provided data in a median of 5 of the 7 waves. Risk behavior was coded as absorbing; having once said yes, and was timed to occur within 6 weeks of the G3 child’s birth-month each year.

Results
Of the 383 children in the TIP study, as reflected in the CONSORT diagram (Figure), 182 G3 youths were examined in the present analyses: 72 in the full intervention and 110 in the control condition. At the first data collection (wave 1; 2002), G2 participants in the control and full treatment conditions had a mean (SD) age of 27 (0.67) years, and their G3 children had a mean age of 7 years (range, 1-13 years). By wave 7 (2011), G2s had a mean (SD) age of 36 (0.5) years, and G3 children ranged in age from 1 to 22 years. Data collection occurred in the participants’ homes and was timed to occur within 6 weeks of the G3 child’s birthday each year.

Recruitment of eligible families into the intergenerational component had a mean of 82% across waves, and retention from wave to wave had a mean of 90%. The G2 SSDP mothers and married parents were consistently more likely to meet eligibility criteria (regular, face-to-face contact with their G3 child) than SSDP fathers and unmarried SSDP parents. Between 95% and 99% of mothers were eligible at each of the 7 waves, and between 75% and 95% of fathers were eligible at each wave (P < .001 to P = .06). Between 40% and 48% of married parents were eligible at each of the 7 waves, compared with 17% to 42% of single parents (P = .001 to P = .84). Once eligible, families were slightly less likely to be recruited into the intergenerational study at each wave if the G2 parent was Asian American (57% to 84% recruited vs 61% to 100% for other racial groups, across waves; P = .008 to P = .29) or had been eligible for the National Free School Breakfast/Lunch program in grades 5 through 7 (61% to 91% recruited at each wave vs 74% to 97% for those not eligible for free lunch in grades 5-7; P = .003 to P = .97). Retention across the 7 waves was not consistently associated with G2 sex; marital status; receipt of Temporary Assistance to Needy Families (a program granting short-term financial assistance for nonmedical assistance to pregnant women and families with dependent children); cigarette use, marijuana use, or binge drinking at TIP baseline; free lunch eligibility in childhood; cigarette use, marijuana use, or binge drinking in high school; or race/ethnicity.
Outcomes of Childhood Preventive Intervention Across 2 Generations

Original Investigation Research

in Grades 1 Through 6 Compared With Control Participants

Table 1. Differences in Children of Parents Who Were in Full Intervention in Supplement 1. We tested for differences between the G3 first-born offspring of G2 full intervention and control group participants at baseline and differential attrition between G3 offspring of G2 full intervention and control participants over time to ascertain the initial comparability of the G3 full intervention and control groups on potentially influential factors, as well as whether the intervention groups remained comparable on these factors throughout the intergenerational component of the study.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (SD) Control</th>
<th>Mean (SD) Intervention</th>
<th>Standardized β (95% CI)</th>
<th>P value</th>
<th>False discovery rate significance (P &lt; .021)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developmental functioning per Ages and Stages Questionnaire&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>49.2 (10.2)</td>
<td>54.0 (5.8)</td>
<td>0.56 (0.29-0.83)</td>
<td>.001</td>
<td>Yes</td>
</tr>
<tr>
<td>Gross motor</td>
<td>51.6 (8.6)</td>
<td>55.3 (6.3)</td>
<td>0.48 (0.17-0.79)</td>
<td>.002</td>
<td>Yes</td>
</tr>
<tr>
<td>Fine motor</td>
<td>44.4 (13.1)</td>
<td>49.6 (10.3)</td>
<td>0.45 (0.14-0.76)</td>
<td>.005</td>
<td>Yes</td>
</tr>
<tr>
<td>Problem solving</td>
<td>49.3 (11.8)</td>
<td>51.3 (7.3)</td>
<td>0.22 (-0.16 to 0.59)</td>
<td>.26</td>
<td>No</td>
</tr>
<tr>
<td>Personal social</td>
<td>52.3 (8.6)</td>
<td>53.0 (7.2)</td>
<td>0.08 (-0.27 to 0.43)</td>
<td>.64</td>
<td>No</td>
</tr>
<tr>
<td>Across all areas</td>
<td>49.2 (8.3)</td>
<td>52.5 (4.6)</td>
<td>0.49 (0.18-0.98)</td>
<td>.002</td>
<td>Yes</td>
</tr>
<tr>
<td>Teacher-rated child behavior&lt;sup&gt;f&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oppositional defiance</td>
<td>0.11 (0.73)</td>
<td>-0.16 (0.059)</td>
<td>-0.39 (-0.63 to -0.15)</td>
<td>.004</td>
<td>Yes</td>
</tr>
<tr>
<td>Conduct problems</td>
<td>0.06 (0.52)</td>
<td>-0.10 (0.52)</td>
<td>-0.31 (-0.58 to -0.04)</td>
<td>.03</td>
<td>No</td>
</tr>
<tr>
<td>Attention-deficit/hyperactivity disorder</td>
<td>0.14 (0.76)</td>
<td>-0.19 (0.65)</td>
<td>-0.46 (-0.76 to -0.20)</td>
<td>.003</td>
<td>Yes</td>
</tr>
<tr>
<td>Social problems</td>
<td>0.06 (0.51)</td>
<td>-0.01 (0.52)</td>
<td>-0.16 (-0.52 to 0.21)</td>
<td>.39</td>
<td>No</td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.05 (0.63)</td>
<td>-0.04 (0.52)</td>
<td>-0.16 (-0.49 to 0.17)</td>
<td>.35</td>
<td>No</td>
</tr>
<tr>
<td>Affective problems</td>
<td>0.12 (0.60)</td>
<td>-0.08 (0.52)</td>
<td>-0.34 (-0.65 to -0.03)</td>
<td>.03</td>
<td>No</td>
</tr>
<tr>
<td>Externalizing problems&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.25 (1.40)</td>
<td>-0.36 (1.23)</td>
<td>-0.41 (-0.67 to -0.14)</td>
<td>.002</td>
<td>Yes</td>
</tr>
<tr>
<td>Internalizing problems&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.20 (1.28)</td>
<td>-0.12 (1.07)</td>
<td>-0.32 (-0.63 to -0.01)</td>
<td>.04</td>
<td>No</td>
</tr>
<tr>
<td>Teacher-rated skills and performance&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive skills</td>
<td>3.47 (0.79)</td>
<td>3.77 (0.67)</td>
<td>0.39 (0.11-0.67)</td>
<td>.006</td>
<td>Yes</td>
</tr>
<tr>
<td>Academic skills</td>
<td>3.59 (0.89)</td>
<td>3.89 (0.71)</td>
<td>0.34 (0.09-0.60)</td>
<td>.009</td>
<td>Yes</td>
</tr>
<tr>
<td>Relative academic performance</td>
<td>3.03 (0.86)</td>
<td>3.22 (0.84)</td>
<td>0.21 (-0.06 to 0.48)</td>
<td>.12</td>
<td>No</td>
</tr>
<tr>
<td>Grades&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.63 (1.07)</td>
<td>2.86 (0.98)</td>
<td>0.18 (-0.08 to 0.44)</td>
<td>.17</td>
<td>No</td>
</tr>
<tr>
<td>Emotional skills</td>
<td>3.67 (0.88)</td>
<td>4.10 (0.75)</td>
<td>0.49 (0.29-0.68)</td>
<td>.001</td>
<td>Yes</td>
</tr>
<tr>
<td>Child-reported risk behavior, No. (%)&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early sex (&lt;17 y)</td>
<td>21 (40.4)</td>
<td>9 (32.1)</td>
<td>0.69 (0.25-1.88)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>.46</td>
<td>No</td>
</tr>
<tr>
<td>Ever drank alcohol</td>
<td>25 (30.2)</td>
<td>10 (16.4)</td>
<td>0.47 (0.21-1.03)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>.06</td>
<td>No</td>
</tr>
<tr>
<td>Ever smoked cigarettes</td>
<td>18 (20.9)</td>
<td>7 (11.5)</td>
<td>0.58 (0.23-1.47)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>.25</td>
<td>No</td>
</tr>
<tr>
<td>Ever smoked marijuana</td>
<td>16 (23.9)</td>
<td>7 (17.1)</td>
<td>0.73 (0.31-1.71)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>.47</td>
<td>No</td>
</tr>
<tr>
<td>Ever tried any drug</td>
<td>32 (37.2)</td>
<td>10 (16.4)</td>
<td>0.27 (0.10-0.73)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>.01</td>
<td>Yes</td>
</tr>
<tr>
<td>Ever violent (fighting, hitting, beating, or robbing)</td>
<td>46 (52.9)</td>
<td>24 (40.0)</td>
<td>0.64 (0.31-1.35)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>.25</td>
<td>No</td>
</tr>
<tr>
<td>Ever committed nonviolent crime (theft or drug sales)</td>
<td>35 (40.2)</td>
<td>17 (27.9)</td>
<td>0.63 (0.23-1.74)&lt;sup&gt;f&lt;/sup&gt;</td>
<td>.38</td>
<td>No</td>
</tr>
</tbody>
</table>

Tests of internal validity are reported in Table 2 and eTable 2 in Supplement 1. We tested for differences between the G3 first-born offspring of G2 full intervention and control group participants at baseline and differential attrition between G3 offspring of G2 full intervention and control participants over time to ascertain the initial comparability of the G3 full intervention and control groups on potentially influential factors, as well as whether the intervention groups remained comparable on these factors throughout the intergenerational component of the study. As reported previously<sup>7,9,27</sup> at baseline and at age 30 years, G2 participants in the full intervention vs control conditions who were followed up did not differ with respect to sex; race/ethnicity; childhood low-income status; mean number of years living in Seattle by grade 6; proportion of single-parent homes; family size; or residence in a disorganized neighborhood. The G1 mothers of control group G2 participants were slightly younger (mean [SD] age, 24.6 [6.2] years) than mothers in the full intervention group (26.5 [5.2] years), and were more likely to have

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<sup>a</sup> All analyses controlling for maternal age at childbirth and cohort clustering. Significance is indicated in the rightmost column after applying Benjamini-Hochberg false discovery rate multiple comparisons adjustment.

<sup>b</sup> β For standardized outcome (standardized on the dependent variable only).

<sup>c</sup> Mean score across all ages available for each measure and across all 7 waves (N = 182); collected on children aged 1 to 5 years.

<sup>d</sup> Standardized within age; collected on participants aged 6 to 18 years.

<sup>e</sup> Externalizing problems include oppositional defiance, conduct problems, and attention-deficit/hyperactivity disorder; internalizing problems include social problems, anxiety, and affective problems.

<sup>f</sup> Mean score across all ages available for each measure and across all 7 waves (N = 182); collected on children aged 6 to 18 years.

<sup>g</sup> Mostly F (quantified as 0) to mostly A grades (quantified as 4).

<sup>h</sup> Cumulative across waves; collected in participants aged 6 to 18 years. All values in this section are reported as numbers (percentages) and odds ratios (95% CIs).
been teenage mothers to the G2 participant ($\chi^2 = 6.56; P = .004$). Therefore, as in prior intervention articles, all analyses of intervention associations in G3 controlled for the status of the G2 parent as a child of a G1 teenage mother. Results from these full-sample validity analyses$^{27}$ are presented in eTable 1 in Supplement 1.

Table 2 shows no significant control vs full intervention differences in whether participants were located for inclusion in the intergenerational study, eligibility for the intergenerational component, participation, proportion of waves participated, proportion by sex of the SSDP parent participating, race/ethnicity, or marital status or parent age at the birth of the G3 child. Table 2 and eTable 1 in Supplement 1 indicate strong internal validity of intervention tests on G3 participants.

Results show significant positive differences for the offspring of RHC intervention parents across the 4 domains studied: improved child developmental functioning (ages 1-5 years), lower teacher-rated behavior problems (ages 6-18 years), higher teacher-rated academic skills and performance (ages 6-18 years), and lower child self-reported risk behaviors (ages 6-18 years). From birth through age 5 years, G3 offspring of parents in the intervention condition showed significantly fewer developmental delays in communication skills ($\beta = 0.56; P = .001$), gross motor skills ($\beta = 0.48; P = .002$), fine motor skills ($\beta = 0.45; P = .005$), and the overall combined measure ($\beta = 0.49; P = .002$). Mean scores for problem-solving and personal social skills were in the expected direction but did not achieve significance. Mean standardized scores for teacher-rated problem behavior assessed at ages 6 to 18 years were significantly lower for offspring of intervention parents for oppositional defiance ($\beta = -0.39; P = .002$), attention-deficit/hyperactivity disorder ($\beta = -0.46; P = .003$), and an overall externalizing measure ($\beta = -0.41; P = .002$). The $P$ values for intervention outcomes on conduct problems, affective problems, and overall internalizing problems were less than .05, but these were dropped following false discovery rate correction for multiple testing. Mean scores for teacher-rated academic skills and performance assessed at ages 6 to 18 years were significantly higher for offspring of intervention parents for cognitive skills ($\beta = 0.35; P = .002$), academic skills ($\beta = 0.34; P = .009$), and emotional skills ($\beta = 0.49; P = .001$). Teacher reports of the G3 child’s relative academic performance and grades were in the expected directions by intervention condition but did not achieve significance. Child self-reported risk behavior was significantly lower for initiation of any drug (alcohol, cigarettes, or marijuana; $n = 30 [16.4\%]$) for offspring of intervention parents compared with those of control parents ($n = 68 [37.2\%]$; odds ratio, 0.27 [95% CI, 0.10-0.73]). All other child-reported risk behaviors (alcohol onset, cigarette onset, marijuana onset, taken singly; early sexual initiation; and violent and nonviolent delinquency) were in the expected direction but did not achieve significance.

### Discussion

A number of prevention trials implemented in the 1980s have continued to follow up participants over the long term and reported sustained positive outcomes into adulthood. To our knowledge, the present study is the first published report of intervention differences in the offspring of participants in a universal preventive intervention provided when the parents were children. These results indicate that positive results from childhood intervention cannot only cascade into adulthood but into the next generation as well.

It is noteworthy that intervention differences across multiple sources reported here are reflected in ratings across multiple years of assessments in developmental delays in the first 5 years of life, multiple teachers of the G3 children, and multiple years of self-reports of the G3 children themselves, all of whom were blinded to the parents’ original exposure to intervention condition. Significant effect sizes ranged from 0.34 to 0.56 SDs, which reflect substantively meaningful outcomes. By comparison, a recent study examining more than 1100 controlled empirical trials of universal mental health prevention programs found the median mean outcome of universal interventions fell within the range of 0.07 to 0.16 SDs.$^{28}$

### Limitations

The study was a nonrandomized controlled trial and geographically limited. Despite the absence of measurable baseline differences between intervention and control groups on available measures in the intergenerational component, unmeasured differences could partially account for the observed outcomes.
Conclusions

Current cost-benefit analyses examine the benefits of childhood intervention in the target generation into adulthood.29 The present study indicates that additional benefits may be realized through better functioning in the next generation as well. These results bolster the promise of social developmental intervention for improving outcomes of targeted children and promoting positive cascades that endure across generations.

REFERENCES