Randomized controlled trial of a telephone-based intervention for child fruit and vegetable intake: long-term follow-up[1–3]

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ABSTRACT

Background: Telephone-based interventions can be effective in increasing child fruit and vegetable intake in the short term (<6 mo). The long-term efficacy of such interventions, however, is unknown.

Objectives: The primary aim of this study was to determine whether the short-term (<6 mo) impact of a telephone-based intervention on children's fruit and vegetable intake was sustained over a longer term. A secondary aim of the study was to assess the long-term impact of the intervention on the intake of foods high in fat, salt, or sugar (noncore foods).

Design: The study used a cluster randomized controlled trial design. Parents were recruited from Australian preschools between February and August 2010 and allocated to receive an intervention consisting of print materials and 4 telephone-counseling calls delivered over 1 mo or to a print information–only control group. The primary endpoint for the trial was the 18-mo postbaseline follow-up. Linear regression models were used to assess between-group differences in child consumption of fruit and vegetables and noncore foods by subscales of the Children's Dietary Questionnaire.

Results: Fruit and vegetable subscale scores were significantly higher, indicating greater child fruit and vegetable intake, among children in the intervention group at the 12-mo (16.77 compared with 14.89; $P < 0.01$) but not the 18-mo (15.98 compared with 16.82; $P = 0.14$) follow-up. There were no significant differences between groups at either of the follow-up periods in the noncore food subscale score.

Conclusion: Further research to identify effective maintenance strategies is required to maximize the benefits of telephone-based interventions on child diet. This trial was registered at http://www.anzctr.org.au/ as ACTRN12609000820202. *Am J Clin Nutr* 2014;99:543–50.

INTRODUCTION

Fruit and vegetables are low-energy sources of vitamins and minerals and are high in fiber (1). Consumption of fruit and vegetables can help maintain bowel and digestive health (2, 3) stabilize glucose concentrations (4), and lower blood pressure (5) and cholesterol (6). The high water and fiber content of fruit and vegetables may also promote satiety and displace other energy-dense foods from the diet, assisting weight management (1). Sufficient consumption of fruit and vegetables in childhood is particularly important because it reduces the risk of future chronic disease (7). Evidence from large prospective cohort studies, for example, has found that higher consumption of vegetables in childhood was associated with a lower risk of stroke (8) and cancer (7) in adulthood.

Most children from developed and developing countries, however, do not meet international guidelines with regard to fruit and vegetable intake (9–11). The preschool years represent a key opportunity to establish healthy dietary behavior in children because dietary habits established in childhood track into adulthood (12). Furthermore, early childhood is a period when children establish an understanding of behavioral norms with regard to eating and meal routines, are imitative of the dietary patterns they observe, and are more responsive to dietary intervention (13, 14). Parents and the home environment are among the most influential determinants of children's eating habits (15, 16) during this period. A number of parent and home food environment factors have been found to influence child diet. For example, parent role modeling, the availability and accessibility of foods in the home, and having set meal times and family rules with regard to eating have been associated with child consumption of fruit and vegetables (17, 18) and intake of "noncore" foods, that is, foods that are typically energy dense and nutrient poor (19–21). As such, interventions targeting families and the home environment represent an opportunity to improve public health nutrition (22).

Despite their influence, few interventions have addressed parent or home environment factors to improve fruit and vegetable intake of children in early childhood. A recent Cochrane review, for example, identified just 4 such randomized trials (23). Two of these trials examined the impact of specific child feeding

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strategies (eg, repeated food exposure and nonfood reward) and found significant short term (<3 mo) increases in consumption of a target vegetable. The remaining 2 trials found that multiple home visiting interventions targeting parent feeding practices and fruit and vegetable availability in the home did not significantly improve child intake (23). Furthermore, the review highlighted the need for future research delivered by using modalities allowing broad community reach, such as via telephone or the Internet; research assessing the longer-term impact of interventions (at least 12 mo), and research assessing the potential unintended adverse effects of interventions (23).

The research team recently undertook a series of studies investigating the potential impact of a brief telephone-based parent intervention ("Healthy Habits") in improving fruit and vegetable intake of children aged 3–5 y (24–26). At a 6-mo follow-up, the Healthy Habits intervention significantly increased fruit and vegetable intake, the primary trial outcome (26), but did not significantly reduce child noncore food consumption, a secondary outcome measure (27). Importantly the intervention did not increase family food expenditure (26), which was a hypothesized unintended adverse impact of the intervention. Despite the positive short-term effects, to assess the potential public health impact of interventions evidence of long-term efficacy is required (28). The primary aim of this study was to determine whether the short-term impact of the Healthy Habits intervention on children's fruit and vegetable intake was sustained 12 and 18 mo after baseline data collection. A secondary aim was to assess the long-term impact of the intervention on noncore food intake.

SUBJECTS AND METHODS

A comprehensive description of the trial methods is provided in the study protocol (25). The study was approved and procedures monitored by the Hunter New England Human Research Ethics Committee (reference no. 08/10/15/5.09) and the Human Research Ethics Committee of the University of Newcastle (reference no. H-200-0410).

Design and setting

The study used a cluster randomized controlled trial design and was conducted in the Hunter region of New South Wales, Australia. The study region is more socioeconomically disadvantaged than the national average, 9% of residents speak a language other than English, and 2% are Aboriginal or Torres Strait Islander (29, 30).

Participants and recruitment

Preschools in the study region were randomly selected and approached to participate in the study. Preschools that provided meals to children, catered for children with special needs, were government preschools, or had participated in child healthy eating research projects in the past 6 mo were excluded. A parent recruitment strategy was developed on the basis of recommendations for recruitment of research participants through schools (31). The strategy included promotion of the trial to parents before formal requests to participate, dissemination of information sheets and consent forms via direct contact with parents (handouts) using brightly colored packages and institutional logos, and parent reminders to return consent forms. Parents were eligible to participate in the study provided they met the following criteria: had children aged 3–5 y who attended a participating preschool, resided with their child for at least 4 d/wk, spoke English, and if their child did not have special dietary requirements for which the intervention strategies would be inappropriate (as determined by an accredited practicing dietitian).

Allocation

After preschool recruitment and baseline data collection, an independent statistician randomly allocated preschools to an intervention or control group in a 1:1 ratio, in randomly sequenced blocks, by using a computerized random number generator (**Figure 1**). Research assistants who recruited parents were blind to group allocation. Preschools were selected as the unit of randomization to prevent intervention contamination between participating parents of children attending the same preschool. Randomization was stratified by the level of disadvantage of the area in which the preschools were located. Parents were not blind to group allocation.

Intervention

The intervention consisted of four 30-min telephone contacts delivered weekly over 1 mo as well as resources including a guidebook that contained information about healthy eating for children. The telephone calls were delivered by trained telephone interviewers with no formal health or medical qualifications. Interviewers attended a 2-d training workshop facilitated by a dietitian, a psychologist specializing in parenting, and a health promotion practitioner. They also completed 10 h of practice telephone contacts. To ensure standardization and intervention fidelity, the content of the calls was scripted by using computer-assisted telephone-interviewing software, and interviewers attended biweekly group supervision. As previously reported, 87% of participants allocated to the intervention group completed all 4 telephone calls, and interviewers covered 97% of key intervention content during the calls (26).

The intervention was based on Golan and Weizman's (32) model for the prevention of obesity among children, which draws on socioecologic theory and seeks to introduce familial norms related to healthy eating in the home. Interventions based on this model have been effective in modifying dietary intake of children (33). Specifically, the intervention sought to increase the availability of fruit and vegetables in the home (eg, ensuring fruit and vegetables are visible and preparing and presenting fruit and vegetables in a way that appeals to children), encourage supportive family eating routines (eg, eating meals as a family and without the television on), and promote parental role modeling of fruit and vegetable consumption. To facilitate maintenance of behavior change, the intervention included strategies for parents to solicit support from all family members, to routinely self-monitor to anticipate future barriers or difficult situations, and to develop contingencies. A comprehensive description of the content of each telephone contact and the behavioral change strategies used, as defined by Abraham and Michie's (34) taxonomy, has been previously published (25). Intervention delivery occurred from April to December 2010.

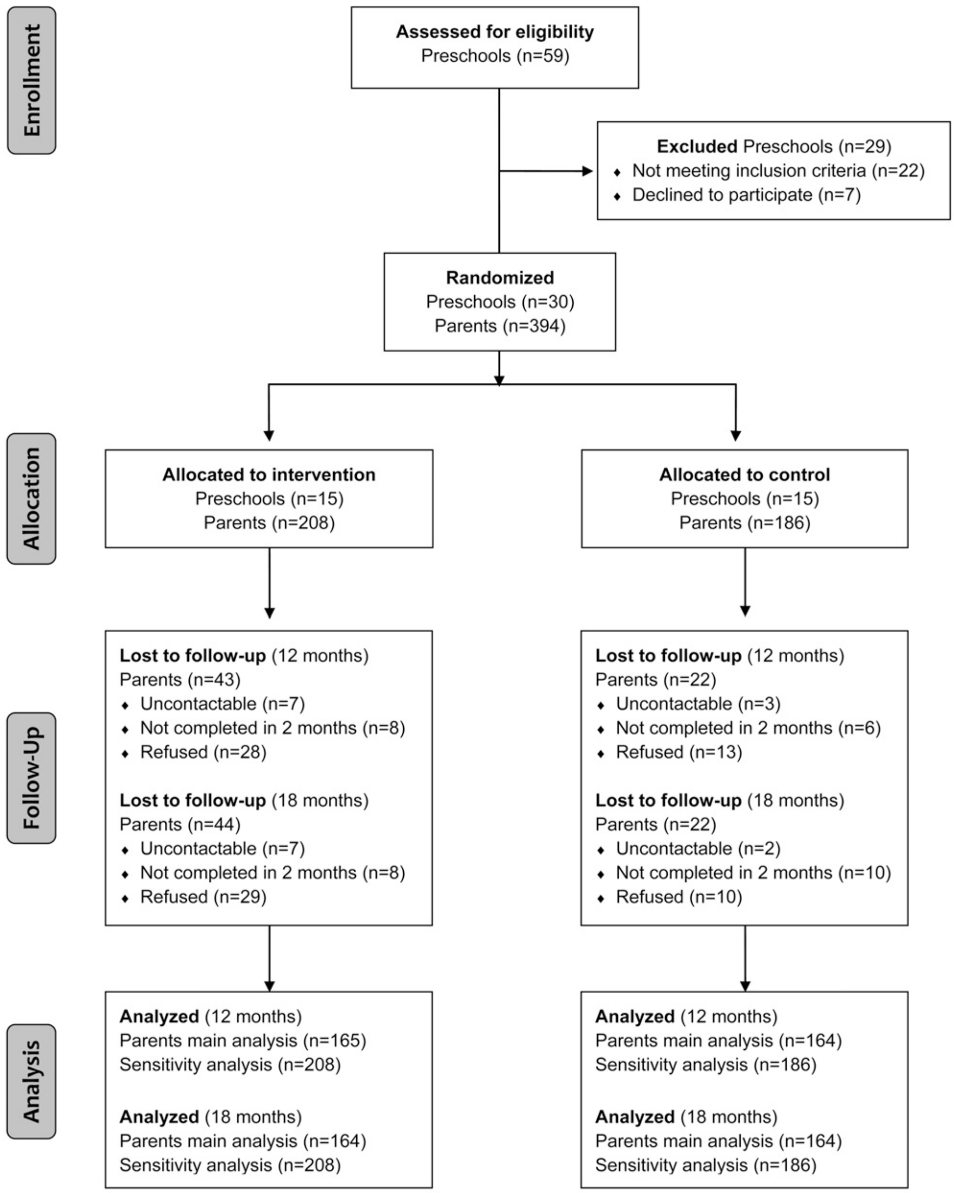

FIGURE 1. Participant recruitment, allocation, and follow-up by group.

The intervention content was based on the *Australian Guide to Healthy Eating* (the National Dietary Guidelines) (35). The guide defines 5 core food groups and recommends specific servings from each be consumed each day. Fruit are one core food group. Vegetables and legumes represent another. Foods or beverages that are not included in a core food group are considered "noncore" foods or "extras" and are typically nutrient poor and high in fat, salt, or sugar. Noncore foods are recommended to be consumed infrequently and in small amounts (35). Consistent with the guidelines, potatoes, dried fruit or vegetables, fruit or vegetable juice, as well as legumes were included in the definition of fruit or vegetables for the purpose of the intervention. Given the energy density and lower fiber content of juice, however, parents were encouraged to give preference to child consumption of whole fruit or vegetables over fruit or vegetable juice. Fried fruit or vegetables were defined as noncore foods, and their consumption was discouraged as part of the intervention. Because the *Australian Guide to Healthy Eating* provides recommendations for children aged ≥4 y, intervention resources and recommendations for children aged 3 y were based on dietary guidelines developed by the Sydney Children's Hospital (36).

Control

Participants in the control group received a copy of the *Australian Guide to Healthy Eating*. The booklet is published by the Australian Government and contains basic nutrition education and recommendations for a healthy diet for adults and children (35).

Data collection

Baseline and follow-up data were collected by trained interviewers who did not participate in recruitment or intervention delivery and who were blind to group allocation. Data collection telephone surveys were scripted and delivered by using CATI software (University of Newcastle) 12 and 18 mo after baseline (April to October 2010). To assess the effectiveness of blinding, immediately after collection of the primary outcome data, interviewers were asked to guess the group allocation of participants. Interviewers correctly guessed the allocation 52% and 57% of the time at 12 and 18 mo, respectively. At the 18-mo follow-up, this was higher than would have been anticipated by chance ($P <$ 0.01).

Measures

Demographic characteristics

Items assessing demographic characteristics of parent participants and their child were sourced from a New South Wales government behavioral risk factor surveillance survey (37) and were collected from the participant consent form and the baseline survey.

Primary outcome: child fruit and vegetable intake

The fruit and vegetable subscale of the Children's Dietary Questionnaire (CDQ) was used to assess child fruit and vegetable intake (38). The CDQ fruit and vegetable subscale requires parents to report the frequency and variety of fruit and vegetables consumed by their child in the past 24 h and in the previous 7 d. Subscale scores can range from 0 to 28 (38). A change of 1 point on the subscale could arise from multiple scenarios, including a child consuming an additional variety of fruit or vegetable or consuming fruit or vegetables on an additional occasion on the previous day. At the time of trial conception, the CDQ was the only food-frequency tool assessing fruit and vegetable intake that had been validated in a sample of Australian preschool-aged children. The subscale was found to be reliable (test-retest intraclass correlation coefficient = 0.75) and valid compared with a 7-d checklist (Spearman correlation coefficient = 0.58) and was recommended for use in assessing the efficacy of interventions to improve the diets of Australian children (38).

Because the CDQ subscale is not a serving-based measure of fruit and vegetable intake, for the 12- and 18-mo follow-up surveys, 2 items from the New South Wales Child Health Survey (39) were also included to provide a crude serving-based quantification of between-group differences in child fruit and vegetable intake. The items were intended to provide additional descriptive information with regard to the trial outcome and were not included in the initial protocol. Specifically, to assess usual fruit intake, parents were asked "How many serves of fruit does [child name] usually eat each day? A child serve is a small piece of fruit or a 1/2 cup of diced pieces." To assess usual vegetable consumption, parents were asked "How many serves of vegetables does [child name] usually eat each day? One serve is equivalent to 1/4 cup of cooked vegetables or 1/2 cup of salad vegetables."

Secondary outcome: child noncore food intake

A key strategy of the intervention was to replace noncore foods with fruit and vegetables. Noncore food consumption was therefore included as a secondary trial outcome. Previously published trial data reported that noncore food intake among children in the intervention group was significantly lower at the 2-mo but not the 6-mo follow-up (27). Noncore food intake was assessed by using the noncore food subscale of the CDQ (38). The subscale assessed the frequency within the past week with which children consumed items from a list of common noncore foods. Subscale scores can range from 0 to 10.3, with a higher score representing greater child intake of noncore foods. Test-retest reliability (correlation coefficient = 0.90), validity (compared with a 7-d food checklist; Spearman correlation = 0.31), and internal consistency (Cronbach's α = 0.56) have been previously established in a sample of Australian children (38).

Unintended adverse impact: family food expenditure

Given that the cost of fruit and vegetables is frequently cited as a barrier to their consumption (40), it was hypothesized that an increase in household food expenditure may be an unintended adverse impact of the intervention. Purpose-designed questions were developed to assess food expenditure. Participants were asked the following question at the 12- and 18-mo follow-up: "On average, how much do you spend on food for your household each week? This includes foods you buy from the supermarket as well as any foods you buy and eat outside the home, for example, takeaway, restaurant meals, lunches." The psychometric properties of the item were unknown.

Sample size calculation

Sample size estimates were calculated a priori and are also described in the trial protocol (25). A sample size of 200 participants/group at baseline was anticipated from 30 preschools, of which 300 of the 400 were expected to be retained at the 18-mo follow-up. A sample of this size would provide a detectable difference between groups in the CDQ fruit and vegetable subscale score of 1.27, with 80% power assuming an interclass correlation coefficient of 0.03 and using an α of 0.05.

Statistical analysis

Data analysis was performed by using SAS statistical software version 9.2 (SAS Institute). Linear regression models within a generalized estimating equation (GEE) framework were used to assess the impact of the intervention on CDQ fruit and vegetable subscale scores, accounting for baseline score and clustering. The primary endpoint for analysis was the 18-mo follow-up. All analyses were conducted under an intention-to-treat approach in which participant data were analyzed in the group to which participants were allocated. As specified a priori, intervention efficacy was assessed by using all of the available data. GEE models assume that any missing data are missing at random. A sensitivity analysis was also performed whereby baseline data were carried forward for any missing data at follow-up to assess the robustness of the missing data at random assumption of the main analysis. In addition, subgroup analyses were performed to determine whether the intervention had a differential impact on the basis of parent socioeconomic status. The sample was divided into 2 subgroups: *1*) according to the household income of the parent participant (≥$80,000 or <$80,000) and *2*) according to the educational attainment of parent participants (university education or no university education). A GEE model was fitted that included a subgroup by experimental group interaction. Differences between groups in servings of fruit and vegetables on the basis of the 2 items from the New South Wales Child Health Survey, in noncore food subscale score, and food expenditure were also assessed by using GEE models.

RESULTS

Four hundred eighteen parents consented to participate in the trial of whom 394 completed the baseline telephone surveys and were randomly assigned (on the basis of the preschool their child attended) to intervention and control groups (Figure 1). The characteristics of the intervention and comparison groups were similar (**Table 1**). At the 18-mo follow-up, 164 intervention participants (78%) and 164 control group participants (88%) provided outcome data (Figure 1). There were no significant differences in the baseline characteristics between participants who provided data at the 12- mo follow-up and those who did not ($P < 0.05$). At 18 mo, a greater proportion of parents who provided follow-up data had a university education compared with those who did not provide data in both the intervention (49% compared with 32%; $P = 0.04$) and control (52% compared with 27%; $P = 0.03$) groups.

Child fruit and vegetable intake

At the 12-mo follow-up, CDQ fruit and vegetable subscale scores were significantly higher among children of the intervention group, indicating greater child fruit and vegetable intake (**Table 2**). The effect remained significant when baseline data were substituted for missing data at follow-up. To contextualize this difference, analysis of postintervention differences between groups at 12 mo found that children in the intervention group consumed significantly more child servings of fruit (mean ± SEM: 2.86 ± 0.11 compared with 2.43 ± 0.09; $P < 0.01$) and vegetables (2.95 ± 0.12 compared with 2.47 ± 0.11; $P < 0.01$). At the 18-mo follow-up, there were no significant differences between groups in the CDQ fruit and vegetable subscale score (Table 2). However, there were significant postintervention differences in the mean (±SEM) number of child servings of fruit (2.91 ± 0.10 compared with 2.42 ± 0.08; $P < 0.001$) and vegetables (2.98 ± 0.11 compared with 2.55 ± 0.10; $P < 0.01$) reportedly consumed, favoring children in the intervention group. There were no significant subgroup (household income or parent education) by experimental group interactions on fruit and vegetable subscale scores ($P > 0.05$).

Child noncore food intake

Mean (±SEM) noncore food subscale scores did not differ significantly between the intervention and control groups at 12 mo (2.30 ± 0.09 compared with 2.40 ± 0.09; $P = 0.71$) or at 18 mo (2.42 ± 0.09 compared with 2.58 ± 0.09; $P = 0.34$).

Family food expenditure

There were no significant differences between groups in weekly grocery spending at either the 12-mo (mean ± SEM: \$250 ± \$7.68 compared with \$249 ± \$5.51) or the 18-mo (\$256 ± \$6.38 compared with \$255 ± \$5.98) follow-up for participants in the intervention and control groups, respectively.

DISCUSSION

The Healthy Habits trial was designed to test the efficacy of a relatively brief telephone-based parent intervention in increasing fruit and vegetable intake among preschool-aged children. The study found that positive changes in CDQ fruit and vegetable subscale scores among children from the intervention group were significantly greater compared with controls at the 12-mo but not the 18-mo follow-up. As reported in trials of interventions targeting older children (41) and adults (42), the findings suggest that sustaining child dietary improvement over the long term represents a considerable challenge for public health practitioners working with preschool-aged children. Further research to identify feasible approaches to provide ongoing dietary support to parents and children to sustain dietary changes is therefore warranted.

The positive intervention effect on the primary trial outcome reported at 12 mo is encouraging given that the intervention was relatively brief, consisting of just 4 telephone contacts and associated print materials. Systematic reviews of telephone-based dietary interventions in adults have found a dose-response relation between intervention efficacy and intervention intensity,

TABLE 1
Baseline characteristics of participants by age group[1]

Characteristic	Control (n = 186)	Intervention (n = 208)
Parents		
Age (y)	35.7 ± 5.0[2]	35.2 ± 5.6
Female (%)	96.8	95.2
Household income ≥\$100,000 (%)	40.2	42.4
University education (%)	49.5	45.2
Aboriginal and/or Torres Strait Islander (%)	3.2	1.0
Number of children (<16 y) in household	2.3 ± 0.7	2.3 ± 0.8
Daily servings of fruit	1.8 ± 1.0	1.8 ± 1.1
Daily servings of vegetables	3.1 ± 1.3	3.3 ± 1.3
Children		
Age (y)	4.3 ± 0.6	4.3 ± 0.6
Female (%)	45.7	51.0
Aboriginal and/or Torres Strait Islander (%)	4.8	1.0

[1] Reproduced with permission from reference 25.
[2] Mean ± SD (all such values).

TABLE 2
Fruit and vegetable subscale scores on the Children's Dietary Questionnaire

Time point	Control	Intervention	Regression coefficient[1] (95% CI)	*P* value
Main analysis				
Baseline (n = 394)	14.51 ± 0.38[2]	15.03 ± 0.34	—	
12 mo (n = 329)	14.89 ± 0.35	16.77 ± 0.27	1.61 (0.88, 2.33)	<0.001
18 mo (n = 328)	15.98 ± 0.36	16.82 ± 0.30	0.51 (−0.17, 1.18)	0.14
Sensitivity analysis				
Baseline (n = 394)	14.51 ± 0.40	15.03 ± 0.34	—	
12 mo (n = 394)	14.79 ± 0.29	16.36 ± 0.23	1.25 (0.64, 1.86)	<0.001
18 mo (n = 394)	15.81 ± 0.32	16.35 ± 0.32	0.20 (−0.44, 0.84)	0.54

[1] Data were analyzed by using a generalized estimating equation framework, adjusted for score at baseline and clustering within preschools.
[2] Mean ± SEM (all such values).

with efficacious intervention typically characterized by interventions lasting for 6–12 mo and consisting of ≥12 telephone contacts (43). Also encouraging is the magnitude of the effect reported at 12 mo. The study found a between-group difference of almost a full child serving of fruit and vegetables (0.43 child servings of fruit and 0.48 child servings of vegetables), which is equivalent to ∼50 g of fruit and vegetables and greater than the effect sizes reported in effective trials included in the Cochrane Review (23). Relative to children in the control group, at the 12-mo follow-up, this increase represented an additional 11% and 10% of children in the intervention group who consumed the minimum daily recommended servings of fruit and vegetables, respectively.

Nonetheless, the intervention was not significantly effective in improving intake at the primary trial endpoint, the 18-mo follow-up. The findings could reflect an attenuation of initial improvements made in the home and family food environment by participants. Increasing the intensity of intervention support through providing greater follow-up contact over a more prolonged period may have increased the likelihood that home and family food environment and fruit and vegetable intake were maintained beyond 12 mo (42). The use of smartphone applications or SMS (Short Message Service) text messaging to prompt and reinforce the use of strategies, such as parent role modeling or fruit and vegetable availability in the home, or to provide updated age-appropriate information and resources may represent a cost-effective way of providing such additional support (44). Future research should test this hypothesis. Alternatively, as children reach school age, they may be less influenced by parents and the home environment as they become more exposed to the dietary behaviors of their peers and the school food environment and have more autonomy with regard to food selection (45, 46). Testing the long-term effectiveness of integrated interventions, which seek to improve the home and school/childcare environments so that they are more supportive of fruit and vegetable consumption, is therefore warranted. Social ecologic theory suggests that such interventions have a greater capacity to improve child diet through influencing multilevel determinants of fruit and vegetable intake (47).

Consistent with the findings of the 6-mo follow-up (27), the intervention did not have a significant impact on child noncore food intake at either the 12- or 18-mo follow-up. Whereas parents were encouraged to role-model consumption of fruit and vegetables in place of noncore foods during meals and snacks, and restrict the availability of noncore foods in the home, addressing such a limited number of determinants of child noncore consumption foods may have been insufficient to improve intake. Systematic reviews suggest that a more targeted intervention addressing multiple determinants and that uses behavior-change techniques across the spectrum of the behavior-change process may be required to reduce child noncore food consumption (48).

A number of methodologic considerations of the trial warrant consideration. First, whereas the study used a validated food-frequency questionnaire to assess the primary trial outcome, a more rigorous assessment of child fruit and vegetable intake, such as multiple 24-h dietary recalls, would have improved the internal validity of the study. Second, the trial also included single-item assessments of fruit and vegetable intake. Brief screeners and food-frequency questionnaires typically underestimate fruit and vegetable intake (49), and brief questionnaires have been found to be less correlated with biomarkers of intake compared with more comprehensive assessments (50). The between-group differences in servings of fruit and vegetables reported in this study should be interpreted with this in mind. Third, participants were more socioeconomically advantaged than their peers in the community from which they were drawn, which may limit the external validity of the findings (51). A subgroup analysis, however, suggests that the effect of the intervention was similar at 12 mo among children from households with a total income of ≥$80,000 and those from households earning <$80,000. The effect size was also similar at 12 mo among children of parents with and without a university qualification. Finally, whereas there was no evidence of an adverse impact of the intervention on household food expenditure, other potentially important unintended adverse effects of the intervention were not investigated. For example, because increases in fruit and vegetable consumption at the 12-mo follow-up did not coincide with reductions in noncore food intake, there is the possibility that the intervention may have displaced other core foods from children's diets or increased total energy intake. Future research should incorporate a comprehensive dietary assessment to investigate the potential for such adverse effects.

Notwithstanding these limitations, the Healthy Habits trial makes an important and novel contribution to the limited evidence base with regard to strategies to improve child fruit and vegetable intake. The trial used a randomized design, achieved high rates of intervention completion (87% of participants completed all intervention calls) and low rates of attrition, and used blinded outcome assessors. The trial followed up participants for an extended period and used a low-cost intervention modality that had not been previously tested to improve fruit and vegetable intake of children of this age. Furthermore, at least among the relatively affluent study sample, there was no evidence that the intervention represented a financial burden to participants. Nonetheless, enhancing the public health impact of the intervention requires researchers and practitioners to identify strategies to sustain effects over the longer term.

The authors' responsibilities were as follows—LW: conceived the study idea, secured funding, led the development of the manuscript, and had primary responsibility for the final content; LW, RW, EC, LB, KJC, AF, JW, JB, and TRH: designed the research; RW and AF: recruited participants; LB: provided psychological supervision of telephone staff; LW, AF, LB, KJC, and JB: developed the intervention; RW: managed intervention implementation and performed the statistical analyses; KJC: provided advice regarding dietary assessment; and all authors: interpreted statistical analyses, provided critical comment on the manuscript drafts, and approved the final manuscript. None of the authors declared a conflict of interest. None of the authors received any benefits from any source perceived to have an interest in the outcome of this study.

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