

Improving Toddlers' Healthy Eating Habits and Self-regulation: A Randomized Controlled Trial

Robert L. Nix, PhD,^a Lori A. Francis, PhD,^{c,d} Mark E. Feinberg, PhD,^{b,d} Sukhdeep Gill, PhD,^e Damon E. Jones, PhD,^{b,d} Michelle L. Hostetler, PhD,^{b,d} Cynthia A. Stifter, PhD^d

abstract

OBJECTIVES: In this study, we tested whether Recipe 4 Success, a preventive intervention featuring structured food preparation lessons, was successful in improving the following 4 protective factors related to overweight and obesity among families living in poverty: toddlers' healthy eating habits, toddlers' self-regulation, parents' responsive feeding practices, and parents' sensitive scaffolding.

METHODS: This randomized controlled trial was open to families enrolled in Early Head Start home visits and included 73 parents and their toddlers aged 18 to 36 months. Multimethod assessments were conducted at baseline and posttreatment.

RESULTS: Compared with toddlers in usual practice Early Head Start, toddlers in Recipe 4 Success consumed healthier meals and snacks ($d = 0.57$; $P < .03$; 95% confidence interval [CI]: 0.08–1.06) and displayed better self-regulation ($d = 0.95$; $P < .001$; 95% CI: 0.43–1.45). Compared with parents in usual practice Early Head Start, parents in Recipe 4 Success engaged in more responsive feeding practices ($d = 0.87$; $P < .002$; 95% CI: 0.34–1.40) and were better able to sensitively scaffold their toddlers' learning and development ($d = 0.58$; $P < .04$; 95% CI: 0.07–1.09).

CONCLUSIONS: This randomized controlled trial revealed medium to large intervention effects on 4 important protective factors that are related to overweight and obesity but are often compromised by living in poverty.



^aDepartment of Human Development and Family Studies, University of Wisconsin–Madison, Madison, Wisconsin; ^bEdna Bennett Pierce Prevention Research Center; ^cDepartments of Biobehavioral Health, and ^dHuman Development and Family Studies, Pennsylvania State University, University Park, Pennsylvania; and ^eDepartment of Human Development and Family Studies, Pennsylvania State University York, York, Pennsylvania

Dr Nix helped conceptualize this trial, conduct focus groups, create the curriculum, train home visitors, supervise treatment, plan data analysis, and write the manuscript; Dr Francis helped conceptualize this trial, conduct focus groups, create the curriculum, supervise treatment, and write the manuscript; Dr Feinberg helped conceptualize this trial, create the curriculum, and write the manuscript; Dr Gill helped conceptualize this trial, create the curriculum, train home visitors, supervise treatment, and write the manuscript; Dr Jones helped plan and conduct data analysis and write the manuscript; Dr Hostetler helped design observation data coding system and analysis, interpret data, and write the manuscript; Dr Stifter helped conceptualize this trial, create outcome measures, and write the manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Deidentified individual participant data will not be made available (families did not provide proper consent for such sharing).

This trial has been registered at www.clinicaltrials.gov (identifier NCT03976089).

DOI: <https://doi.org/10.1542/peds.2019-3326>

WHAT'S KNOWN ON THIS SUBJECT: Few preventive interventions improve healthy eating habits and self-regulation during the toddler years, when these factors related to overweight and obesity are developing most rapidly.

WHAT THIS STUDY ADDS: Recipe 4 Success simultaneously promotes healthy eating habits and self-regulation among toddlers living in poverty and enhances the efficacy of Early Head Start home visits.

To cite: Nix RL, Francis LA, Feinberg ME, et al. Improving Toddlers' Healthy Eating Habits and Self-regulation: A Randomized Controlled Trial. *Pediatrics*. 2021;147(1):e20193326

Obesity is one of the most reliable indicators of poor health across a person's life span.¹ Four protective factors reduce the incidence of childhood overweight and obesity but are less prevalent among families living in poverty: toddlers' healthy eating habits, toddlers' self-regulation, parents' responsive feeding practices, and parents' sensitive scaffolding. In the current study, we report on the first clinical trial of Recipe 4 Success, a home-based preventive intervention that targets those protective factors.

Healthy eating habits are established early in life when taste preferences are being formed.² Healthy eating habits in young children are one of the best predictors of diet in adulthood.³ However, because the least expensive foods are high in calories but low in nutrients, children in food-insecure households are less likely to develop healthy eating habits and more likely to have overweight and obesity.⁴

Self-regulation, which is also established early in life, is multifaceted and involves managing thinking processes and emotions to enable goal-directed behaviors. Physiological and psychological components of self-regulation predict what foods children crave, as well as BMI.⁵ Indeed, self-regulation appears to account for much of the relation between poverty and weight gain over time.⁶ Complex interactions of both genes and environment, including factors such as temperament, parenting, and poverty, affect children's self-regulation.⁷ Importantly, however, self-regulation appears malleable, especially in the presence of responsive and sensitive parenting during early development.⁸

Responsive feeding practices involve the gentle encouragement of healthy eating habits without coercive pressure. For example, a parent might state how tasty a food is and ask the child whether they would like to try it

but accept the child's "no" without further comment. Such responsive feeding practices support children's autonomy and self-regulation in eating and the likelihood of maintaining normal weight.^{9,10}

Positive parenting in general modulates the stress young children experience, thereby reducing allostatic load, including weight gain.¹¹ Sensitive scaffolding, which involves structuring tasks so children are engaged and challenged but not overwhelmed, appears to be especially important to the development of self-regulation.¹²

Systematic reviews have identified few home-based preventive interventions that have positive effects on healthy eating habits in toddlers.^{13,14} In addition, systematic reviews have identified few home-based preventive interventions that help parents promote toddlers' self-regulation.⁸ Although there have been many successful preventive interventions targeting positive parenting, only a few of those interventions have had effects on both healthy eating habits and behaviors related to self-regulation, and those interventions were designed for families with older children.^{15,16}

As depicted in Fig 1, with Recipe 4 Success, we assumed an integrated approach to promoting toddlers' healthy eating habits and self-

regulation and parents' responsive feeding practices and sensitive scaffolding among families living in poverty. Recipe 4 Success was cocreated by administrators and home visitors from Early Head Start to enhance the efficacy of that evidence-based program and to take advantage of its preexisting national infrastructure for dissemination. Given the extensive involvement of Early Head Start in developing the intervention (and given the team of investigators' experience conducting basic research on toddlers' healthy eating habits and self-regulation and clinical trials of preventive interventions for families in community settings), no initial pilot study of feasibility, process, or description was planned.¹⁷ From the beginning, this randomized controlled clinical trial was designed to test whether Recipe 4 Success would result in posttreatment differences in its 4 primary outcomes: toddlers' healthy eating habits, toddlers' self-regulation, parents' responsive feeding practices, and parents' sensitive scaffolding.

METHODS

This trial was approved by the Institutional Review Board of Pennsylvania State University. This trial was conducted from April to October 2013 and registered post hoc at clinicaltrials.gov: NCT03976089. (The original institutional review

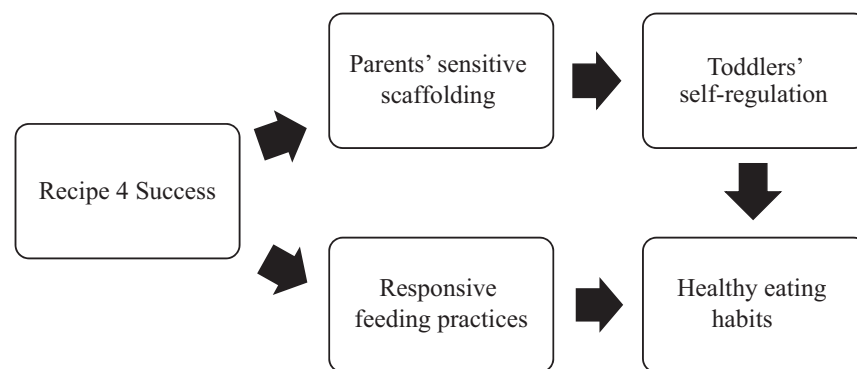


FIGURE 1
Recipe 4 Success conceptual model.

board protocol, intervention curriculum, and assessment battery are available from the first author.)

Participants

To be eligible for this trial, families had to meet the following requirements: (1) have a toddler 18 to 36 months old; (2) be enrolled in home-based Early Head Start with 1 of our 3 community partners during the 3-month recruitment period; and (3) be able to complete assessments in English. To qualify for Early Head Start, most families had to have incomes below the federal poverty threshold. As presented in Fig 2, 152 families were eligible for this trial; 73 families enrolled; and 66 were retained through posttreatment.

Approximately 48% of families were non-Hispanic white; 29% were Black; and 23% were Hispanic or Latinx. Approximately 78% of families were enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children or the Supplemental Nutrition Assistance Program. Almost all parents were biological mothers; 61% were single; 29% had not graduated from high school; only 11% were employed full-time. On average, toddlers were 30.72 months old at trial entry (SD = 6.96); 44% were female.

Randomization and Masking

Home visitors asked parents if they were interested in learning about the trial. If families were interested,

project interviewers explained everything in detail, including consent.

Once baseline assessments were complete, families were randomly assigned to trial conditions with an intended allocation of 1:1, blocked within Early Head Start centers, and based on a coin toss performed by the first author. Families received Recipe 4 Success, delivered as part of Early Head Start home visits, or usual practice Early Head Start home visits, which typically follow the evidence-based Parents as Teachers curriculum.¹⁸ Almost all home visitors had families in both conditions. Neither participating families nor home visitors could be blind to condition, but all project staff members who collected and coded data were.

Intervention Procedure

Recipe 4 Success consisted of 10 consecutive weekly lessons, implemented by families' regular Early Head Start home visitors. The lessons required ~45 minutes of the 90-minute home visits. Recipe 4 Success provided an alternative means of delivering Early Head Start-mandated content that promotes parents' ability to support toddlers' cognitive, social-emotional, language, pre-literacy, numeracy, and physical development. Families in Recipe 4 Success participated in different kinds of lessons for the intervention period but did not receive extra or longer home visits. There were no known harms or unintended effects of Recipe 4 Success; however, if families missed critical material from usual practice Early Head Start, they would have received that material once the trial ended.

Each Recipe 4 Success lesson included some didactic information, such as how toddlers often need to be exposed to a new food 10 to 20 times before they will eat it or how poor sleep can undermine emotional and/

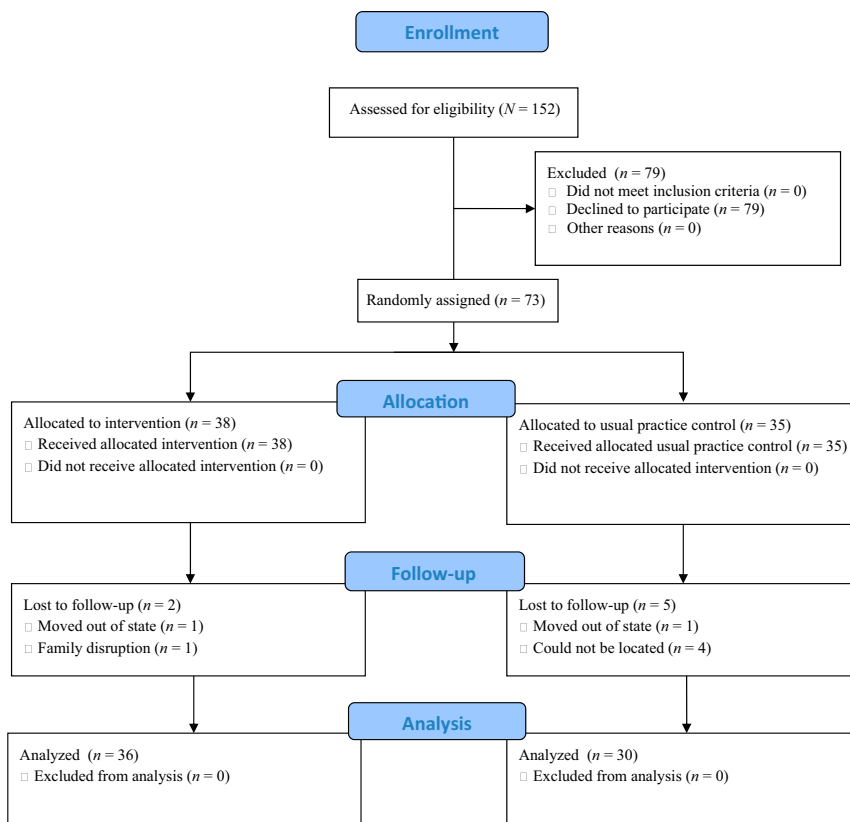


FIGURE 2 Consolidated Standards of Reporting Trials 2010 flow diagram.

or behavioral control and lead to weight gain. However, most of each lesson was focused on active coaching of carefully structured and sequenced food preparation activities involving 3 to 6 ingredients we provided (adjusted as necessary to accommodate food allergies or limited cooking equipment and/or facilities). Toddlers are more likely to eat something they help make.¹⁹ In addition, food preparation provides multiple opportunities for toddlers to practice self-regulation, such as waiting patiently while ingredients cook, and for parents to practice sensitive scaffolding based on techniques used in parent-child interaction therapy,²⁰ such as behavior descriptions and specific praise. Lessons were tailored to toddlers' skill levels. (Even the youngest toddlers could place a piece of cheese on a tortilla, stir dry ingredients in a bowl, or peel a banana.) As part of each lesson, home visitors helped parents identify opportunities for skill generalization in other contexts.

At the end of each lesson, home visitors rated 15 items assessing implementation fidelity, including "I was able to complete this lesson as planned," with 1 = not true and 4 = very true and an average score of 3.53 (SD = 0.52). At the end of each lesson, parents rated 8 items assessing therapeutic engagement, including "My child and I made a good team during the cooking activity today," with the same response options and an average score of 3.72 (SD = 0.43).

Before implementation, home visitors completed one day of training and received a detailed manual. Throughout the trial, home visitors continued to meet with their Early Head Start supervisors but were also encouraged to consult with trial investigators on regularly scheduled conference calls or by e-mail. The cost of providing Early Head Start is \$8000 to \$15 000 per year per child,

depending on state of residence and the mix of center- versus home-based services.²¹ The additional one-time cost of Recipe 4 Success, provided within Early Head Start home visits, was <\$300 per family: \$100 for food, <\$100 for manuals and intervention materials, and <\$100 for group trainings and implementation support. All other costs associated with Recipe 4 Success, such as home visitor salaries, were fixed and incurred regardless of curriculum used.

Assessment Protocol

The same set of measures were collected at baseline, ideally one week before the first lesson, and posttreatment, ideally one week after the last lesson. There were no changes to primary outcomes after the trial began.

Project interviewers conducted in-home assessments, which lasted ~90 minutes. All interviewers had experience from previous research projects, completed training on administering measures for this trial, and were closely supervised by the Pennsylvania State University Survey Research Center.

Undergraduate research assistants coded all video recordings of parent-child interactions. Research assistants completed extensive training on the rating scales until they were reliable with a master coder (intraclass correlation coefficient > 0.80). They also double-coded 30% of all videos to ensure they were reliable with each other (intraclass correlation coefficient = 0.79).

Outcome Measures

Toddlers' healthy eating habits were assessed by parent recall of what food and drinks toddlers consumed in the previous 24 hours. Interviewers collected these recalls on 3 separate occasions, once in person and twice over the telephone, usually within the same week and never including intervention days. These recalls were

structured so parents were separately asked about breakfast, lunch, and dinner, and morning, afternoon, and evening snacks, as well as anything else toddlers ate or drank. To summarize overall healthy eating habits, we computed the percentage of all meals and snacks that included: (1) a fruit and/or vegetable, (2) a source of protein, and (3) no sweets and/or junk food, including ice cream, potato chips, and soda.

Toddlers' self-regulation was assessed with 3 measures tapping different dimensions of the umbrella construct: delay of gratification, task orientation, and emotional and/or behavioral control. The first measure relied on the well-validated snack delay task,²² in which toddlers are presented with an M&M in 4 separate trials and asked to wait 5, 15, 30, and 60 seconds before eating it, with scores ranging from 0 = ate the M&M before time was up to 2 = waited the entire time (Cronbach's α [consistency of scores across trials] = 0.76). The second measure was the task orientation and/or regulation subscale²³ of the Infant Behavior Record.²⁴ After completing the entire assessment battery, interviewers rated toddlers' attention span with scores ranging from 1 = fleeting attention to 9 = long continued absorption; interviewers also rated toddlers' object orientation with scores ranging from 1 = does not indicate interest in objects to 9 = reluctantly relinquishes test materials ($r = 0.50, P < .001$). The third measure was from the well-validated Infant-Toddler Social and Emotional Assessment.²⁵ Parents rated 8 items on toddlers' abilities to stop doing what they wanted and comply with parents' requests, with scores ranging from 1 = not true or rarely and 3 = very true or often (Cronbach's α [consistency of ratings across items] = 0.71). For a summary score, these 3 measures of self-regulation were each standardized, with mean = 0 and SD = 1.00, and averaged.

Parents' responsive feeding practices²⁶ were assessed with video recordings of how parents introduced toddlers to 3 novel healthy foods, such as dried seaweed, which were not part of any intervention lesson. Research assistants rated whether parents praised their toddlers and whether they exerted negative pressure with 0 = behavior absent and 1 = behavior present; the individual ratings were then added together across the 3 foods. Research assistants also rated parents' sensitivity and/or responsiveness and their demandingness across the entire snack-sharing interaction on a 5-point Likert scale with 1 = not at all and 5 = very much. For a summary score, negative pressure and demandingness were reverse scored, and all 4 ratings were standardized and averaged.

Parents' sensitive scaffolding²⁷ was also assessed with video recordings. After viewing each of 3 3-minute interaction tasks (bowling, building a block tower, and completing a shape sorter), research assistants rated parents' tendencies to structure the activity in a developmentally appropriate manner that promotes self-regulation, with scores ranging from 1 = almost never to 5 = almost always. For a summary score, ratings were averaged.

Plan for Analysis

To test the effectiveness of Recipe 4 Success, linear regression equations were estimated for each of the 4 primary outcomes. The following were independent variables in each equation: treatment status, site, child age, days between baseline and posttreatment assessments (range = 90–215), and baseline score of the outcome. All results are reported as Cohen's *d*, which represents the difference in means between families in the treatment and control conditions divided by the pooled SD and adjusted for model covariates. By convention, a Cohen's *d* of 0.20 is

considered small, 0.50 is medium, and 0.80 is large.²⁸

Previous preventive interventions most similar to Recipe 4 Success had medium effect sizes.¹⁰ Optimal Design²⁹ software indicates that a trial needs a sample of 94 families to have 0.80 statistical power to detect a medium effect size of 0.50 with a probability value of 0.05 and covariates, including the baseline score, accounting for 25% of the variance in the outcome. Our recruitment goal was 100 to 105 families. With a sample of 73 families, this trial had 0.80 statistical power to detect an effect size of 0.57.

RESULTS

Descriptive statistics and intervention effects are summarized in Table 1. At baseline, the correlation between toddlers' healthy eating habits and self-regulation was $r = 0.25$ ($P < .05$), and the correlation between parents' responsive feeding practices and sensitive scaffolding was $r = 0.46$ ($P < .001$). The correlation between healthy eating habits and responsive feeding practices was $r = 0.32$ ($P < .01$), and the correlation between self-regulation and sensitive scaffolding was $r = 0.46$ ($P < .001$). Correlations of this magnitude suggest that the 4 primary outcomes were distinct constructs. At baseline, there were no statistically significant differences between families in the treatment and control conditions on any outcome measures or covariates.

Results reveal that, compared with toddlers continuing to receive usual practice Early Head Start, toddlers randomly assigned to Recipe 4 Success were more likely to eat balanced meals and snacks consisting of fruits and/or vegetables, protein, and no sweets and/or junk food (Cohen's $d = 0.57$; $P < .03$; 95% confidence interval [CI]: 0.08–1.06). This value of 0.57 indicates that, on average, toddlers in the 2

experimental conditions differed by more than one-half of 1 SD, which would be considered a medium effect size. Compared with toddlers in usual practice Early Head Start, toddlers in Recipe 4 Success also showed better self-regulation, including delay of gratification in the presence of highly desired food (Cohen's $d = 0.95$; $P < .001$; 95% CI: 0.43–1.45; a large effect size). Compared with parents in usual practice Early Head Start, parents in Recipe 4 Success were more likely to engage in responsive feeding practices (Cohen's $d = 0.87$; $P < .002$; 95% CI: 0.34–1.40; a large effect size). Finally, compared with parents in usual practice Early Head Start, parents in Recipe 4 Success were more likely to demonstrate sensitive scaffolding (Cohen's $d = 0.58$; $P < .04$; 95% CI: 0.07–1.09; a medium effect size).

DISCUSSION

In this trial, we found that implementation of Recipe 4 Success improved multiple protective factors related to childhood overweight and obesity that are often compromised by living in poverty: toddlers' healthy eating habits and self-regulation and parents' responsive feeding practices and sensitive scaffolding. Recipe 4 Success joins a small group of home-based preventive interventions demonstrating success in improving young children's healthy eating habits.^{13–15} Because early food preferences are one of the best predictors of later diet, Recipe 4 Success could impact healthy eating habits across a person's life span.³

Simultaneously, Recipe 4 Success joins a small group of home-based preventive interventions that help accelerate toddlers' acquisition of self-regulation during a sensitive period of development.^{8,30} There is notable rank-order stability in self-regulation after preschool. However, high and low levels of self-regulation become self-reinforcing, making

TABLE 1 Descriptive Statistics and Intervention Effects for Clinical Trial Outcome Measures

Outcome Measure Description	Group Means (SD), <i>n</i>				Intervention Effects		
	Baseline Control	Baseline Treatment	Postintervention Control	Postintervention Treatment	Cohen's <i>d</i>	95% CI	<i>P</i>
Healthy eating habits							
Percentage of meals and snacks over 3 days that included a fruit and/or vegetable, a source of protein, and no sweets or junk food (possible range = 0–1.00)	0.12 (0.10), 35	0.13 (0.11), 38	0.09 (0.08), 30	0.13 (0.12), 36	0.57	0.08–1.06	.03
Self-regulation							
Composite measure representing mean of 3 standardized scales (mean = 0, SD = 1.00): delay of gratification, ²² task orientation, ^{23,24} and emotional and/or behavioral control. ²⁵	0.15 (0.64), 35	−0.10 (0.66), 38	−0.16 (0.76), 30	0.13 (0.59), 36	0.95	0.43–1.45	.001
Responsive feeding practices							
Composite measure representing mean of 4 standardized ratings (mean = 0, SD = 1.00) of shared snack: praise, negative pressure to eat (reverse scored), sensitivity, and demandingness (reverse scored). ²⁶	0.02 (0.51), 32	−0.02 (0.50), 36	−0.18 (0.51), 27	0.18 (0.47), 34	0.87	0.34–1.40	.002
Sensitive scaffolding							
Ratings of parents' ability to structure each of 3 new activities to promote toddlers' learning (Likert scale range = 1.00–5.00). ²⁷	3.19 (0.58), 33	3.49 (0.75), 36	3.09 (0.53), 29	3.42 (0.58), 34	0.58	0.07–1.09	.04

Lower sample sizes for responsive feeding practices and sensitive scaffolding were because of video recording problems. Cohen's *d* represents the difference between treatment and control group means as a proportion of the SD adjusted for covariates.

trajectories diverge over time.³¹ As a consequence, individual differences in self-regulation early in life are associated with dramatic heterogeneity in adult physical health, substance use, criminal arrests, educational attainment, and income.³²

Recipe 4 Success, like most preventive interventions for infants, toddlers, and young children, targets parents to effectuate change. Previous research has revealed that positive parenting reduces the negative impact of environmental risk on adolescents' allostatic load, including weight gain.³³ Previous research has also revealed that experimentally induced changes in positive parenting can help halt premature cellular aging due to chronic stress.³⁴ In the present trial, the quality of parenting was most highly related to healthy eating habits and self-regulation at baseline. By improving parents' responsive feeding practices and sensitive scaffolding even more, Recipe 4 Success may help inoculate toddlers

from the deleterious effects of poverty on a number of health and development outcomes.

Improving Community Capacity to Promote Child Health and Well-being

The results of this trial underscore how Early Head Start can become even more effective in meeting the needs of families living in poverty. Usual practice Early Head Start home visits yield positive but small gains across multiple domains (statistically significant intervention effect sizes = 0.09–0.20).³⁵

This trial demonstrates the potential of focused, time-limited modules embedded within Early Head Start. By targeting specific interrelated outcomes with an integrated, theoretically driven intervention model, Recipe 4 Success was able to substantially boost the effectiveness of Early Head Start (statistically significant intervention effect sizes = 0.57–0.95) in just 10 weeks with a minimal increase in funding.

Trial Qualifications and Conclusions

The primary weakness of this trial was a baseline-posttreatment design, which makes it impossible to determine if intervention effects will be sustained. This trial was also limited to families who speak English, and fewer of those families than expected chose to participate within the limited recruitment period. Because most home visitors had families in both Recipe 4 Success and usual practice Early Head Start, there may have been some contamination across conditions that reduced internal validity. However, any contamination would have made intervention effects smaller, not larger.

The primary strength of this trial included a randomized control condition that was evidence based. The intervention effects of Recipe 4 Success represent changes above what would be expected from usual practice Early Head Start home visits alone. Moreover, those intervention

effects were assessed through multiple independent informants and procedures.

Overall, this trial provides evidence that Recipe 4 Success was successful in promoting protective factors related to childhood overweight and obesity, including healthy eating habits and self-regulation. This trial contributes to our understanding of how to ameliorate

the impact of poverty on toddlers' development and increase the likelihood of long-term health and well-being.

ACKNOWLEDGMENTS

This trial would not have been possible without the invaluable contributions of our Early Head Start partners: Community Progress

Council in York, Pennsylvania; Community Services for Children in Allentown, Pennsylvania; and Success Through Engagement and Partnership (STEP) in Williamsport, Pennsylvania.

ABBREVIATION

CI: confidence interval

Accepted for publication Oct 21, 2020

Address correspondence to Robert L. Nix, PhD, Department of Human Development and Family Studies, University of Wisconsin–Madison, 1300 Linden Dr, Madison, WI 53706. E-mail: robert.nix@wisc.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

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FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: Funded by the National Center for Advancing Translational Sciences (grant UL Tr000127 to the Clinical and Translational Science Institute of Pennsylvania State University), the Eunice Kennedy Shriver National Institute of Child Health and Human Development (grant R01HD081361), and the Social Sciences Research Institute and Edna Bennett Pierce Prevention Research Center of Pennsylvania State University. Funded by the National Institutes of Health (NIH).

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

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Pediatrics 2021;147;

DOI: 10.1542/peds.2019-3326 originally published online December 28, 2020;

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Pediatrics 2021;147;

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