RESEARCH
Original Research

The Relationship between Number of Fruits, Vegetables, and Noncore Foods Tried at Age 14 Months and Food Preferences, Dietary Intake Patterns, Fussy Eating Behavior, and Weight Status at Age 3.7 Years

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ABSTRACT

Objective We examined whether exposure to a greater number of fruits, vegetables, and noncore foods (ie, nutrient poor and high in saturated fats, added sugars, or added salt) at age 14 months 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 age 3.7 years.

Methods This study reports secondary analyses of longitudinal data from mothers and children (n=340) participating in the NOURISH randomized controlled trial. Exposure was quantified as the number of food items (n=55) tried by a child from specified lists at age 14 months. At age 3.7 years, food preferences, intake patterns, and fussiness (also at age 14 months) were assessed using maternal-completed, established questionnaires. Child weight and length/height were measured by study staff at both age points. Multivariable linear regression models were tested to predict food preferences, intake patterns, fussy eating, and body mass index *z* score at age 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 age 14 months predicted corresponding preferences and higher intakes at age 3.7 years but did not predict child body mass index *z* score. Adjusting for fussiness at age 14 months, having tried more vegetables at age 14 months was associated with lower fussiness at age 3.7 years.

Conclusions 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.
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THE FIRST 2 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 that approximately one-quarter of Australian children (aged 2 to 18 years)[3] and almost one-third (31.8%) of American children (aged 2 to 19 years)[4] are overweight or obese. In the United States, 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 (F/V) and limit intake of noncore foods (ie, those that are nutrient poor and high in saturated fats, added sugars, or added salt).[5] Various studies in children aged 0 to 3 years show that while up to one-third did not eat fruit or vegetables, 80% to 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 (eg, F/V) 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 ages 2 and 6 years,[11-15] often results in the rejection of new foods, particularly vegetables. Highly neophobic children tend to have lower preference for and intake of F/V, 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 F/V may increase the amount and variety of these foods consumed later in childhood. Skinner and colleagues[20-22] found early fruit exposure (ie, age at which fruit was first introduced) and early fruit variety (during the first 2 years of life) were associated with school-age children's fruit variety at ages 6 to 8 years. However, a parallel association between vegetable exposure and intake was not found. Cooke and colleagues[23] also reported that earlier introduction of F/V (based on retrospective maternal report) was associated with higher frequency (variety not examined) of F/V consumption in children aged 2 to 6 years. Overall, these findings support the hypothesis that early exposure to F/V 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 influence on children's dietary and health outcomes of early eating experience during ages 12 to 14 months when the major transition to family food occurs.[21] Understanding the influence 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 F/V 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 age 14 months is prospectively related to preference for and patterns of intake of these foods, food fussiness, and weight at age 3.7 years.

MATERIALS AND METHODS

Study Design and Participants

We report a secondary analysis of data from the NOURISH randomized controlled trial.[29] NOURISH evaluated the efficacy of anticipatory guidance on protective feeding practices to first-time mothers. Six hundred ninety-eight participants from two Australian cities, Brisbane and Adelaide, were enrolled during 2008-2009. Eligibility criteria included healthy term infants (gestational age >35 weeks, weighing ≥2,500 g) and their primiparous mothers aged ≥18 years who have the ability to write and speak in English.

Participants allocated to the intervention condition attended two modules commencing when the infants were aged ~4 and ~14 months. Each module was composed of six 1.5- to 2-hour interactive group sessions held once every 2 weeks. Sessions were co-led by a dietitian and a psychologist and content included anticipatory guidance on responsive feeding and parenting practices. Control participants had self-directed access to usual child health services (eg, 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 are described elsewhere.[29,30] The overall consent rate was 44% (excluding noncontacts) and consenting mothers were older (aged 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 (before allocation to the intervention or control group) when children were aged approximately 4 months (mean age=4.3±1.0 months), midintervention (before commencement of the second intervention module) when children were aged ~14 months (mean age=13.7±1.3 months), and at two follow-up assessments when children were aged 2 years (mean age=24.1±0.7 months) and 3.7 years (mean age=44.5±3.1 months). For the present study, data collected primarily at ages 14 months and 3.7 years were used; however, covariate data collected at baseline, age 4 months, and age 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 with mothers excluded due to missing data, those included in the analyses were slightly older (mean age in years±standard deviation at delivery: 30.9±5.0 vs 29.3±5.5; $P<0.001$), had a lower body mass index (BMI) at baseline (child age 4 months) (25.5±5.1 vs 26.5±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 sex ($P=0.15$).

Eleven human research ethics committees covering Queensland University of Technology, Flinders University, and all the recruitment hospitals approved the NOURISH randomized controlled trial. The trial was registered with the Australian and New Zealand Clinical Trials Registry (no. ACTRN12608000056392).

Measures

Number of Fruits, Vegetables, and Noncore Foods Tried at Age 14 Months and Liked at Age 3.7 Years. An adapted version of an established tool[31] listed foods commonly consumed by Australian children. The tool was used to assess the number of fruits, vegetables, and noncore foods that the child had ever tried at age 14 months, and the number of fruits, vegetables, and noncore foods that the child liked at age 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, and 6=never tried) was used at both ages 14 months and 3.7 years. At age 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 to 5) vs never tried (response=6) and the number of items tried was summed to obtain the independent variables (ie, number of fruits/vegetables/noncore foods tried at age 14 months). At age 3.7 years there were 16 fruits, 22 vegetables, and 17 noncore food items listed. Commercial infant foods included in the listed F/V at age 14 months were removed from the version used at age 3.7 years. Chocolate was omitted unintentionally from the list of noncore food items at age 3.7 years. For each of the three food categories, responses were dichotomized as likes (response=1 to 2) vs not liked/never tried (response=3 to 6) and the number of items liked was summed to obtain the dependent variables: