Impact of an early-life intervention on the nutrition behaviors of 2-y-old children: a randomized controlled trial$^{1,2}$

Louise J Fangupo,$^3$ Anne-Louise M Heath,$^3$ Sheila M Williams,$^4$ Megan R Somerville,$^3$ Julie A Lawrence,$^2$ Andrew R Gray,$^4$
Barry J Taylor$^5$ Virginia C Mills,$^3$ Emily O Watson,$^2$ Barbara C Galland,$^5$ Rachel M Sayers,$^5$ Maha B Hanna,$^5$ and Rachael W Taylor$^6$*

Departments of $^3$Human Nutrition, $^4$Preventive and Social Medicine, $^5$Women’s and Children’s Health, and $^6$Medicine, University of Otago, Dunedin, New Zealand

**ABSTRACT**

**Background:** Despite an extensive well-child health service, 30% of New Zealand’s 2- to 4-y old children are overweight or obese. This suggests that additional intervention is necessary to establish healthy nutrition behaviors.

**Objective:** The aim of this study was to assess the effect of intervention from 0 to 18 mo of age on food and nutrient intake, eating behaviors, and parental feeding practices in 18- to 24-mo-old children.

**Design:** In total, 802 families with healthy infants were randomly allocated to 1 of 4 groups: Usual Care (UC); Food, Activity, and Breastfeeding (FAB); Sleep; or FAB and Sleep (Combination). All groups received standard “well-child” care. The FAB intervention comprised 7–8 additional contacts for education and support around breastfeeding, food, and activity. The Sleep intervention comprised 2 additional contacts for guidance about sleeping habits. Combination families received both interventions. A validated food-frequency questionnaire assessed food intake at 2 y. A questionnaire assessed eating behaviors and parental feeding practices at 18 and 24 mo.

**Results:** At 2 y, there were no statistically significant differences in food and nutrient intake or eating behaviors in the groups receiving the FAB intervention (FAB, Combination; 325 children) compared with the groups who did not (Sleep, UC; 341 children). With the use of a 5-point scale, small but statistically significant differences in parental feeding practices were observed in the groups receiving the FAB intervention: greater child control over eating (difference: 0.14; 95% CI: 0.02, 0.26) and less pressure to eat (difference: 0.18; 95% CI: 0.04, 0.32) at 18 mo, as well as greater encouragement of nutrient-dense foods at 24 mo (difference: 0.16; 95% CI: 0.03, 0.30). No statistically significant differences were observed between the groups who received the Sleep intervention (Sleep, Combination; 313 children) and those who did not, except higher meat intake in the former (11 g/d).

**Conclusion:** Additional education and support for parents from birth did not improve nutrition behaviors in this population at 2 y of age. This suggests that additional intervention is necessary to establish healthy nutrition behaviors.

**Keywords:** infants, intervention, nutrition, toddlers, food

**INTRODUCTION**

Infants who gain weight rapidly between birth and 2 y of age have a 2- to 3-fold increased risk of obesity (1), and overweight children are more likely to become overweight adults, with associated morbidity and mortality risks (2). Food preferences and eating patterns are established during infancy (3) and continue into childhood and beyond (4, 5). This is of particular concern because dietary quality is suboptimal for many children during the first 2 y of life (6, 7). Parents play a critical role in the development of food preferences and eating behaviors (8) and have potential as key targets in health interventions (9). In particular, parents of infants have been shown to access health care services and seek wellness advice frequently, which may suggest a potential need for, and receptivity to, additional information and support (10). Furthermore, it is well documented that obesity interventions beginning in later childhood (up to 18 y of age) have had limited success (11, 12). This has been attributed, at least in part, to these interventions beginning after lifestyle factors such as dietary intake and activity levels are well established and therefore difficult to modify (13). Such findings have increased interest in interventions that encourage parents to establish healthy behaviors around food and eating in their children in the first few years of life (14, 15). However, little is known about how to intervene effectively in this group, with few published studies to date. Three Australian randomized controlled trials (16–18) have each reported modest intervention effects on the intake of just a few foods and eating behaviors in 20- to 24-mo-old children, despite detailed intervention messages and multiple outcome measures.

Child health is a leading government priority in New Zealand (19). A free package of universal health services, entitled Well Child Tamariki Ora, is offered to all New Zealand families for their children from birth to 5 y of age. The package includes 12 core contacts and serves as a gateway to specialist services for children and families with additional needs (20). Despite this.
excellent service, New Zealand has high rates of child overweight and obesity, with 1 in 3 children already overweight or obese by 2–4 y of age (21). The Prevention of Overweight in Infancy (POI) study was designed to determine whether additional support and education around food, activity, and sleep from late pregnancy to 18 mo of age could positively affect the diet, food-related behaviors, and body weight of young New Zealand children (22). Here, we aim to determine whether the nutrition intervention delivered as part of the POI study had an impact on the food and nutrient intake, eating behaviors, and parental feeding practices of children at 2 y of age.

METHODS

Study design

The POI study was a randomized controlled trial undertaken in Dunedin, New Zealand, between 2009 and 2012. The protocol has been described in detail elsewhere (22), but relevant information is outlined briefly here. The study was approved by the New Zealand Lower South Regional Ethics Committee (LRS/08/12/063).

Women booking into the Queen Mary Maternity Unit, Dunedin Hospital (the only birthing center in the city of Dunedin [population 120,000]), were eligible to participate if they were aged at least 16 y, were able to communicate in English or Te Reo Māori (the indigenous language of New Zealand), and were planning to live in the Dunedin area for the next 2 y. Women planning home births (<3%) were provided with information about the study by their lead maternity carer (usually a midwife). Exclusion criteria applied after birth were prematurity (born before 36.5 wk of gestation) or identification of a congenital abnormality or a physical or intellectual disability likely to affect feeding, physical activity, or growth. The study statistician used a computerized random-number generator to assign blocks of participants to 1 of 4 study groups: Usual Care (UC); Food, Activity, and Breastfeeding (FAB); Sleep; or Combination (receiving the FAB and Sleep interventions). Stratified block allocation was used to control for socioeconomic status [low, medium, and high, defined as a New Zealand Deprivation Index score of 1–3, 4–7, and 8–10, respectively (23)] and parity (first child, subsequent child). A block size of 3 was used within each combination of strata (total length 12). Families were enrolled antenatally by research nurses, and enrollments were confirmed at birth. Allocations were made by opening sealed opaque envelopes prepared for each of the 6 strata after inclusion and exclusion criteria had been checked and the mother had provided written informed consent. It was not possible to blind participants to their intervention groups. Research nurses were blinded to anthropometric outcomes but not to food-frequency questionnaire (FFQ) or questionnaire outcomes. Statistical analyses were undertaken blinded, with group codes revealed after the analysis of the main outcomes.

Families in all 4 groups received the standard government-funded care service available to all New Zealand families. The Well Child Tamariki Ora schedule includes 6 core visits in the first 18 mo of a child’s life (20). Each of these visits incorporates 3 key components: health and development assessments, family support, and health education (which includes information on breastfeeding, food and activity, and a number of other topics, including safety and injury prevention, immunization, oral health, newborn hearing, newborn metabolic screening, recognition of childhood illnesses, and prevention of shaken baby syndrome). Lead maternity carers (usually midwives) typically provide the first visit at 4–6 wk of age and then refer the family to another provider for further visits at 8–10 wk, 3–4 mo, 5–7 mo, 9–12 mo, and 15–18 mo of age (20). Families in the 3 intervention groups received support and education according to group allocation in addition to this standard care.

The FAB intervention (delivered to the FAB and Combination groups) comprised 8 additional parent contacts for education and support around breastfeeding, food, and activity over the first 18 mo. Only 4 of these visits (at 4, 7, 13, and 18 mo of age) are relevant to the food intervention and are discussed here. The remaining visits were for breastfeeding support (antenatal and at 1 wk of age) and the physical activity intervention (at 3, 9, and 18 mo of age). The main nutrition intervention messages are outlined in Figure 1. Trained research staff (under the supervision of nutritionists and pediatricians) discussed the messages and provided written and visual resources during individual face-to-face sessions with the mother at ∼4, 7, and 13 mo of age. The 18-mo session was a group session in which parents and their children participated in 3 different interactive stations targeting healthy snack and drink ideas, healthy food shopping, and basic food label reading skills.

The Sleep intervention (delivered to the Sleep and Combination groups) comprised 2 additional parent contacts to provide guidance and resources for developing appropriate sleep habits. These were delivered at a group antenatal session and at an individual home visit at 3 wk of age.

The Combination group received 9 intervention visits in total because the FAB and Sleep antenatal visits were combined.

Outcome measurements

Questionnaires were completed at baseline (late pregnancy) and 18 mo and 2 y of age. Demographic variables were collected at baseline and included maternal self-reported prepregnancy BMI (in kg/m²), parity, education level, and age at child’s birth; the ethnicity of each parent; and the household’s New Zealand Deprivation Index score (23). Most demographic questions were the same as those used for the New Zealand Census (24) to allow comparisons with the New Zealand population.

Specific eating behaviors relevant to the intervention were assessed at 2 y by using the following questions: “How many different fruits is your toddler offered each day?” “How many different vegetables is your toddler offered each day?” “Does your child usually drink from a cup or a bottle?” “How many days each week does your toddler usually eat breakfast?”

Two statements were scored by using 5-point Likert-type items (1 = never to 5 = always): “We eat our evening meal together as a family” and “I allow my child to play and watch TV during a meal.” Household scores for the availability of fruit and vegetables and obesogenic (high fat or sugar) foods were

7 Abbreviations used: EAT, Eating Assessment in Toddlers; FAB, Food, Activity, and Breastfeeding; FFQ, food-frequency questionnaire; POI, Prevention of Overweight in Infancy; UC, Usual Care.
1. Eat from the four main food groups each day:
   a. Fruit and Vegetables
   b. Bread and Cereals
   c. Milk and Milk Products
   d. Lean meat and alternatives
2. Offer two different fruits each day
3. Offer two different vegetables each day
4. Limit intake of high-sugar foods and energy-dense snack foods
5. Avoid sugary drinks, cordials, soft drinks, fruit drinks
6. Eat breakfast every day
7. Eat with the family most nights and most breakfasts, at the table
8. Avoid eating meals in front of the television
9. Limit the availability of sugary drinks and energy-dense snack foods in the home
10. Parents model desirable food consumption behaviors
11. Parents use an authoritative feeding style.

FIGURE 1 Main nutrition intervention messages for infants and toddlers in the intervention groups receiving the FAB intervention (FAB and Combination). Breastfeeding messages are not reported because the outcomes are not measured here. FAB, Food, Activity, and Breastfeeding.

determined by using the home food inventory by Fulkerson et al. (27), which was modified to be suitable for New Zealand families. Parents indicated which of 200 foods or food groups they had in their house on a randomly assigned day, and the scores were subsequently calculated.

Parental feeding practices were assessed at 18 and 24 mo of age. Ten subscales from the Comprehensive Feeding Practices Questionnaire were used at 18 mo of age: Encourage Balance and Variety, Environment, Food as Reward, Involvement, Modelling, Monitoring, Pressure, Restriction for Health, Restriction for Weight Control, and Teaching about Nutrition (25). Each subscale consists of several items, and each item is measured by using one of two 5-point scales: either a response scale from “never” to “always” or an anchored scale (disagree, slightly disagree, neutral, slightly agree, agree). The feeding control instrument by Murashima et al. (26) was used at 2 y. This instrument employs a 7-factor structure to assess directive, non-directive, and food environmental control of feeding. The 7 factors are high control, high contingency, child-centered feeding, nutrient-dense food-encouraging practice, energy-dense food-discouraging practice, mealtime behavior, and timing of meal. Each factor consists of several items, and each item is scored by using 5-point Likert-type items (1 = never to 5 = always, with reverse scoring for items measuring undesirable behaviors).

Dietary intake: FFQ

Dietary intake was assessed at 24 mo of age by using the Eating Assessment in Toddlers (EAT) FFQ (28, 29). The EAT FFQ is semiquantitative and assesses the intake of 91 food items over the previous 4 wk, using 10 frequency categories ranging from “not eaten this month” to “number of times eaten per day.” The amount of each food item consumed is measured by using either natural portion sizes (e.g., one slice of bread, one kiwifruit) or child’s palm volume (defined as palm width \times length \times thickness) for foods that do not have a natural portion size (e.g., number of palms of porridge, number of palms of rice). Palm volume was chosen as a method of quantifying portion size because a child’s palm is always in close proximity to the food he or she is eating and is therefore theoretically easier for the caregiver to recall when completing the FFQ (30). Researchers at the University of Otago created the EAT FFQ by adapting the Southampton Women’s Survey FFQ (31) for use with New Zealand toddlers. A separate validation study (n = 153 parents of 12- to 24-mo-old New Zealand toddlers) in 2012 demonstrated that the EAT FFQ had acceptable relative validity for ranking toddlers according to nutrient intake (28) and for identifying dietary patterns in toddlers (29) compared with a weighed food record completed on 5 random, nonconsecutive days over a month. Further validation of the FFQ was required here to report food group intakes and is described in the Supplemental Material. To summarize this additional validation, based on statistical tests, the EAT FFQ was considered to have adequate relative validity for ranking participants’ intake in grams of the following 11 food groups: bread, pasta, rice, and low-sugar cereal; meat; eggs and beans; vegetables; fruit; milk and milk products; spreads; cakes, cookies, puddings, confectionary, sweet snacks, and sweet cereals; sweet drinks; French fries, roast potato, and sweet potato; and savory snacks. It was considered to have adequate relative validity for reporting absolute intake amounts (in grams) of 5 food groups: meat; vegetables; French fries, roast potato, and sweet potato; sweet drinks; and toddler milk and infant formula.

Palm volume

Child palm volume (used to calculate grams of intake in the FFQ) was defined as palm width \times length \times thickness. At 24 mo of age, each child’s palm was scanned (Canoscan LiDE 110; Canon USA), and the computer program ImageJ (Free Software Foundation) was then used to determine palm width and length. Palm thickness was measured by using an anthropometer (Model 01291; Lafayette Instrument Company).

Statistical analysis

The POI study had a 2 \times 2 factorial design, meaning that the 4 study groups (FAB, Sleep, Combination, and UC) could be analyzed in different combinations to determine the effects of the 2 interventions separately—that is, an analysis of the FAB intervention (received by the FAB and Combination groups but not by the Sleep and UC groups) and a separate analysis of the Sleep intervention (received by the Sleep and Combination groups but not by the FAB and UC groups). This approach, using combinations of groups, is more efficient than comparing the 4 groups individually, providing more precise estimates of the main effects (32, 33). It is only appropriate, however, if there is no interaction between the interventions (i.e., if the effect of the FAB intervention is not modified by the presence or absence of the Sleep intervention), and because a large sample size is required to identify an interaction effect, the study may not have sufficient power to detect an interaction effect. A 2 \times 2 factorial design is, however, the only design that allows such interaction effects to be investigated (32).

The data were analyzed according to modified intention to treat (all available data were used) by using regression models with terms for FAB intervention (i.e., membership of either the
FAB or Combination group) and Sleep intervention (i.e., membership of either the Sleep or Combination group) to analyze the data. Interaction terms were included in the first instance to test for the existence of interactions despite our assumption that an interaction effect was unlikely [interaction effects are more likely to occur when the 2 interventions have related mechanisms of action, which is not the case in this study (33)]. The interaction terms were later excluded because they were not statistically significant. The stratification variables socioeconomic status [low, medium, and high, defined as New Zealand Deprivation Index score of 1–3, 4–7, and 8–10, respectively (23)] and parity (first child, subsequent child) were also included in the model. Quantile regression was used to estimate the differences between the median food group intakes for the presence or absence of the FAB intervention and the presence or absence of the Sleep intervention. Poisson regression with robust SEs was used to compare the differences in eating behavior and the results presented as RRs (34). Linear regression was used to examine parental feeding practices.

Statistical analyses were carried out by using Stata 13 (StataCorp). A 2-sided \( P \) value <0.05 was considered to indicate statistical significance.

RESULTS

Participant flow through the study is shown in Figure 2. Of the 2946 mother-infant pairs assessed for eligibility, 1488 (51%) did not meet the inclusion criteria (in 747 cases, this was because they lived outside the Dunedin area). A total of 847 (58%) of the eligible mother-infant pairs agreed to participate. Forty-five participants met the postpartum exclusion criteria, leaving a final sample size of 802 mother-infant pairs. Of these 802, a total of 608 provided relevant data from the 18-mo questionnaire, and at 24 mo, 496 provided data from the questionnaire, 499 from the FFQ, and 502 from the home food inventory. In total, 666 (83%) participants who provided some or all nutritional data to 2 y of age could be included in the current analysis.

In Table 1, we describe the demographic characteristics of the 666 mothers, infants, and households according to whether they received the FAB intervention (i.e., FAB and Combination vs Sleep and UC) and whether they received the Sleep intervention (i.e., Sleep and Combination vs FAB and UC). Overall, mothers in the analyses reported here had a mean age of 32 y and a self-reported mean prepregnancy BMI of 25, and 65% had a university degree or higher qualification. Almost half (47%) were primiparous. Most infants (79%) were of New Zealand European ethnicity, and 37% of households had low levels of deprivation compared with an expected 30% (23).

There were no significant differences between the groups in intakes of any of the 11 food groups \( (P \) values for the differences between the groups ranged from 0.086 (fruit food group) to 0.891 (savory snacks food group), treating the data as ranks rather than as absolute intakes—see Supplemental Material]. Absolute intake amounts were available for meat; vegetables; French fries, roast potato, and sweet potato; sweet drinks; and toddler milk and infant formula. There were no differences in the amounts of these foods consumed by those who received the FAB intervention (FAB and Combination) compared with those who did not (Sleep and UC). Similarly, there were no significant differences in energy \( (P = 0.912) \) or nutrient intake (carbohydrate, \( P = 0.637 \); protein, \( P = 0.808 \); fat, \( P = 0.756 \)) between children whose families had received the FAB intervention and children whose families had not.

In Table 2, we illustrate that no differences were observed in terms of the eating behaviors of the children at 24 mo of age, comparing families who had and had not received the FAB intervention. In Tables 3 and 4, parental feeding practices at 18

![FIGURE 2](https://academic.oup.com/ajcn/article-abstract/102/3/704/4564349) Participant flow through the study to 24 mo of age. Colored boxes indicate the pairs of groups that were combined to enable statistical analysis of the effects of the FAB and Sleep interventions: blue refers to the FAB intervention comparisons, and green refers to the Sleep intervention comparisons. FAB, Food, Activity, and Breastfeeding.
and 24 mo of age, respectively, are documented. At 18 mo of age, parents who had received the FAB intervention allowed children greater control over eating (difference: 0.14; 95% CI: 0.02, 0.26) and exerted less pressure on children to eat at mealtimes (difference: 0.18; 95% CI: 0.04, 0.32) than parents who had not received the FAB intervention. At 24 mo of age, parents who had received the FAB intervention were more likely to encourage nutrient-dense foods (difference: 0.16; 95% CI: 0.04, 0.32) and exerted less pressure on children to eat at mealtimes, and at 24 mo of age, they were more likely to encourage consumption of nutrient-dense foods.

Three large Australian early life nutrition and obesity interventions (16–18) have also demonstrated relatively little impact on children’s dietary intake at 18–24 mo of age. The Infant Feeding Activity and Nutrition Trial (35) and Nourish (36) trials assessed intake by using detailed 3-d diet recalls. Only one signiﬁcant difference, which was of small magnitude, was observed: children in the Infant Feeding Activity and Nutrition Trial intervention group consumed 3.6 g less sweet foods daily at 20 mo of age (35). The third Australian intervention, the Healthy Beginnings Trial, used a 17-item FFQ to assess intake of a few key foods and drinks at 24 mo. The only significant intervention effect was that children in the intervention arm were more likely to eat one or more daily servings of vegetables (89% vs. 83%) (37). Thus, it appears to be difﬁcult to alter dietary intake in early life, at least using individualized and group-based interventions such as those employed in the Australian and POI studies.

Although a number of tools exist for measuring parental feeding practices (25, 26, 38, 39), early life interventions to date have published few data using them. The few data that do exist suggest that interventions may have a greater impact on parental feeding practices than on dietary intake; however, overall effects are small and inconsistent. Although the Nourish study reported signiﬁcantly more favorable scores for 6 of 9 subscales of the

### DISCUSSION

Despite the convincing rationale for early life nutrition interventions (14, 15), our FAB intervention showed no effect on the food, energy, and nutrient intakes or eating behaviors of 2-y-old children and only minimal effects on a limited number of parental feeding practices. The only signiﬁcant differences between those who received the FAB intervention and those who did not were that, at 18 mo of age, parents who received the FAB intervention allowed children greater control over eating and exerted less pressure on children to eat at mealtimes, and at 24 mo of age, they were more likely to encourage consumption of nutrient-dense foods.
TABLE 2
Eating behaviors at 2 y of age of participants whose families received the FAB intervention and those who did not

<table>
<thead>
<tr>
<th>Eating behavior</th>
<th>FAB intervention</th>
<th></th>
<th></th>
<th>RR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offered 2 different fruits every day</td>
<td>Yes (FAB and Combination)</td>
<td>234 (96)</td>
<td>244</td>
<td>237 (94)</td>
<td>251</td>
</tr>
<tr>
<td>Offered 2 different vegetables every day</td>
<td></td>
<td>240 (98)</td>
<td>245</td>
<td>242 (96)</td>
<td>251</td>
</tr>
<tr>
<td>Used a cup, not a bottle</td>
<td></td>
<td>131 (53)</td>
<td>245</td>
<td>118 (47)</td>
<td>251</td>
</tr>
<tr>
<td>Ate breakfast every day</td>
<td></td>
<td>227 (93)</td>
<td>244</td>
<td>226 (91)</td>
<td>251</td>
</tr>
<tr>
<td>Ate with the family, at the table, every evening</td>
<td></td>
<td>144 (59)</td>
<td>243</td>
<td>164 (66)</td>
<td>250</td>
</tr>
<tr>
<td>Did not eat meals in front of the television</td>
<td></td>
<td>42 (17)</td>
<td>243</td>
<td>37 (15)</td>
<td>250</td>
</tr>
<tr>
<td>Household fruit and vegetable availability</td>
<td></td>
<td>32 ± 8</td>
<td>254</td>
<td>31 ± 9</td>
<td>248</td>
</tr>
<tr>
<td>Number of obesogenic foods in household</td>
<td></td>
<td>21 ± 7</td>
<td>254</td>
<td>21 ± 7</td>
<td>248</td>
</tr>
</tbody>
</table>

In total, 502 participants provided data for the Home Food Inventory (household fruit and vegetable availability and number of obesogenic foods in household variables), and 496 participants provided data for the 2-y questionnaire (all other variables). The n value for each variable indicates the number of participants who completed the relevant questions in the 2-y questionnaire and Home Food Inventory. FAB, Food, Activity, and Breastfeeding; UC, Usual Care.

Ratio (RR) of those displaying the behavior in the groups who received the FAB intervention and those who did not, determined by using Poisson regression.

P value compares the percentages displaying each behavior in the groups who received the FAB intervention and those who did not, determined by using Poisson regression.

Mean ± SD (all such values).

Difference between the mean scores of the groups who received the FAB intervention and those who did not, determined by using linear regression.

P value for the differences in mean scores between the groups who received the FAB intervention and those who did not, determined by using linear regression.

Child Feeding Questionnaire and Parental Feeding Style Questionnaire, the actual differences in the scores were small. The largest difference recorded on the 5-point scale in the Child Feeding Questionnaire was 0.5 (95% CI: 0.33, 0.67) for the construct “pressure to eat” (40). At 2 y of age, children in the intervention group of the Healthy Beginnings Trial were less likely to be given food as a reward (62% vs. 72%) (37). Although, to our knowledge, the maternal feeding practices of participants in the Infant Feeding Activity and Nutrition Trial study are yet to be published, a recent mediation analysis found that of the 6 subscales from the Comprehensive Feeding Practices Questionnaire, only the parental feeding practice “use of food as a reward” mediated an intervention effect on child diet quality (41).

The few statistically significant differences in parental feeding practices observed in our study seem too small to be of practical importance. Although in our study, the comparison of the groups who received the Sleep intervention (Sleep and Combination) and those who did not (UC and FAB) suggested that those in the groups receiving the Sleep intervention were consuming significantly more meat, there is no obvious mechanism for such an effect, and there were no differences for any of the other food groups. We suggest that care should be taken in the interpretation of statistically significant results when they are few, small in magnitude and unlikely to be of practical importance, and part of an analysis that includes a large number of statistical comparisons.

The outcomes of early life nutrition interventions may vary depending on the characteristics of the populations studied (42).

TABLE 3
Parental feeding practices at 18 mo of age of parents who received the FAB intervention and those who did not

<table>
<thead>
<tr>
<th>Construct</th>
<th>FAB intervention</th>
<th></th>
<th></th>
<th>Difference (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child control</td>
<td></td>
<td>2.71 ± 0.76</td>
<td>2.57 ± 0.76</td>
<td>0.14 (0.02, 0.26)</td>
<td>0.020</td>
</tr>
<tr>
<td>Emotion regulation</td>
<td></td>
<td>2.03 ± 0.71</td>
<td>2.03 ± 0.71</td>
<td>0.002 (−0.11, 0.12)</td>
<td>0.967</td>
</tr>
<tr>
<td>Environment</td>
<td></td>
<td>4.24 ± 0.71</td>
<td>4.15 ± 0.84</td>
<td>0.09 (−0.03, 0.21)</td>
<td>0.158</td>
</tr>
<tr>
<td>Food as reward</td>
<td></td>
<td>1.63 ± 0.82</td>
<td>1.73 ± 0.90</td>
<td>−0.10 (−0.23, 0.04)</td>
<td>0.172</td>
</tr>
<tr>
<td>Monitoring</td>
<td></td>
<td>4.43 ± 0.69</td>
<td>4.49 ± 0.71</td>
<td>−0.06 (−0.18, 0.05)</td>
<td>0.258</td>
</tr>
<tr>
<td>Modeling</td>
<td></td>
<td>4.24 ± 0.71</td>
<td>4.15 ± 0.84</td>
<td>0.09 (−0.03, 0.21)</td>
<td>0.158</td>
</tr>
<tr>
<td>Pressure</td>
<td></td>
<td>2.38 ± 0.91</td>
<td>2.57 ± 0.91</td>
<td>−0.18 (−0.33, −0.04)</td>
<td>0.013</td>
</tr>
<tr>
<td>Restriction for health</td>
<td></td>
<td>3.23 ± 1.06</td>
<td>3.25 ± 1.08</td>
<td>−0.02 (−0.19, 0.16)</td>
<td>0.857</td>
</tr>
<tr>
<td>Restriction for weight control</td>
<td></td>
<td>1.82 ± 0.50</td>
<td>1.83 ± 0.53</td>
<td>−0.01 (−0.09, 0.07)</td>
<td>0.796</td>
</tr>
</tbody>
</table>

Constructs as per subscales from the Comprehensive Feeding Practices Questionnaire (25). Scored with 5-point Likert scale where 1 = never and 5 = always, with reverse scoring employed for items measuring undesirable behavior. FAB, Food, Activity, and Breastfeeding; UC, Usual Care.

Difference between mean score for each construct, in groups who received the FAB intervention and those who did not.

P value compares the mean score of each construct between groups who received the FAB intervention and those who did not, determined by using linear regression.

Mean ± SD (all such values).
TABLE 4
Parental feeding practices with children 2 y of age of families who received the FAB intervention and those who did not

<table>
<thead>
<tr>
<th>Construct</th>
<th>Yes (FAB and Combination)</th>
<th>n</th>
<th>No (Sleep and UC)</th>
<th>n</th>
<th>Difference (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High control</td>
<td>1.70 ± 0.65</td>
<td>244</td>
<td>1.75 ± 0.69</td>
<td>250</td>
<td>−0.05 (−0.17, 0.07)</td>
<td>0.387</td>
</tr>
<tr>
<td>High contingency</td>
<td>1.48 ± 0.56</td>
<td>244</td>
<td>1.51 ± 0.55</td>
<td>250</td>
<td>−0.03 (−0.12, 0.07)</td>
<td>0.592</td>
</tr>
<tr>
<td>Child-centered feeding</td>
<td>3.22 ± 0.72</td>
<td>244</td>
<td>3.18 ± 0.75</td>
<td>250</td>
<td>0.04 (−0.09, 0.17)</td>
<td>0.516</td>
</tr>
<tr>
<td>Encourage nutrient-dense foods</td>
<td>3.52 ± 0.79</td>
<td>244</td>
<td>3.36 ± 0.75</td>
<td>250</td>
<td>0.16 (0.03, 0.30)</td>
<td>0.020</td>
</tr>
<tr>
<td>Discourage energy-dense foods</td>
<td>4.23 ± 0.58</td>
<td>243</td>
<td>4.21 ± 0.62</td>
<td>250</td>
<td>0.02 (−0.08, 0.13)</td>
<td>0.647</td>
</tr>
<tr>
<td>Mealtime behavior</td>
<td>4.34 ± 0.65</td>
<td>243</td>
<td>4.30 ± 0.69</td>
<td>250</td>
<td>0.04 (−0.08, 0.16)</td>
<td>0.475</td>
</tr>
<tr>
<td>Timing of meals</td>
<td>3.22 ± 0.81</td>
<td>243</td>
<td>3.27 ± 0.85</td>
<td>250</td>
<td>−0.05 (−0.20, 0.10)</td>
<td>0.531</td>
</tr>
</tbody>
</table>

1Constructs as per the Feeding Control Instrument by Murashima et al. (26). Scored with 5-point Likert scale where 1 = never and 5 = always, with reverse scoring employed for items measuring undesirable behavior. In total, questionnaire data were collected from 496 children at 2 y of age, although not all questionnaires were fully completed. The n value for each variable indicates the number of participants who provided relevant questionnaire data. FAB, Food, Activity, and Breastfeeding; UC, Usual Care.

2Difference between mean score for each construct, in groups who received the FAB intervention and those who did not.

3P value compares the mean score for each construct between groups who received the FAB intervention and those who did not, determined by using linear regression.

4Mean ± SD (all such values).

In combination, the characteristics of the mothers and families in our study, particularly their age, education, socioeconomic status, BMI, and ethnicity, may at least partly explain the lack of intervention effects observed. The mothers who participated had a mean age of 32 y and were well educated, with 65% having completed a university degree, whereas <20% of families scored highly on the New Zealand Deprivation Index (compared with the national average of 30%) (23). Younger maternal age has been associated with poorer diet quality in infants and preschool children (43, 44). Parental education has been more consistently inversely associated with overweight than other measures such as parental occupation or income (45). However, variations in obesity-related behaviors by socioeconomic status have also been observed throughout childhood and adolescence (46). Furthermore, the children of obese parents are more likely to become obese themselves (47). The self-reported prepregnancy mean BMI of the mothers in the POI study was 25, which is lower than the national mean of 27.7 in 25- to 34-y-old women (21). Moreover, 79% of infants in the POI study were of New Zealand European ethnicity, whereas only 8% and 2% were of Maori and Pasifika ethnicities, respectively. Indicators of diet quality in Maori and Pasifika children in New Zealand are poorer than those of New Zealand European children (48).

It is also important to note that the FAB (and Sleep) interventions were administered to families who already had access to “well-child” care. Annually, 97% of New Zealand newborns and their families are referred to a Well Child Tamariki Ora provider (19). Although it is possible that this existing health care limited our ability to achieve additional intervention effects, this seems unlikely given the extensive nutrition-specific, face-to-face education and support provided by our FAB intervention. Although the first 2 components of well-child visits (health and development assessments, as well as family support) require thorough and systematic clinical assessments (i.e., anthropometric measurements of growth and family needs assessments), the third component (health education) is very broad and may simply involve the provision of brief written resources on numerous health-related topics, with nutrition being just one of these topics (20). In contrast, the FAB intervention provided education and support about a range of nutritional issues, including establishing healthy food intakes and eating behaviors and developing appropriate parental feeding practices.

The strengths of our study include the robust randomized controlled trial design and large sample size. Although it has been reported that only one-quarter of new parents will participate in intervention studies (49), our study had a much higher recruitment rate of 58% of all eligible families. In addition, follow-up is under way at 3.5 and 5 y of age to identify any longer term effects that may be observed as the children grow and nutrition behaviors become more established. The limitations of our study include varying rates of completion for the FFQ and questionnaires at 18 and 24 mo of age. For example, of the 666 families who provided nutritional data to 2 y of age, only 499 (74.9%) provided FFQ data. In an effort to reduce respondent burden at the 2-y appointment, the FFQ was sent to families to complete beforehand. Noncompleters were given another copy and asked to post it back. However, many did not do so, with younger mothers with lower education levels, with higher household deprivation scores, and from an ethnic minority group being less likely to complete the FFQ and questionnaires.

In conclusion, the food, activity, and breastfeeding intervention conducted as part of the POI study did not have a significant impact on the food or nutrient intakes or eating behaviors of 2-y-old Dunedin, New Zealand, children. A limited number of changes to parental feeding practices were observed, but these were small. The consistency of these findings and those from recent early intervention trials in Australia suggest that interventions that focus on education and support do not appear to be sufficient to modify parent feeding and infant eating, and therefore a different approach is required in future early life interventions.

The authors’ responsibilities were as follows—A-LMH, MRS, ARG, BJT, BCG, and RWT: designed the research; MRS, JAL, RMS, and MBH: conducted the research; VCM and EOW: provided essential materials; SMW: performed the statistical analyses; LJF: wrote the manuscript; LJF, A-LMH, and RWT: had primary responsibility for the final content; and all authors: made important intellectual contributions to drafts of the work and read and approved the final manuscript. None of the authors reported a conflict of interest related to the study.
REFERENCES


30. Watson EO, Validation of a home nutrient food frequency questionnaire to determine nutrient intakes of New Zealand toddlers 12–24 months old [thesis]. Dunedin (New Zealand): Department of Human Nutrition, University of Otago; 2012.


Downloaded from https://academic.oup.com/ajcn/article-abstract/102/3/704/4564349 by guest on 25 November 2018