

Outcomes of an Early Feeding Practices Intervention to Prevent Childhood Obesity

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KEY WORDS

childhood obesity, feeding practices, infant, randomized controlled trial

ABBREVIATIONS

CFQ—Child Feeding Questionnaire

PFSQ—Parental Feeding Style Questionnaire

RCT—randomized controlled trial

Dr Daniels conceived the study; led the design, successful funding application, and overall implementation of the study; and wrote the first draft of the manuscript. Dr Mallan undertook the statistical analysis under the mentorship of Dr Battistutta and drafted the results and methods sections. Dr Nicholson contributed to funding applications, intervention development, and design of outcome assessments. Dr Battistutta contributed to the design, funding applications, and implementation, and provided mentorship to Dr Mallan. Dr Magarey contributed to the design, funding applications, and development of the intervention, and led implementation at the Adelaide site. All authors contributed to interpretation of the results and preparation of the manuscript.

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WHAT'S KNOWN ON THIS SUBJECT: About one in five 2-year-olds are overweight, with potential adverse outcomes. Early feeding practices lay the foundation for food preferences and eating behavior and may contribute to future obesity risk. High-quality obesity prevention trials commencing in infancy are rare.



WHAT THIS STUDY ADDS: In this large randomized controlled trial, anticipatory guidance on the “when, what, and how” of complementary feeding was associated with increased maternal “protective” feeding practices. Differences in anthropometric indicators were in the expected direction but did not achieve statistical significance.

abstract

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OBJECTIVE: The goal of this study was to evaluate outcomes of a universal intervention to promote protective feeding practices that commenced in infancy and aimed to prevent childhood obesity.

METHODS: The NOURISH randomized controlled trial enrolled 698 first-time mothers (mean \pm SD age: 30.1 ± 5.3 years) with healthy term infants (51% female) aged 4.3 ± 1.0 months at baseline. Mothers were randomly allocated to self-directed access to usual care or to attend two 6-session interactive group education modules that provided anticipatory guidance on early feeding practices. Outcomes were assessed 6 months after completion of the second information module, 20 months from baseline and when the children were 2 years old. Maternal feeding practices were self-reported by using validated questionnaires and study-developed items. Study-measured child height and weight were used to calculate BMI z scores.

RESULTS: Retention at follow-up was 78%. Mothers in the intervention group reported using responsive feeding more frequently on 6 of 9 subscales and 8 of 8 items (all, $P \leq .03$) and overall less controlling feeding practices ($P < .001$). They also more frequently used feeding practices (3 of 4 items; all, $P < .01$) likely to enhance food acceptance. No statistically significant differences were noted in anthropometric outcomes (BMI z score: $P = .10$) nor in prevalence of overweight/obesity (control 17.9% vs intervention 13.8%; $P = .23$).

CONCLUSIONS: Evaluation of NOURISH data at child age 2 years found that anticipatory guidance on complementary feeding, tailored to developmental stage, increased use by first-time mothers of “protective” feeding practices that potentially support the development of healthy eating and growth patterns in young children. *Pediatrics* 2013;132:e109–e118

The rationale for early interventions that target feeding practices as an effective approach to obesity prevention is strong.^{1–4} Nevertheless, there are very few randomized controlled trials (RCTs) that have commenced in infancy.^{5,6} The NOURISH RCT⁷ evaluated an obesity prevention intervention that provided anticipatory guidance on early feeding to first-time mothers and commenced when the infants were 4 months old. Our overarching hypothesis was that “protective” early feeding practices can support the development of healthy child eating habits and potentially confer some resilience to the contemporary “obesogenic” environment. The intervention comprised 2 interactive 6-session parent education modules with both shared and unique content matched to developmental age at commencement of each module (mean age: 4 and 13 months, respectively). Evaluation of the first module alone (infants aged 14 months, before commencement of module 2) has been reported.⁸ We now report short-term outcomes, specifically maternal feeding practices (impact evaluation) and child anthropometric data (outcome evaluation), 6 to 8 months after completion of the total planned intervention (ie, both education modules) when children were 2 years old.

We predicted that, compared with self-directed access to usual care, receiving anticipatory guidance on early feeding practices would demonstrate increased use by first-time mothers of: (1) food exposure practices postulated to promote the development of food preferences consistent with healthy dietary intake^{9–13}; and (2) responsive feeding behaviors that support child self-regulation of intake.^{4,14,15} A secondary hypothesis was that the intervention would result in lower anthropometric indicators of obesity risk at 2 years of age.

METHODS

Study Design

The NOURISH RCT commenced in 2008 across 2 Australian cities (Brisbane and Adelaide). The protocol has been published elsewhere.^{7,16} The outcome assessment at 20 months from baseline when the children were 2 years old (range: 21–27 months) is reported here. The trial was approved by the Queensland University of Technology Human Research Ethics Committee.

Recruitment, Participants, and Allocation

The 2-stage recruitment strategy has been described elsewhere.^{7,16} A consecutive sample of first-time mothers (≥ 18 years old) of healthy term infants (>35 weeks’ gestation, ≥ 2500 g birth weight) was approached at 7 maternity hospitals across both cities. Additional inclusion criteria subsequently assessed were facility with written and spoken English and no documented or self-reported history of intravenous substance abuse, domestic violence, or eating disorders. We conceptualized this study as an efficacy trial, and the intent was to optimize the potential intervention effect. Mothers who consented to later contact provided demographic and other data (Table 1) and were recontacted for full enrollment

when their infant was 4 months old (range: 2–7 months). Assessments and intervention delivery occurred in community child health clinics located across each city. After baseline assessment, participants were randomly allocated to an intervention or a control group by an external statistician. A permuted-block schedule with blocks of 4 within each assessment clinic location was used to optimize the balance of participant socioeconomic characteristics across the groups. Participants were not compensated for time or travel to attend intervention or assessment sessions.

Treatment Components

Modules 1 and 2 commenced immediately after baseline, when the children were aged 4 to 7 months and 13 to 16 months, respectively. Each module comprised 6 interactive group sessions of 1 to 1.5 hours duration, delivered over 12 weeks (40 groups across both modules and sites). Sessions were cofacilitated by a dietitian ($n = 13$) and a psychologist ($n = 13$). Facilitators received standardized training, used a comprehensive facilitator manual and standard presentation materials, and participated in fortnightly supervision teleconferences to promote intervention quality and integrity.

TABLE 1 Characteristics of 2094 First-Time Mothers who Consented at Stage 1 and Were Allocated or not Allocated at Stage 2

Variable ^a	Allocated ($n = 698$)		Not Allocated ^b ($n = 1396$)	
	Consented	Did not Consent ($n = 885$)	Could not Recontact ($n = 511$)	
Maternal age at delivery, y^c ($n = 2087$)	30.1 \pm 5.3	28.0 \pm 5.5	26.2 \pm 5.5	
Maternal education (university degree) ^d ($n = 2078$)	58 (406)	36 (311)	27 (137)	
Born in Australia/New Zealand ^d	78 (542)	77 (667)	75 (376)	
Married/de facto ^d ($n = 2062$)	95 (659)	90 (778)	83 (421)	
Intend to breastfeed exclusively ^d ($n = 2088$)	93 (652)	90 (794)	87 (441)	
Smoked during pregnancy ^d ($n = 2081$)	12 (85)	21 (185)	32 (164)	

n values given in parentheses reflect missing data. Stage 1, when participants were first approached in hospital postdelivery; Stage 2, second contact, infants aged 2 to 7 months.

^a Based on data provided at stage 1.

^b Excluding an additional 75 participants who became ineligible.

^c Mean \pm SD.

^d Proportion % (count) reported.

The intervention was informed by 3 theoretical models. Attachment theory centers on maternal sensitivity to infant cues¹⁴ and hence provides a framework for responsive feeding.⁴ Anticipatory guidance is a proactive approach that provides parents with information about behaviors they can expect and constructive ways to manage these behaviors, rather than waiting until parents seek advice on established problems.¹⁵ A social cognitive approach¹⁷ informed intervention activities to promote maternal self-efficacy, competence, and confidence to adopt program recommendations. Strategies included progressive goal setting, identification of facilitators/barriers to implementation, self-monitoring and review, and individualized problem solving. It was pilot tested in 25 mothers.

Content provided anticipatory guidance, targeted to developmental stage, on 3 aspects of early feeding associated with positive outcomes in children's eating behavior and weight status: (1) exposure to a wide range of textures and tastes to promote development of healthy food preferences^{9–13} (module 1); (2) responsive feeding that recognizes and responds appropriately to infant cues of hunger and satiety to promote self-regulation of energy intake to need^{4,18,19} (module 2); and (3) positive parenting (warmth, encouragement of autonomy, and self-efficacy)^{20–22} (modules 1 and 2). Content as presented to mothers focused on healthy eating patterns and growth, rather than obesity prevention. All intervention participants were provided with detailed written information that covered session content. The control group had standard access to universal community child health services, which, at the mothers' initiative, could include child weighing and information via the Web or the telephone help line. An important distinction was that controls sought advice in response

to an existing need/problem and hence did not receive anticipatory guidance. No data were collected on the frequency with which mothers accessed standard care.

Outcome Measures

Demographic and behavioral data were collected by using self-completed questionnaires at first contact (face-to-face), baseline, and follow-up (by mail).

Feeding Practices

The Child Feeding Questionnaire (CFQ)²³ is the most widely used tool to assess parents' attitudes and practices related to feeding children aged 2 to 11 years. Five of the 7 subscales were included to assess controlling feeding practices (restriction, pressure to eat, and monitoring) and perceived responsibility and concern about child weight. The Parental Feeding Style Questionnaire (PFSQ)²⁴ was also used because it assesses additional feeding practice constructs that reflect parent use of (non-)responsive feeding. Four subscales were included: instrumental feeding, encouragement, emotional feeding, and control over eating. Internal consistency estimates in our sample were equivalent or higher than those reported in the original validation studies. Items based on clinical experience of the investigators and used previously²⁵ examined mothers' overall perceptions of their child's eating behavior and specific strategies they used in response to refusal of familiar foods (cues of satiety) or unfamiliar foods (neophobia). Two additional items assessed Satter's conceptualization of responsive feeding ("parent provide, child decide")²⁶: (1) Who decides what your child eats—you or your child?; and (2) Who decides how much food your child eats—you or your child? Responses were scored as 1 = you only to 5 = your child only.

Anthropometric measurements were taken by trained study staff blinded to participant group and independent of intervention delivery. Duplicate child naked weight and recumbent length (baseline) or standing height (follow-up) and single maternal height and weight were measured by using standard clinic equipment. Standardized weight-for-age, length/height for age, and BMI-for-age z scores were calculated by using the World Health Organization Anthro version 3.0.1 and macros program. As recommended, 0.7 cm was added to the follow-up standing height of children aged <2 years to correct for use of recumbent length in the reference sample.²⁷ Classification as overweight (including obese) was based on International Obesity Task Force gender-specific 2-year-old BMI cutoffs.²⁸ Birth weight was obtained from hospital records.

Covariates

Covariate data were collected at first contact in the maternity hospitals from 2094 mothers who consented to later contact (Table 1). Birth weights were collected from hospital records. Socio-economic status was determined by using the Socio-Economic Indexes for Areas score for the Index of Relative Advantage and Disadvantage. Scores below the seventh decile (sample median) indicated relative disadvantage.²⁹

Statistical Analysis

Sample size calculations were based on expected meaningful differences at the 2-year-old follow-up in selected impact outcomes that included a subset of protective feeding practices reported here. Details of the anticipated differences based on our pilot study of children aged 12 to 36 months²⁵ are provided in the protocol article.⁷ Assuming 80% power and a type I error of 5% (2-tailed), we sought to have 265 subjects per group at follow-up and to

enroll 830 based on an anticipated 35% attrition rate. Anthropometric variables were considered as secondary outcomes in the original protocol and were excluded from sample size calculations.⁷ At the time the study was planned (2006), there were no data from relevant interventions commencing in infancy to enable effect size estimations as a basis for sample size calculation.

An intention-to-treat approach to analysis was used as far as missing data permitted (no imputations were made). There was no evidence of differences by group (intervention versus control) at baseline (Table 2). Accordingly, no adjustment for covariates was undertaken, and comparisons between groups on continuous and dichotomous outcome variables used independent sample *t* tests and likelihood ratio χ^2 tests, respectively. The CFQ²³ restriction, pressure to eat, and monitoring subscale means were examined

by using a multivariate analysis of variance to test for an overall intervention effect on controlling feeding practices and to statistically account for the close theoretical relatedness of these subscales.

All statistical tests were computed by using SPSS version 19 (IBM SPSS Statistics, IBM Corporation, Armonk, NY). A *P* value of .05 (2-tailed) was used throughout to indicate statistical significance.

RESULTS

Participant flow is shown in Fig 1, and Table 1 displays the characteristics of mothers who participated in the trial versus those who agreed to a second contact but either could not be recontacted or declined enrollment. There were no differences according to group allocation at baseline (Table 2). At follow-up (20 months from baseline), total attrition was 22% (*n* = 157). Rea-

sons for withdrawal were no longer interested (*n* = 14), returned to work (*n* = 11), poor health of child or family (*n* = 11), or did not need feeding advice (*n* = 4). Fifteen participants moved out of the region, and 1 child was deceased. Withdrawal was higher among younger and less educated mothers (all, *P* < .001) (Table 3) and in the intervention group (26%, *n* = 92) than in the control group (19%, *n* = 65; *P* = .01), but it did not differ according to mothers' BMI (*P* = .51). However, there were no differences by group in the baseline characteristics of those who withdrew (data not shown). Attendance at ≥ 2 sessions for module 1 was *n* = 229 (65%) and module 2 was *n* = 130 (45% of those retained at module commencement). At follow-up, the mean age of children (52% female) was 24.1 \pm 0.7 months, 8% of mothers were still breastfeeding (control: *n* = 19; intervention: *n* = 16), and 25% had a second child (control: *n* = 50; intervention: *n* = 65).

Maternal Feeding Practices

Across the measures of maternal feeding, there were significant differences by group in the expected directions on 6 of 9 subscales from the CFQ²³ and PFSQ²⁴ (Table 4) and on 11 of 12 individual items assessing responses to food refusal (Table 5). For example, intervention mothers used nonresponsive feeding practices significantly less often and responsive feeding practices more often (*P* values, .033 to <.001). There was no difference according to group in the proportion of mothers reporting that they were "mostly/only" responsible for what their child eats (intervention: 72%, *n* = 159; control: 76%, *n* = 187 [*P* = .29]). However, more intervention mothers than control mothers (82% [*n* = 183] vs 49% [*n* = 120]) reported that their child was mostly/only responsible for how much to eat (*P* < .001). Specific feeding practices in response to child neophobia are

TABLE 2 Characteristics of Mothers and Children Allocated to the Control Group Compared With the Intervention Group

Variable	Control (<i>n</i> = 346)	Intervention (<i>n</i> = 352)	Total (<i>N</i> = 698)
Mother			
Education (university degree)	58 (199)	59 (207)	58 (406)
Smoked during pregnancy	11 (40)	13 (45)	12 (85)
Born in Australia	79 (270)	78 (272)	78 (542)
Married/de facto	95 (327)	95 (332)	95 (659)
SEIFA for the Index of Relative Advantage and Disadvantage (relative disadvantage \leq seventh decile)	34 (117)	32 (113)	33 (230)
Age at delivery, y	29.9 \pm 5.3	30.2 \pm 5.3	30.1 \pm 5.3
BMI	26.2 \pm 5.5	25.8 \pm 5.1	26.0 \pm 5.3
Infant			
Gender (female)	50 (173)	51 (181)	51 (354)
Birth weight, kg	3.5 \pm 0.4	3.5 \pm 0.4	3.5 \pm 0.4
Birth weight z score ^a	0.38 \pm 0.87	0.39 \pm 0.88	0.38 \pm 0.87
Age (months) at baseline assessment	4.3 \pm 1.0	4.3 \pm 1.0	4.3 \pm 1.0
Current feeding mode^b			
Fully/exclusively breast-fed	55 (170)	60 (191)	57 (361)
Formula only	27 (83)	26 (84)	27 (167)
Combination (formula + breast-fed)	19 (59)	14 (44)	16 (103)
Ever breast-fed ^b	96 (266)	98 (250)	97 (516)
Ever given solids ^b	34 (114)	34 (115)	34 (229)
Age solids introduced (weeks) ^c	22.7 \pm 4.9	22.8 \pm 4.4	22.8 \pm 4.7

% within group (count) reported for dichotomous variables and mean \pm SD reported for continuous variables.

SEIFA, Socio-Economic Indexes for Areas.²⁸

^a World Health Organization standards.³⁶

^b Data collected from questionnaire administered at baseline.

^c Data collected from questionnaire administered at first follow-up visit when infants were aged 14 months (*n* = 529).

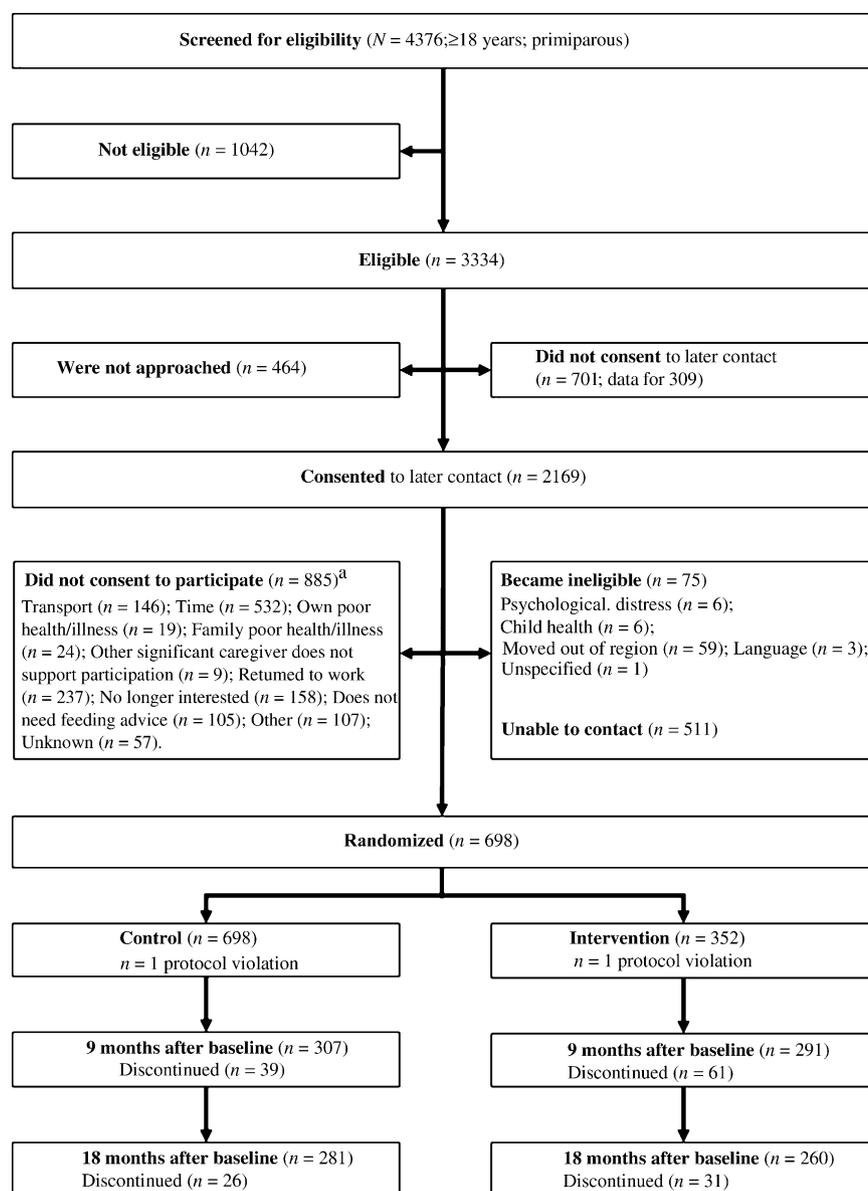


FIGURE 1 CONSORT diagram showing flow of all participants. ^aSome provided multiple reasons.

TABLE 3 Characteristics of Allocated Mothers ($N = 698$) who Completed the Study or Discontinued

Variable ^a	Completed ($n = 541$)	Discontinued ^b ($n = 157$)
Maternal age at delivery, y^c	30.6 \pm 5.2	28.0 \pm 5.5
Maternal education (university degree) ^d	63 (343)	40 (63)
Born in Australia/New Zealand ^d	81 (438)	82 (129)
Married/de facto ^d ($n = 696$)	92 (516)	92 (143)
Intend to breastfeed exclusively ^d ($n = 694$)	94 (509)	92 (143)
Smoked during pregnancy ^d ($n = 696$)	12 (62)	15 (23)
BMI ($n = 691$) ^c	25.9 \pm 5.3	26.3 \pm 5.4

n values given in parentheses reflect missing data.

^a Based on data provided at stage 1 except BMI, which was measured at baseline when infants were aged 4 months.

^b Discontinued due to either active withdrawal or could not be contacted.

^c Mean \pm SD.

^d % within group (count).

shown in Table 5. There were no differences in the proportion of toddlers reportedly often/very often refusing food (22% [$n = 102$]). However, intervention mothers were more likely than control mothers to “strongly agree/agree” that their child was easy to feed (83% [$n = 184$] vs 75% [$n = 183$]; $P = .03$).

Anthropometric Outcomes

Child anthropometric data at baseline and follow-up are shown in Table 6. Using gender-specific international BMI cut-offs,³⁰ 13.8% (34 of 246) of intervention children versus 17.9% (49 of 274) of control children were classified as overweight or obese ($P = .23$).

DISCUSSION

NOURISH is one of the first and largest RCTs to report outcomes of an intervention to prevent childhood obesity that commenced in infancy and explicitly targets maternal feeding practices. We found that anticipatory guidance on early feeding, tailored to developmental stage, increased use by first-time mothers of protective feeding practices that potentially support the development of healthy eating and growth patterns in their 2-year-old children. Anthropometric differences were consistently in the expected direction; however, effect sizes did not achieve statistical significance.

In healthy toddlers, refusal of familiar, usually accepted foods generally signals satiety.^{8,25} The responsive feeding response is to trust the child’s appetite and to interpret refusal as satiety.¹⁸ Nonresponsive feeding fails to accept that the child has eaten enough and is characterized by excess overt maternal control.^{2,4} Specific nonresponsive feeding practices include pressure and active encouragement to eat more by using a range of strategies such as coaxing (eg, game playing), using rewards (food or nonfood), or offering favorite foods as alternatives. Praise

TABLE 4 Child-Feeding Practices at Follow-up Visits of Mothers Enrolled in the NOURISH Trial

Maternal Feeding Practices ^a	Control (<i>n</i> = 245)	Intervention (<i>n</i> = 222)	<i>P</i>
CFQ			
Perceived responsibility (3 items, $\alpha = 0.80$); for example, How often are you responsible for deciding if your child has eaten the right kind of foods?	4.4 ± 0.5	4.3 ± 0.6	.61
Concern child is overweight (3 items, $\alpha = 0.76$); for example, How concerned are you about your child eating too much when you are not around her?	1.3 ± 0.6	1.2 ± 0.4	.016
Controlling feeding practices^b			<.001
Restriction (8 items, $\alpha = 0.75$); for example, I have to be sure my child does not eat too many sweets	3.0 ± 0.7	2.9 ± 0.8	.055
Pressure to eat (4 items, $\alpha = 0.77$); for example, If my child says "I am not hungry" I try to get her to eat anyway	2.3 ± 1.0	1.8 ± 0.9	<.001
Monitoring (3 items, $\alpha = 0.93$); for example, How much do you keep track of the snack foods that your child eats?	4.3 ± 0.9	4.3 ± 1.0	.76
PFSQ			
Instrumental feeding (4 items, $\alpha = 0.77$); for example, I reward my child with something to eat when she is well behaved	1.6 ± 0.5	1.4 ± 0.5	<.001
Encouragement (8 items; $\alpha = 0.75$); for example, I praise my child if she eats what I give her	4.0 ± 0.5	3.9 ± 0.5	.005
Emotional feeding (5 items, $\alpha = 0.81$); for example, I give my child something to eat to make him feel better when he is upset	1.6 ± 0.5	1.5 ± 0.5	.039
Control over eating (10 items, $\alpha = 0.72$); for example, I let my child decide when he would like to have his meal	3.9 ± 0.4	4.0 ± 0.4	.56

Mean child age overall was 24.1 ± 0.7 months; 52% were female. *n* values given in parentheses indicate missing data; α is Cronbach's α . CFQ²⁰ response options: perceived responsibility and monitoring, 1 = never to 5 = always; pressure and restriction, 1 = disagree to 5 = agree; concern, 1 = unconcerned to 5 = very concerned. PFSQ²¹ response options: 1 = never to 5 = always.

^a Continuous variables based independent samples *t* tests; mean ± SD reported.

^b Between-group difference on related constructs tested via multivariate analysis of variance, $F_{(3,463)} = 9.023$, $P < .001$, $\eta_p^2 = 0.055$.

for eating and using food to comfort, distract, or reward good behavior (emotional feeding) are also non-responsive feeding strategies in that they encourage the child to eat for reasons unrelated to appetite.²⁵ Overall, these nonresponsive feeding practices are postulated to result in discordant feeding in which children are habitually encouraged to eat more than they want and need.⁴ As such, they undermine intrinsic regulation of intake and in the longer term result in positive energy balance and excess weight gain.^{4,19,25,31,32} On the PFSQ,²⁴ intervention mothers used lower levels of instrumental and emotional feeding and prompting encouragement. In addition, differences according to study group for all 8 items assessing responses to refusal of familiar foods indicated that intervention mothers

were more likely to interpret food refusal as a signal of satiety and less likely to use nonresponsive or coercive practices such as insisting their child eat or offer a reward for eating. These results indicate that maternal behaviors are modifiable. Overall, intervention mothers more frequently used a range of responsive feeding practices.

Intervention mothers overall used less controlling feeding practices. On the CFQ,²³ intervention mothers had lower scores on "pressure" and "restriction" subscales, which, at an item level, predominantly assess controlling maternal behaviors in relation to what or how much the child eats. These results were consistent with a higher proportion of intervention mothers (82%) compared with control mothers (49%) reporting their child was mostly/only responsible for deciding how much to

eat. Three of the feeding subscales did not show significant differences by group at follow-up: CFQ perceived responsibility and monitoring²³ and PFSQ control.²⁴ Inspection of the items in these scales provides some insight into this apparent inconsistency. In the PFSQ control subscale, 9 of 10 items refer to maternal versus child roles in determining the timing and location of eating. Similarly, the CFQ perceived responsibility subscale comprises 3 items assessing mothers' responsibility for feeding at home, the kind of food offered, and portion size. Thus, these scales seem to assess the "where" and "when" and responsibility for feeding, rather than recognition of and response to child satiety cues. The CFQ monitoring subscale assesses maternal tracking of their child's consumption of unhealthy foods, which is plausibly an antecedent to, rather than a feeding practice. The absence of group differences on these 3 feeding subscales is consistent with these "practices" not being a focus of the intervention. The high mean scale scores for monitoring and responsibility indicate high levels of these practices and are not unexpected in mothers who volunteer for a feeding trial. These variable findings highlight the definitional and measurement issues existing in this field of research, which not only make it challenging to interpret findings within studies but also confound between-study comparisons.²¹

Refusal of novel or unfamiliar foods (neophobia) is very common in toddlers.¹¹ A key intervention message was that children need to be explicitly taught to like new foods through repeated neutral exposure. Intervention mothers were more likely to respond to refusal of new foods with strategies likely to increase familiarity, acceptance, and intake, thus supporting increased dietary variety and quality.^{9,11,33} We found no group differences in the frequency of toddler food refusal; however, mothers

TABLE 5 Child-Feeding Strategies Used in Response to Food Refusal at Follow-up of Mothers Enrolled in the NOURISH Trial

Variable ^a	Control (n = 245)	Intervention (n = 222)	P
Response to refusal of familiar foods ^b			
Nonresponsive feeding strategies: override satiety cues			
Insist child eats it (n = 466)	37 (90)	18 (39)	<.001
Offer milk drink instead (n = 464)	22 (53)	14 (30)	.022
Offer liked food instead (n = 465)	78 (189)	63 (140)	.001
Encourage to eat: turn mealtime into game (n = 466)	57 (139)	21 (47)	<.001
Offer food reward (n = 465)	31 (75)	9 (19)	<.001
Encourage to eat: offer nonfood reward (n = 464)	27 (65)	18 (39)	.026
Responsive feeding strategies: respond appropriately to satiety cues			
Offer no food until next usual meal/snack time (n = 463)	48 (116)	67 (147)	<.001
Accept that child may not be hungry; take food away (n = 464)	91 (222)	96 (213)	.033
Response to refusal of unfamiliar foods (neophobia) ^c			
Assume child dislikes; do not offer again (n = 457)	13 (32)	5 (11)	.003
Disguise food (n = 456)	65 (156)	45 (98)	<.001
Offer with liked food (n = 462)	94 (229)	94 (206)	.99
Times offered a food before deciding whether liked (≥ 6 times) (n = 465)	35 (87)	72 (159)	<.001

Mean child age overall was 24.1 ± 0.7 months; 52% were female. *n* values given in parentheses indicate missing data. *P* values based on likelihood ratio chi-square test.

^a Dichotomous variables; % within group (count) reported.

^b Response options: 1 = never to 5 = most of the time, dichotomized to 1, 2 versus 3, 4, 5 and % reported.

^c Response options: 1 = never to 4 = often, dichotomized to 1, 2 versus 3, 4 and % reported.

in the intervention group were less likely to interpret their child as being a difficult eater. This finding suggests that the intervention anticipatory guidance assisted mothers to expect and understand neophobia as normal behavior and hence to be less concerned and to respond appropriately. This finding is supported by the mothers in the intervention group also reporting less food fussiness in their children (data not shown).

Very few RCTs evaluating interventions to reduce childhood obesity risk have

commenced before 12 months of age.^{5,6} Only 2 comparable studies have reported outcomes of early feeding obesity prevention interventions, both of which were delivered via nurse-led home visits. Paul et al³⁴ reported outcomes at 12 months of age (*n* = 110; 69% retention) of a 3-visit intervention that targeted nonfeeding soothing strategies and/or the timing and process of solid introduction. Wen et al,³⁵ in another large Australian study (HBT [Healthy Beginnings Trial]), reported outcomes at 2 years of age (*n* = 497;

75% retention) after 6 visits. Both studies^{34,36} reported improvements in breastfeeding and timing of solid introduction, but no comparable feeding practices data were provided. Using a single-item measure, Wen et al³⁵ reported that intervention mothers were less likely to use food as a reward (62% vs 72%) with their 2-year-old children.

Despite strong and consistent intervention effects on maternal feeding practices, we failed to find statistically significant group differences in growth or weight status. Because we were unable to postulate a priori the expected meaningful differences for these measures, a type II error is possible. Nevertheless, differences in anthropometric data were all in the expected directions. Paul et al³⁴ reported lower mean weight-for-length percentiles (33rd vs 50th; *n* = 22 vs *n* = 30) at 12 months of age (69% retention) for the combined intervention. The HBT³⁵ showed a small (2.3%) but statistically significant standardized mean difference (intervention – control) of -0.23 BMI units (*n* = 249 and 234; *P* = .01) at 2 years compared with our result of -0.14 (*n* = 279 and 251; *P* = .12). As in NOURISH, HBT found no significant intervention – control difference in weight (-0.17 vs -0.16 kg, respectively) or length (0.31 vs -0.15 cm, respectively).

TABLE 6 Anthropometric Data at Birth, Baseline, and Follow-up for Children Enrolled in the NOURISH Trial

Variable	Baseline		Difference		Follow-up		Difference	
	Control	Intervention	Intervention – Control		Control	Intervention	Intervention – Control	
	Mean \pm SD		Mean (SE)	<i>P</i>	Mean \pm SD		Mean (SE)	<i>P</i>
<i>N</i>	346	352			279	251		
Age, mo	4.3 \pm 1.0	4.3 \pm 1.0	-0.01 (0.07)	.89	24.1 \pm 0.8	24.1 \pm 0.6	-0.06 (0.06)	.33
Weight, kg	6.84 \pm 0.96	6.83 \pm 1.01	-0.01 (0.07)	.93	12.94 \pm 1.55	12.78 \pm 1.56	-0.16 (0.14)	.23
Weight z score	-0.03 ± 0.91	-0.04 ± 0.93	-0.01 (0.07)	.95	0.69 \pm 0.91	0.58 \pm 0.98	-0.11 (0.08)	.20
<i>N</i>	345	349			274	246		
Length/height (cm)	64.06 \pm 3.04	64.26 \pm 3.15	0.20 (0.24)	.39	87.35 \pm 3.24	87.20 \pm 3.16	-0.15 (0.28)	.60
Length/height z score	0.27 \pm 0.95	0.39 \pm 0.98	0.11 (0.07)	.12	0.27 \pm 0.99	0.24 \pm 0.96	-0.02 (0.09)	.78
BMI	16.61 \pm 1.48	16.46 \pm 1.48	-0.15 (0.11)	.17	16.94 \pm 1.49	16.74 \pm 1.43	-0.20 (0.13)	.12
BMI z score	-0.26 ± 0.98	-0.36 ± 0.98	-0.10 (0.07)	.18	0.75 \pm 0.98	0.61 \pm 1.01	-0.14 (0.09)	.10

P value for test of difference between conditions using independent sample *t* test; mean difference (intervention – control) and SE of difference reported. Weight available at baseline for *n* = 696; recumbent length available at baseline for *n* = 694; female 51%. Weight available at follow-up for: *n* = 530/541 retained; standing height available at follow up for *n* = 520/541 retained; female 51%.

It is possible that in HBT, the relatively higher intervention length (as denominator) may have contributed to the significant difference in BMI. HBT also reported a 2.9% point lower prevalence of overweight in their intervention group compared with a 4.1% point lower prevalence found in NOURISH. Although not statistically significant ($P = .23$), if translated to a population level, this difference would be important from a public health and longer term obesity prevention perspective.

There are several possible explanations for the differences in BMI-for-age z score outcomes between the NOURISH and HBT³⁵ trials. HBT was conducted in a socially disadvantaged area, with mothers who were younger (75% <30 years old) and less well educated (24% university degree). Given the sociodemographic differentials in health-related behaviors and obesity prevalence,³⁷ there may have been more scope for intervention response in the HBT sample. The intervention approaches varied with respect to age at commencement (HBT: 1 month; NOURISH: 4 months), the relative intensity (dose) of intervention, the home visit versus group delivery format, and the extent to which there was a focus on breastfeeding maintenance and physical activity (both greater in HBT). The 2 approaches have been evaluated within different populations and service delivery modalities. Together, they provide evidence of the potential capacity of interventions commencing in infancy to reduce early obesity risk. Much more work is clearly required to understand the most effective intervention components for different populations and to determine the longer term effectiveness. A planned prospective meta-analysis (EPOCH [Early Prevention of Obesity in Children])³⁸ will include data from both trials to begin to answer these questions.

Our midterm evaluation of the first module (infants aged 14 months) showed positive intervention effects on 5 of 12 specific feeding strategies (Table 5) relevant to responsive feeding and neophobia.⁸ By 2 years of age, the intervention effect on maternal feeding practices seems to have strengthened, with group differences evident for 11 of 12 of these same strategies. (The subscales reported in Table 4 have not been validated for use with children aged <2 years and were not used in the midterm follow-up at 14 months.) However, this relative strengthening of intervention effect on maternal feeding practices does not seem to have translated to commensurate enhanced effects on anthropometric outcomes. At 2 years of age, we found a standardized mean difference (intervention – control) in BMI-for-age z scores of -0.14 ($n = 274$ and 246 ; $P = .10$) compared with -0.22 ($n = 292$ and 273 ; $P < .01$) at 14 months of age.⁸ There are a number of plausible explanations. The intervention focused on intrinsic drivers of eating habits, namely food preferences and appetite regulation. It is possible that intervention effects on anthropometric factors may not manifest until children become more independent and face the challenges of the obesogenic environment beyond predominantly maternal control. In addition, interindividual variations in rates of weight gain are high from 0 to 2 years. From ages 2 to 5 years, growth parameters show less variability, better tracking, and more directly reflect the interaction between environmental factors and genetic propensity for obesity.^{39–42} Our planned follow-up contacts at age 3.5 and 5 years will examine whether significant benefits to weight accrue over the longer term. Strengths of NOURISH include its design and implementation according to CONSORT guidelines,⁴³ large sample size, and good retention. Researchers

were blinded to group allocation for outcome assessment and analysis. The use of group education sessions was consistent with programs delivered in the relevant community child health sectors at the time of the study. The lack of a true attention control group does not allow us to preclude a Hawthorn effect. However, this option was not feasible in terms of cost, participant burden, and identification of 18 hours of authentic content that would not potentially affect parenting and obesity risk. Self-report behavioral data always have the potential for acquiescence bias but are the only feasible option in large population-based studies. Our consecutive sampling framework, an approach rarely used in obesity prevention trials, enabled detailed assessment of selection and retention biases. This method revealed evidence of both, with the most important difference being higher levels of education among mothers who consented and completed. However, these biases do not compromise the internal validity of the trial. Given that our participants were comparatively well-educated, first-time mothers, most of whom were born in Australia, the wider generalizability of the intervention and its effectiveness are unknown. Although attrition was higher in the intervention group than in the control group, the characteristics of non-completers did not vary by group. Attendance at module 2 was disappointing. It is possible that module attendance has led to an underestimation of effect size, but the CONSORT-recommended intention-to-treat analytical approach has provided the most unconfounded, albeit conservative, estimation we could achieve. Although all intervention participants received detailed written information, these data suggest that different delivery formats (eg, telephone or Web-based) which are more convenient for mothers faced with the

demands of caring for a toddler need to be explored. We acknowledge that multiple comparisons do not allow us to exclude the potential of a type I error. However, given that we reported significant group differences in feeding practices consistent with intervention focus in 17 of 21 possible feeding subscales or items, this source of type I error is unlikely to alter our overall conclusions.

CONCLUSIONS

NOURISH is an obesity prevention intervention that focused on maternal feeding practices and commenced in the first few months of life. It represents an important advance in efforts to prevent pediatric obesity.⁶ Across several measures, mothers in the intervention group consistently reported higher levels of responsive feeding

practices and lower levels of non-responsive feeding practices with their 2-year-old children. Overall, anticipatory guidance on the “when, what, and how” of infant feeding resulted in increased use of protective feeding practices that potentially support expanded food preferences and child self-regulation of intake, clearly indicating that maternal feeding practices are modifiable. The intervention effects on maternal behaviors did not translate into statistically significant differences in anthropometric child outcomes at 2 years of age. The 4.1% point reduction in prevalence of overweight/obesity found here translated to population level would represent an important reduction in prevalence and longer term obesity risk. It is plausible that the extent to which protective feeding practices that

focus on intrinsic determinants of eating habits, such as food preferences and appetite regulation, can confer resilience to the contemporary obesogenic environment may not manifest until the child is older. Further follow-up when the children are 3.5 and 5 years old is underway to shed light on the longer term efficacy of obesity prevention interventions that start in infancy and target maternal feeding practices.

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