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# The relationship between number of fruits, vegetables and noncore foods tried at 14 months and food preferences, dietary intake patterns, fussy eating behavior and weight status at 3.7 years

## Abstract

**Background:** The present study examined whether exposure to a greater number of fruits, vegetables and noncore foods (nutrient poor; high in saturated fats, added sugars or added salt) at 14 months of age was related to children's preference for and intake of these foods as well as maternal reported food fussiness and measured child weight status at 3.7 years.

**Methods:** This study reports secondary analyses of longitudinal data from mothers and children (*n*=340) participating in the NOURISH RCT. Exposure was quantified as the number of food items (*n*=55) 'tried' by a child from specified lists at 14 months. At 3.7 years food preferences, intake patterns and fussiness (also at 14 months) were assessed using maternal-completed established questionnaires. Child weight and length/height were measured by study staff at both ages. Multivariable linear regression models were tested to predict food preferences, intake patterns, fussy eating and BMI Z score at 3.7 years adjusting for a range of maternal and child covariates.

**Results:** Having tried a greater number of vegetables, fruits and noncore foods at 14 months predicted corresponding preferences and higher intakes at 3.7 years but did not predict child BMI Z score. Adjusting for fussiness at 14 months, having tried more vegetables at 14 months was associated with lower fussiness at 3.7 years.

**Conclusion:** These prospective analyses support the hypothesis that early taste and texture experiences influence subsequent food preferences and acceptance. These findings indicate

introduction to a variety of fruits and vegetables and limited noncore food exposure from an early age are important strategies to improve later diet quality.

## The relationship between number of fruits, vegetables and noncore foods tried at 14 months and food preferences, dietary intake patterns, fussy eating behavior and weight status at 3.7 years

## Introduction

The first two years of life are critical for development of food preferences and eating behaviors that shape children's dietary patterns, which in turn have implications for the development of overweight and obesity.[1, 2] Recent data indicate around a quarter of Australian children (2-18 years)[3] and almost one third (31.8%) of American children (2-19 years)[4] are overweight or obese. In the US rates of childhood obesity are estimated at 16.9%.[4] Clearly there is a need to improve understanding of how early feeding experiences contribute to unhealthy dietary patterns and weight outcomes. Contemporary nutrition guidelines[5] recommend both children and adults consume a wide variety of fruits and vegetables and limit intake of noncore foods (nutrient poor; high in saturated fats, added sugars or added salt)[5].Various studies in 0-3 year olds show that while up to one third did not eat fruit or vegetables, 80-90% consumed noncore foods on the survey day, with the latter contributing up to 30% of energy intake.[6-9] This evidence indicates there are substantial dietary quality issues even in young children.

Children's acceptance and hence intake of both nutrient dense (e.g., fruits and vegetables) and nutrient poor (noncore) foods are in part shaped by their food preferences and eating behaviors such as food neophobia. Food neophobia – the fear of new foods – is commonly interpreted by mothers as food fussiness.[10] Food neophobia, which tends to peak between 2-6 years of age,[11-15] often results in the rejection of new foods, particularly vegetables. Highly neophobic children tend to have lower preference for and intake of fruits and vegetables, but similar preference for noncore foods than less neophobic children.[16]

Although both food preferences and eating behaviors (such as neophobia or food fussiness) are heritable, they are readily influenced by early feeding experiences.[17, 18] Repeated exposure to new foods has been shown to reduce neophobia and positively influence food preference and acceptance.[11, 19-21] Similarly, evidence suggests early exposure to fruits and vegetables may increase the amount and variety of these foods consumed later in childhood. Skinner *et al*.[20-22] found early fruit exposure (i.e., age at which fruit was first introduced) and early fruit variety (in the first 2 years of life) were associated with school children's fruit variety at 6-8 years of age. However, a parallel association between vegetable exposure and intake was not found. Cooke *et al*.[23] also reported that earlier introduction of fruits/vegetables (based on retrospective maternal report) was associated with higher frequency (variety not examined) of fruit/vegetable consumption in 2-6 year old children. Overall, these findings support the hypothesis that early exposure to fruits and vegetables leads to subsequent preferences for and intake of these foods. Whether early exposure to noncore foods may similarly enhance preference for noncore foods has yet to be systematically explored but seems plausible given that infants show an innate preference for sweet and salty tastes.[18, 20]

There is limited evidence regarding the impact on children's dietary and health outcomes of early eating experience during 12-14 months when the major transition to family food occurs.[21] Understanding the impacts of early exposure to *both* nutrient dense and nutrient poor foods is warranted given the high exposure to noncore foods currently experienced by even very young children.[6, 7] Whereas the consumption of fruits and vegetables may confer protection against chronic diseases[24, 25] and adiposity,[26, 27] consumption of noncore foods may lead to excess energy intake and excess weight gain and obesity.[28] Thus, the aim of the present study was to examine whether exposure (in terms of variety) to vegetables, fruits and noncore foods at 14 months is prospectively related to preference for and patterns of intake of these foods, food fussiness and weight at 3.7 years of age.

## Methods and Materials

### *Study Design and Participants*

This paper reports a secondary analysis of data from the NOURISH randomized controlled trial (RCT).[29] NOURISH evaluated the efficacy of anticipatory guidance on protective feeding practices to first-time mothers. Six hundred and ninety-eight participants from two Australian cities, Brisbane and Adelaide, were enrolled in 2008-2009. Eligibility criteria included: healthy term infants (>35 weeks, ≥2500g); primiparous mothers ≥18 years, ability to write and speak in English.

Participants allocated to the intervention condition attended two modules commencing when the infants were ~ 4 and ~ 14 months old. Each module comprised of six 1.5-2 hour interactive group sessions held once every two weeks. Sessions were co-led by a dietitian and psychologist and content included anticipatory guidance on responsive feeding and parenting practices. Control participants had self-directed access to 'usual child health services' (e.g., free access to visit child health nurses at government funded clinics or a nurse-led telephone help line). Further details on the recruitment and retention protocols and outcomes for NOURISH has been described.[29, 30] The overall consent rate was 44% (excluding non-contacts) and consenting mothers were older (30 vs 28 years) and more likely to have a tertiary education (58% vs 36%).

Data collection for NOURISH occurred at: birth (first contact); baseline (prior to allocation to the intervention or control group) when children were aged approximately 4 months (Mean [*M*] =4.3, Standard Deviation [*SD*] =1.0 months); mid-intervention (prior to commencement of the second intervention module) when children were aged 14 months (*M*=13.7 ± *SD*=1.3 months); and at two follow-up assessments when children were aged 2 years (*M*=24.1 ±

*SD*=0.7 months) and 3.7 years (*M*=44.5 ± *SD*=3.1 months). For the present study data collected primarily at 14 months and 3.7 years were used; however covariate data collected at baseline, 4 months and 2 years were also used.Due to missing data on variables and covariates of interest, the final sample size for the current analyses was 340. This included participants allocated to both conditions (intervention and control). As such, group allocation was controlled for in all analyses. Compared to mothers excluded due to missing data, those included in the analyses were slightly older (age in years at delivery: *M*=30.9 ± *SD*=5.0 vs *M*=29.3 ± *SD*=5.5, $p<0.001$), had a lower BMI at baseline (child age 4 months) (*M*=25.5 ± *SD*=5.1 vs *M*=26.5 ± *SD*=5.4, $p=0.015$), and were more likely to have university level education (70.3% vs 46.6%, $p<0.001$).There were no differences in terms of group allocation ($p=0.70$) or child gender ($p=0.15$).

Eleven Human Research Ethics Committees covering Queensland University of Technology, Flinders University and all the recruitment hospitals approved the NOURISH RCT. The trial was registered with the Australian and New Zealand Clinical Trials Registry Number (ACTRN12608000056392).

***Measures***

<u>Number of fruits, vegetables and noncore foods tried at 14 months and liked at 3.7 years</u>

An adapted version of an established tool[31] listed foods commonly consumed by Australian children. The tool was used to assess (i) the number of fruits, vegetables and noncore foods that the child had ever tried at 14 months, and (ii) the number of fruits, vegetables and noncore foods that the child liked at 3.7 years. A 6 point scale (1=likes a lot, 2=likes a little, 3=neither likes nor dislikes, 4=dislikes a little, 5 = dislikes a lot, 6=never tried) was used at both 14 months and 3.7 years. At 14 months there were 19 fruits, 25 vegetables and 18 noncore food items listed. For each of these three food categories responses were dichotomized as ‘tried’ (response=1-5) vs ‘never tried’ (response=6) and the number of items tried was summed to obtain the independent variables: number of fruits/vegetables/noncore foods tried at 14 months. At 3.7 years there were 16 fruits, 22 vegetables and 17 noncore food items listed. Commercial infant foods included in the listed fruits and vegetables at 14 months were removed from the version at 3.7 years. Chocolate was omitted unintentionally from the list of noncore food items at 3.7 years. For each of the three food categories responses were dichotomized as ‘likes’ (response=1-2) vs ‘not liked/never tried’ (3-6) and the number of items liked was summed to obtain the dependent variables: number of fruits/vegetables/noncore foods liked at 3.7 years of age. Although never having tried a food is different to not liking a food, for the calculation of the number of foods liked variables this distinction was not considered problematic, especially given the typically small number of vegetables (median = 1, range 0-15), fruits (median = 1, range = 0-9) and noncore foods (median = 2, range 0-8) never tried at 3.7 years.

Food intake patterns

The *Fruit and vegetable* and *Noncore foods* subscales from the *Children’s Dietary Questionnaire* (CDQ)[32] were used to assess intake patterns at child age 3.7 years. Both subscales have shown reasonable reliability and relative validity in five separate study samples of children (*n*=706) aged 4-16 years. The *Fruit and vegetable* subscale score was calculated by summing the scores on 8 items assessing aspects of children’s intake of fruits and vegetables: (i) the total number of fruits eaten (yes/no) in the last week from a list of 20 divided by 7; (ii) the total number of vegetables eaten (yes/no) in the last week from a list 25 divided by 7; (iii) and the total number of days in the last week on which *any* fruit was consumed divided by 7; (iv) the total number of days in the last week on which *any* vegetable was consumed divided by 7; (v) the total number of *different* fruits consumed in the last 24 hours; (vi) the total number of *different* vegetables consumed in the last 24 hours; (vii) the total number of occasions *any* fruit was consumed in the previous 24 hours, and (viii) the total number of occasions *any* vegetable was consumed in the previous 24 hours. The Cronbach's α was 0.72 in the present sample vs 0.76 in the original validation study.[32] The *Noncore foods* subscale asks parents to report on their child's intake in the last week of 12 noncore food items (frequency of intake is divided by 7); Cronbach's α =0.53 vs 0.56 in the original validation study.[32] A higher score on the *Fruit and vegetable* subscale and a lower score on the *Noncore foods* subscale indicate a healthier intake pattern.

Fussiness

Food fussiness was measured at child ages 14 months and 3.7 years using the *Fussiness* subscale (6 items; Cronbach's α=0.86 [14 months] and 0.91 [3.7 years]) from the validated and widely used *Children's Eating Behaviour Questionnaire* (CEBQ).[10]

Anthropometry

Gender- and age-adjusted child BMI Z score at 14 months and 3.7 years of age were calculated using WHO Anthro[33] based weight and length (at 14 months)/height (at 3.7 years) measurements collected by trained study staff using a standardized protocol in which children were measured without footwear or outer clothes using standardized equipment.[34]

Covariates

Maternal and child characteristics were collected at first contact (maternal age, maternal education, child gender). Maternal BMI was calculated based on weight and height measured by trained assessors at baseline (child age 4 months). Duration of breastfeeding (weeks) was based on maternal reports corroborated across all time points (excluding at birth). As only around one third of children had been introduced to solids at baseline (child age 4 months), age of introduction to solids (weeks) was based on maternal report at child age 14 months.

### *Data Analysis*

Multivariable linear regression analyses were conducted for each of the outcome variables described above. In all cases covariates (ie. maternal and child characteristics including *Fussiness* score at 14 months) and the three independent variables (number of fruits, vegetables and noncore foods tried at 14 months) were entered into the model. For the regression model for BMI Z score, BMI Z score at 14 months was also included as a covariate.

## Results

Characteristics of the mother-child dyads included in the sample are presented in Table 1. There were no differences (*p* values >0.15) between participants allocated to the control or intervention group of the NOURISH trial on any of the characteristics listed in Table 1 with the exception of child BMI Z score at 14 months (mid-intervention) which was lower in the intervention group (*p*=0.03). Number of fruits, vegetables and noncore foods children had tried at 14 months are shown in Table 1. As a proportion of the listed items, children had tried (on average) 82% of vegetables, 78% of fruits and 47% of noncore foods.

The linear regression models assessing the association between number of fruits, vegetables and noncore foods tried at 14 months with number of foods within these groups liked at 3.7 years are shown in Table 2. All three models were significant (*p* values <0.001). Greater numbers of fruits (β=0.16, *p*=.007) and vegetables (β=0.14, *p*=0.022) tried at 14 months were associated with liking a greater number of fruits at 3.7 years. A greater number of vegetables tried at 14 months was also associated with liking a greater number of vegetables at 3.7 years (β=0.15, *p*=0.017). A higher number of noncore foods tried at 14 months corresponded with a greater liking for noncore foods at 3.7 years (β=0.20, *p*=0.001).

Table 3 shows the linear regression models assessing the association between number of fruits, vegetables and noncore foods tried at 14 months with the *Fruit and vegetable* and *Noncore foods* scores on the CDQ at 3.7 years. Both models were significant (*p* values ≤0.001). Greater numbers of fruits (β=0.19, *p*=0.003) and vegetables (β=0.12, p=0.054) tried at 14 months were associated with a higher *Fruit and vegetable* score at 3.7 years. Likewise, having tried more noncore foods (β=0.29, *p*<0.001) at 14 months was associated with a higher *Noncore foods* score at 3.7 years.

Having tried fewer vegetables (β=-0.12, p=0.030) at 14 months was associated with a higher *Fussiness* score at 3.7 years, adjusting for *Fussiness* score (β=0.47, p<0.001) at 14 months (Table 3). No association between number of fruits, vegetables and noncore foods tried at 14 months and child BMI Z score at 3.7 years was observed (Table 3).

## Discussion

This is one of the first studies to provide evidence that both the type and variety of foods to which a child is exposed (has tried) by the end of the first year of life predict both food preferences and dietary quality at 3.7 years of age. Specifically, we found the number of fruits and vegetables tried at 14 months was associated with children liking a wider range of fruits and vegetables and displaying healthier intake patterns of these foods at 3.7 years of age. This prospective relationship was independent of duration of breastfeeding, age of introduction of solid foods, maternal age, maternal education and maternal BMI (at child age 4 months) and maternal-reported child food fussiness at 14 months. Of particular importance is the finding that wider exposure to noncore foods (i.e., higher number of items tried at 14 months) independently predicted increased preference for and later intake of these foods. Finally, children who had tried a wider variety of vegetables at 14 months were rated as less fussy on a maternal-completed measure of eating behavior in the period when neophobia tends to peak (2-6 years).[11-15]

Based on the existing largely short-term experimental evidence[35, 36] in young infants, it is generally agreed that increasing early intake of a wide variety of fruit and vegetables is likely to positively impact preferences for and intake of these foods.[1, 2, 21, 37] This is one of few studies to provide prospective longer-term data, adjusted for key covariates, supporting this contention. Children who had tried a greater number of vegetables at 14 months liked a greater number of fruits and vegetables at 3.7 years. Similarly having tried a larger number of fruits at 14 months was linked to increased numbers of fruits but not vegetables liked at 3.7 years of age. Consistent with these enhanced preferences, having tried more fruits and vegetables at 14 months was also associated with healthier fruit and vegetable intake patterns. The benefits to be gained from introducing a range of vegetables to children from a young age in terms of dietary quality seem clear. These results appear to justify numerous short-term studies that focus on strategies to get children to taste fruit and vegetables and recommendations to increase variety and quantity consumed.[38-41]

Numerous studies have documented frequent exposure to noncore foods[7, 9, 42-44] and correspondingly high intakes[9, 42] even in very young children. Evidence from a range of studies indicates that children's acceptance of novel foods are influenced by genetic taste preferences[18] as well as environmental factors, particularly repeated exposure (familiarity).[11, 19-21] The social context and emotional climate (e.g. offered as reward or with adult attention), as well as role modelling are also important in developing food preferences.[2, 21, 45] Given these 'mechanisms' of food preference development and the availability and social use of noncore foods in our 'obesogenic' food environment, the potential for incidental learning associated with high levels of early exposure to these foods is theoretically very strong. Despite the nutritional implications, few studies have examined the long-term dietary outcomes of being exposed to a wide variety of different noncore foods at an early age. Our results indicate that children who have tried a larger number of noncore foods at 14 months show an increased liking for and more frequent intake of noncore foods at 3.7 years. This suggests that greater exposure to noncore foods from an early age lays the foundation for a diet characterized by frequent intake of noncore foods, which may in turn increase the possibility of future obesity risk.[5, 46-48]

The number of fruits, vegetables and noncore foods tried at 14 months did not significantly account for variance in BMI Z score at 3.7 years in this study. This is perhaps not unexpected given the wide range of determinants of weight gain trajectory and status in children.[48, 49] It is also possible that the influence of early unhealthy dietary intake patterns on weight may not manifest until later in childhood and longer-term follow up is required to assess this proposal.

It is also important to note that poor dietary quality is a risk factor for a range of short- and long-term adverse health outcomes, independent of weight status.[5]

Compared with the focus on increasing early fruit and vegetable exposure and intake, prospective studies examining outcomes of restricting exposure to noncore foods in infants and toddlers (< 2years of age) are few.[1, 21] A number of commonly cited reviews conclude restricting unhealthy foods is counterproductive[2, 20, 50] and include explicit recommendations to parents that restricting access to a food increases preference and consumption.[2] We acknowledge that the evidence underlying these recommendations relate to restriction of foods already being consumed by older children and most have used weight status, rather than dietary quality as an outcome. In contrast, studies in young children found that restriction was protective in terms of dietary quality[51] and weight status.[52, 53] Consistent with these studies, our results indicate that limiting the variety of noncore foods that children are offered during the first year of life is likely to be an effective strategy for improving diet quality during the first four years of life. It is important that both parents and health professionals make the distinction between restricting exposure during the infancy and toddler stages and restriction in older children with established food preferences.

Food fussiness measured at 14 months strongly predicted fussiness at 3.7 years. Fussy eating behavior at 14 months was also associated with fewer liked fruits and vegetables and a lower fruit and vegetable intake score at 3.7 years, independent of the number of fruits and vegetables tried at 14 months. This highlights the ongoing difficulties parents with ‘fussy eaters’ face in terms of encouraging healthy dietary patterns. However, we found that even after adjusting for fussiness at 14 months, a greater number of vegetables tried at this age was independently associated with less fussy eating behavior at 3.7 years. It is interesting to note that it is only early vegetable and not fruit or noncore exposure that appears to reduce later fussiness. This is consistent with studies showing children typically display a stronger neophobic response to vegetables that are less sweet and hence less liked than fruit and noncore foods.[38, 39, 54] These data suggest introducing a wide selection of vegetables before neophobic behavior begins to peak at around 2 years of age[11-15] can diminish fussy eating tendencies later in childhood. Despite the obvious challenges, parents of 'fussy' (or neophobic) children need to understand the importance and potential benefits of persisting with encouraging their infant to try a variety of vegetables from an early age and require appropriate guidance on evidenced-based strategies to do so. However, it is worth noting that our measure of fussy eating behavior was based on maternal perception which may be influenced by whether children's intake of certain foods (e.g., fruits and vegetables) match maternal expectations.

This study has a number of strengths and limitations. The use of a multivariable approach allows for the unique influence of exposure to fruits, vegetables and noncore foods to be assessed simultaneously, whilst also controlling for maternal and child covariates. These adjusted analyses revealed relatively small effects of our independent variables on the outcomes (β values <0.30). Regarding the measurement of the independent variables, our response option of 'never tried' on the adapted food preferences questionnaire cannot distinguish between whether the child had never been offered the food or had been offered the food but refused to taste it. Using a range of 'outcome' variables was a strength of the study as this allowed for a more comprehensive evaluation of how the variety of foods tried at 14 months relates to later dietary patterns (intake) as well as food preferences and fussy eating behavior. A particular strength of the CDQ[32] is that it captures two important dimensions of fruit and vegetable intake – frequency and variety – that are not captured by the most commonly used dietary outcome variables, grams or servings per day consumed.

By combining data from participants from the NOURISH control and intervention group a satisfactory sample size was achieved and the risk of type II error reduced. The patterns of association between variables would not theoretically differ depending on group allocation, nonetheless with the exception of BMI Z score at 14 months there were no differences between groups on the independent variables and covariates. Furthermore, group allocation was adjusted for in all regression analyses and was only significant in one (number of fruits liked) of the seven models. The present sample was not representative of the population, thus the generalizability of the results to younger, heavier and non-university educated mothers is uncertain. However maternal age was only significantly related to one of the seven outcome variables (number of noncore foods liked), similarly maternal BMI was only related to one outcome (child BMI Z score) and interestingly maternal education was not associated with any of the outcomes in the regression models. These findings lessen our concerns regarding the impact of bias in the sample on the robustness of the overall patterns of associations found. A final concern was the less than ideal (<0.70) Cronbach's α values of the CDQ *Noncore foods* subscale; although the estimated internal reliability value reported in the present sample ($\alpha = 0.53$) was similar to that reported in the original validation study ($\alpha = 0.56$).[32]

## *Conclusion*

Our prospective analyses clearly demonstrate that introducing infants and toddlers to a wide variety of different fruits and vegetables has positive associations with food preferences, dietary quality and potentially fussy eating behavior in preschoolers. The present results also suggest that having tried a greater number of different high energy, low nutrient noncore foods early in infancy may have adverse consequences for the later development of both preferences for these foods and unhealthy dietary intake patterns. Despite the widely promulgated notion that dietary restriction is counterproductive, our results provide clear evidence that limiting the number of different noncore foods a child tries during infancy may have a positive impact on dietary quality of preschool children. Parents need clear advice that doing so is equally as important as providing repeated neutral exposure to fruit and vegetables. Overall this study provides longitudinal data that supports the notion that very young children 'learn to like and like to eat'.[37] It provides evidence for the need for early feeding interventions that promote including a wide variety of fruit and vegetables and limiting noncore foods in the weaning and toddler diet.

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**Table 1.** Characteristics of mothers and their children (*n*=340) from the control and intervention groups of the NOURISH RCT.[29, 34]

| Characteristic | Total (*n*=340) | Control (*n*=166) | Intervention (*n*=174) | Difference[a] (*p* value) |
|---|---|---|---|---|
| ***Maternal*** | | | | |
| Age at delivery (years), mean ± SD | 30.9 ± 5.0 | 30.7 ± 5.0 | 31.0 ± 5.0 | 0.56 |
| University education, % (count) | 70.3 (239) | 68.7 (114) | 71.8 (125) | 0.55 |
| BMI (Kg/$m^2$)[b], mean ± SD | 25.5 ± 5.1 | 25.8 ± 5.7 | 25.2 ± 4.4 | 0.25 |
| ***Child*** | | | | |
| Male, % (count) | 46.5 (158) | 44.0 (73) | 48.9 (85) | 0.37 |
| Breastfeeding duration (weeks), mean ± SD | 39.4 ± 24.5 | 37.5 ± 24.0 | 41.2 ± 24.9 | 0.17 |
| Age solids introduced (weeks), mean ± SD | 22.9 ± 4.4 | 23.0 ± 4.8 | 22.9 ± 4.1 | 0.86 |
| Fussiness at 14 months[c], mean ± SD | 2.2 ± 0.6 | 2.2 ± 0.7 | 2.2 ± 0.6 | 0.66 |
| BMI Z score at 14 months[d], mean ± SD | 0.36 ± 0.85 | 0.46 ± 0.81 | 0.26 ± 0.89 | 0.03 |
| Number fruits tried at 14 months[e], mean ± SD | 14.8 ± 2.5 | 14.6 ± 2.6 | 15.0 ± 2.5 | 0.22 |
| Number vegetables tried at 14 months[e], mean ± SD | 20.4 ± 2.8 | 20.2 ± 2.9 | 20.5 ± 2.7 | 0.32 |
| Number noncore foods tried at 14 months[e], mean ± SD | 8.4 ± 3.8 | 8.5 ± 3.9 | 8.3 ± 3.7 | 0.63 |

SD=Standard Deviation.

[a] Difference between control and intervention groups assessed via independent samples t-test or likelihood chi-square test.

[b] Measured height and weight at NOURISH baseline (Mean infant age =4.3 ± *SD*=1.0 months).[34]

[c] Measured via the *Children's Eating Behaviour Questionnaire*.[10]

[d] Based on measured weight and length (*n*=338) and converted to gender and age adjusted Z score using WHO Anthro.[33]

[e] Calculated as number of listed items (fruits: 19 items; vegetables 25 items; noncore foods 18 items) 'tried' on an adapted version of the child food preferences questionnaire[31]

**Table 2.** Relationship between number of fruits, vegetables and noncore foods tried at 14 months of age and food preferences at 3.7 years.

| **Predictors** | **Food preferences – number of foods liked at 3.7 years** | | | | | |
|---|---|---|---|---|---|---|
| | **Fruits[a]** | | **Vegetables[a]** | | **Noncore foods[a]** | |
| | *M*=11.6 ± *SD*=3.2 (*n*=340) | | *M*=11.6 ± *SD*=5.0 (*n*=340) | | *M*=13.3 ± *SD*=2.2 (*n*=340) | |
| | β | *p* value | β | *p* value | β | *p* value |
| ***Covariates*** | | | | | | |
| Group (control vs intervention)[b] | 0.13 | 0.011 | 0.010 | 0.84 | -0.006 | 0.90 |
| Maternal age at delivery | -0.066 | 0.23 | 0.016 | 0.78 | -0.30 | 0.15 |
| University education (no vs yes) | 0.016 | 0.77 | -0.068 | 0.22 | 0.079 | 0.15 |
| Maternal BMI[c] | -0.040 | 0.43 | 0.031 | 0.56 | 0.044 | 0.39 |
| Child gender (male vs female) | -0.043 | 0.41 | 0.15 | 0.006 | 0.013 | 0.80 |
| Breastfeeding duration | 0.081 | 0.14 | 0.016 | 0.006 | -0.001 | 0.99 |
| Age solids introduced | 0.016 | 0.76 | 0.092 | 0.087 | -0.068 | 0.19 |
| Fussiness at 14 months[d] | -0.24 | 0.001 | -0.23 | <0.001 | -0.055 | 0.29 |
| ***Independent variables*** | | | | | | |
| Number fruits tried at 14 months[e] | 0.16 | 0.007 | 0.098 | 0.12 | 0.016 | 0.79 |
| Number vegetables tried at 14 months[e] | 0.14 | 0.022 | 0.15 | 0.017 | 0.006 | 0.93 |
| Number noncore foods tried at 14 months[e] | -0.068 | 0.23 | -0.056 | 0.34 | 0.20 | 0.001 |
| ***Overall variance explained (%)*** | 19 | | 14 | | 18 | |

Results based on multivariable linear regression analyses.

*M*: Mean; *SD*: Standard Deviation.

β: Beta – standardized regression coefficient (range: -1 to 1); all values given are from final model.

Overall variance explained: Based on $R^2$ (R squared) – proportion of variance in the dependent variable explained by the overall model (i.e. includes all covariates and independent variables).

[a] Calculated as number of listed items 'liked' (fruits: 16 items; vegetables: 22 items; noncore foods: 17 items) on an adapted version of the child food preferences questionnaire[31] at child age 3.7 years.

[b] Based on allocation at baseline (child age 4 months) to control vs intervention group of the NOURISH RCT.[34]

[c] Measured height and weight at baseline (child age 4 months).

[d] Measured via the *Children's Eating Behaviour Questionnaire*[10] at child age 14 months.

[e] Calculated as number of listed items (fruits: 19 items; vegetables 25 items; noncore foods 18 items) 'tried' on an adapted version of the child food preferences questionnaire[31] at child age 14 months.

**Table 3.** Relationship between number of fruits, vegetables and noncore foods tried at 14 months of age and dietary intake patterns, fussy eating and BMI Z score at 3.7 years.

| **Predictor** | **Dietary Intake Score at 3.7 years[a]** | | | | **Fussiness at 3.7 years[b]** | | **BMI Z score at 3.7 years[c]** | |
|---|---|---|---|---|---|---|---|---|
| | **Fruit and vegetable** | | **Noncore foods** | | | | | |
| | *M*=14.6 ± *SD*=3.8 (*n*=333) | | *M*=1.9 ± *SD*=0.9 (*n*=322) | | *M*=2.9 ± *SD*=0.8 (*n*=339) | | *M*=0.53 ± *SD*=0.84 (*n*=337) | |
| | β | *p* value | β | *p* value | β | *p* value | β | *p* value |
| ***Covariates*** | | | | | | | | |
| Group (control vs intervention)[d] | 0.077 | 0.14 | 0.038 | 0.49 | -0.001 | 0.99 | 0.004 | 0.93 |
| Maternal age at delivery | -0.10 | 0.072 | 0.010 | 0.87 | 0.067 | 0.19 | -0.032 | 0.51 |
| University education (no vs yes) | -0.004 | 0.95 | 0.036 | 0.54 | 0.037 | 0.47 | -0.072 | 0.13 |
| Maternal BMI[e] | -0.028 | 0.60 | -0.037 | 0.51 | 0.038 | 0.42 | 0.23 | <0.001 |
| Child gender (male vs female) | .031 | 0.55 | 0.020 | 0.72 | -0.11 | 0.024 | -0.077 | 0.090 |
| Breastfeeding duration | 0.056 | 0.32 | -0.050 | 0.40 | 0.005 | 0.93 | 0.074 | 0.13 |
| Age solids introduced | 0.070 | 0.19 | 0.050 | 0.38 | -0.088 | 0.074 | -0.017 | 0.71 |
| Fussiness at 14 months[f] | -0.21 | <0.001 | 0.039 | 0.48 | 0.47 | <0.001 | -0.043 | 0.35 |
| BMI Z score at 14 months[g] | -- | | -- | | -- | | 0.51 | <0.001 |
| ***Independent variables*** | | | | | | | | |
| Number fruits tried at 14 months[h] | 0.19 | 0.003 | 0.051 | 0.44 | -0.020 | 0.72 | 0.015 | 0.78 |
| Number vegetables tried at 14 months[h] | 0.12 | 0.054 | -0.034 | 0.61 | -0.12 | 0.030 | -0.083 | 0.12 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Number noncore foods tried at 14 months[h] | -0.10 | 0.07 | 0.29 | <0.001 | 0.044 | 0.40 | -0.026 | 0.60 |
| ***Overall variance explained (%)*** | 17 | | 10 | | 29 | | 37 | |

Results based on multivariable linear regression analyses; *n* values for regression models vary due to missing data on outcome variables.

*M*: Mean; *SD*: Standard Deviation.

β: Beta – standardized regression coefficient (range: -1 to 1); all values given are from final model.

Overall variance explained: Based on $R^2$ (R squared) – proportion of variance in the dependent variable explained by the overall model (i.e. includes all covariates and independent variables).

[a] Subscale scores from the *Children's Dietary Questionnaire*[32] at child age 3.7 years.

[b] Measured via the *Children's Eating Behaviour Questionnaire*[10] at 3.7 years.

[c] Based on measured weight and height at child age 3.7 years and converted to gender and age adjusted Z score using WHO Anthro.[33]

[d] Based on allocation at baseline (child age 4 months) to control vs intervention group of the NOURISH RCT.[34]

[e] Measured height and weight at baseline (child age 4 months).

[f] Measured via the *Children's Eating Behaviour Questionnaire*[10] at child age 14 months.

[g] Based on measured weight and length at child age 14 months and converted to gender and age adjusted Z score using WHO Anthro.[33]

[h] Calculated as number of listed items (fruits: 19 items; vegetables 25 items; noncore foods 18 items) 'tried' on an adapted version of the child food preferences questionnaire[31] at child age 14 months.