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Baby knows best? The impact of weaning style on food preferences and body mass index in early childhood in a case–controlled sample

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ABSTRACT

Objective: The impact of different weaning methods on food preferences and body mass index (BMI) in early childhood is not known. Here, we examine if weaning method—baby-led weaning versus traditional spoon feeding—influences food preferences and health-related outcomes.

Design, setting and participants: Parents (n=155) recruited through the Nottingham Toddler laboratory and relevant internet sites completed a questionnaire concerning (1) infant feeding and weaning style (baby-led=92, spoon-fed=63, age range 20–78 months), (2) their child's preference for 151 foods (analysed by common food categories, eg, carbohydrates, proteins, dairy) and (3) exposure (frequency of consumption). Food preference and exposure data were analysed using a case–controlled matched sample to account for the effect of age on food preference. All other analyses were conducted with the whole sample.

Main outcome measures: The primary outcome measures were food preferences, exposure and weaning style. The secondary outcome measures were BMI and picky eating.

Results: Compared to the spoon-fed group, the baby-led group demonstrated (1) significantly increased liking for carbohydrates (no other differences in preference were found) and (2) carbohydrates to be their most preferred foods (compared to sweet foods for the spoon-fed group). Preference and exposure ratings were not influenced by socially desirable responding or socioeconomic status, although an increased liking for vegetables was associated with higher social class. There was an increased incidence of (1) underweight in the baby-led group and (2) obesity in the spoon-fed group. No difference in picky eating was found between the two weaning groups.

Conclusions: Weaning style impacts on food preferences and health in early childhood. Our results suggest that infants weaned through the baby-led approach learn to regulate their food intake in a manner, which leads to a lower BMI and a preference for healthy foods like carbohydrates. This has implications for combating the well-documented rise of obesity in contemporary societies.

ARTICLE SUMMARY

Article focus

- Although numerous studies have focused on when to introduce solid foods into an infant's diet, there is a dearth of evidence concerning the impact of different weaning methods on food preferences and health.
- Baby-led weaning is suitable for most infants and is associated with reduced maternal anxiety about weaning and feeding and a maternal feeding style that is low in control.

Key messages

- Our study suggests that baby-led weaning has a positive impact on the liking for foods that form the building blocks of healthy nutrition, such as carbohydrates.
- Baby-led weaning promotes healthy food preferences in early childhood, which may protect against obesity.

Strengths and limitations of this study

- One limitation of the present study is that we relied on self-report. However, using a self-report questionnaire is a standard approach when dealing with food preferences, and we controlled for self-presentation effects (none were uncovered).
- A second criticism that may be levied here is our reliance on a small sample size. However, we used a matched sample and report robust effect sizes.

INTRODUCTION

How should solid foods be introduced to infants? Do different weaning methods impact on food preferences and health-related outcomes? These questions are currently unanswered. To date, the focus on weaning has been on when, rather than how, to wean.[1] Recently, much media attention has centred on baby-led weaning,[2 3] which emphasises infant self-feeding with solid finger foods from the outset rather than parental spoon feeding with purees. Baby-led

weaning is suitable for most infants[4] and is associated with (1) reduced maternal anxiety about weaning and feeding[5] and (2) a maternal feeding style, which is low in control.[6] However, the impact of this weaning method on food preferences and health-related outcomes is not known. Thus, we examined the influence of different weaning styles on food preference, body mass index (BMI) and picky eating in early childhood.

METHODS

Parents of 155 children (aged 20–78 months) were recruited to the study between June 2006 and January 2009. The baby-led group (n=92) was recruited through an advert posted on relevant internet sites; the spoon-fed group (n=63) was recruited from our toddler laboratory database.

Participants completed a questionnaire (a standard research tool for examining food preferences[7]) concerning the following: (1) infant feeding and weaning style. (2) Child's preference (rated from 1 'loves it' to 5 'hates it') for 151 foods (adapted from Wardle *et al*[8]), which was analysed by standard food categories, for example, carbohydrates, proteins, dairy,[9] and included a category called 'meals' for whole meals like lasagne.[8] See supplementary information in etable 1 for details. (3) Exposure (frequency of consumption) rated from 1 'more than once a day' to 7 'less than once per month', as this is closely related to food preferences.[10 11] (4) Picky eating (a single item requiring a 'yes/no' response to 'Would you classify your child as a picky eater?'). (5) Child height and weight for BMI calculation (weight in kilograms divided by the square of the height in metres). In the spoon-fed group, these measurements were made using standardised procedures when assessed in our laboratory. We calculated BMI z-scores using the WHO Growth Standards.[12] BMI percentile ranks were calculated using the Centers for Disease Control and Prevention (CDC) Child and Teen BMI Calculator[13] and the National Health Service (NHS) Choices BMI Calculator[14] (which uses UK90 reference data for children older than 4 years[15] and WHO Growth Standards data for children younger than 4 years).[12] (6) Socioeconomic status (via postcode using the Income Deprivation Affecting Children Index (IDACI) score and rank for 2007 and National Statistics 2001 Area Classification of Super Output Areas and Data Zones)).[16] These measures are frequently used in social and health-related research with children and by government departments.[17] Socioeconomic status has been shown to influence eating practices and behaviours.[18–20] (7) Marlowe–Crowne Social Desirability Scale (short form).[21] Parents who returned a completed questionnaire were entered into a prize draw for £50. Ethical approval was granted by the University of Nottingham School of Psychology Ethics Committee. Parents completed a consent form prior to participation in the study.

Data were analysed using PASW Statistics V.18.0.[22] Pearson's correlations and t tests were used to examine relationships between outcome measures and groups, respectively. Non-parametric tests (Spearman's rank correlations, Mann–Whitney U) were used when there was significant skew or problems with homogeneity (Bonferroni-corrected for multiple comparisons). Missing food preference data were accounted for in the calculation of averages across categories. Cases with other missing data (eg, BMI) were excluded from analyses. Preliminary analyses showed that exposure and preference ratings were not contaminated by socially desirable responding and only liking for vegetables was significantly related to socioeconomic status (IDACI score) ($r_s=-0.25$, $p=0.005$) (higher social class associated with increased liking for vegetables).

As no formal definition of baby-led weaning exists,[6] parental self-report of weaning style was used to generate weaning groups. To verify the veracity of self-reported weaning style, responses to items concerning weaning methods were interrogated. This confirmed that the baby-led group were more likely to have handled food from the introduction of solid foods, were given finger foods earlier and fewer had been spoon-fed with pureed foods at all (table 1). Thus, the two groups differed significantly on criteria typically used to characterise baby-led weaning.[6]

RESULTS

The baby-led group was significantly younger than the spoon-fed group (table 1), and overall age and preference were significantly correlated (collapsed across food categories, $r_s=0.28$, $p=0.001$; and for the individual food categories of dairy, $r_s=0.35$, $p<0.0001$; snacks, $r_s=0.21$, $p<0.009$ and meals, $r_s=0.26$, $p=0.001$). To control for this effect of age, a case–controlled age-matched sample of 74 participants (37 pairs) was generated to analyse the food preference data (see table 2 for details).

Between the two weaning groups, significant differences in preference were found for only one food category—the baby-led group liked carbohydrates more than the spoon-fed group ($t(72)=-3.11$, $p=0.003$, $d=-0.53$). Indeed, carbohydrates were the most liked food category for the baby-led group, whereas sweet foods were most liked by the spoon-fed group (table 2). The baby-led group also liked proteins ($t(72)=-2.71$, $p=0.008$, $d=-0.63$) and whole meals ($U=448.00$, $p=0.02$, $d=-0.40$) more than the spoon-fed group, but these differences did not survive Bonferroni adjustment.

Next, we investigated the effects of exposure on food preferences in the matched sample[10 11] (table 3). Across groups, comparisons revealed increased exposure to vegetables, fruit, carbohydrates, protein, meals and sweets in the spoon-fed group. Exposure was significantly associated with liking for dairy foods ($r_s=0.58$, $p<0.0001$), snacks ($r_s=1$, $p<0.001$), vegetables ($r_s=0.47$, $p<0.0001$) and proteins ($r_s=0.44$, $p<0.0001$). No association was found for carbohydrates ($r_s=0.19$, $p=0.11$), sweet foods ($r_s=0.19$, $p=0.11$), fruits ($r_s=0.10$, $p=0.39$) and meals ($r_s=0.17$, $p=0.14$). This suggests that for

Table 1 Outcomes on weaning style and infant feeding, socioeconomic status scores, picky eating and BMI*

Characteristic	Baby-led (n=92)	Spoon-fed (n=63)	p Value
Child age at testing (months)	32.12 (10.30)	41.62 (13.58)	<0.0001
Female†	57.6% (53/92)	39.7% (25/63)	0.03
Handled food from introduction of solids	96.7% (89/92)	15.87% (10/63)	<0.0001
Exposed to pureed food	32.6% (30/92)	100% (63/63)	0.0001
First exposed to finger food (age in months)	6.49 (1.41)	7.10 (1.63)	0.001
Child was breastfed‡	98.9% (91/92)	88.9% (56/63)	0.008
Duration (months) of breastfeeding	23.70 (11.27)	9.50 (9.30)	<0.0001
Socioeconomic status: IDACI score	0.11 (0.08)	0.14 (0.11)	0.17
Socioeconomic status: IDACI rank	19566.81 (8304.26)	21679.33 (7218.74)	0.16
Birth weight (lbs/oz)	7.64 (2.70)	7.09 (1.31)	0.09
Child BMI: NHS UK percentile rank	54.38 (28.91)§	64.79 (26.20)	0.05
Child BMI: CDC US percentile rank	48.46 (29.71)§	61.44 (26.98)	0.009
Parent BMI	24.08 (5.46)	24.91 (1.31)	0.91
Child is picky eater	18.5% (17/92)	23.8% (15/63)	0.43

*Means and SDs are shown in parentheses for continuous variables. Analyses were conducted on the whole sample.
†In the matched sample (used to analyse weaning style preference data), there was no gender difference (table 2).
‡There was no difference in breastfeeding between the groups in the matched sample (92% were breastfed in the spoon-fed group compared to 97% in the baby-led group) (χ^2=0.30, p=0.62).
§BMI data were missing from 29/92 (32%) because parents had not weighed or measured their child recently. Within the baby-led group, there was no difference in preference ratings between those children with BMI scores and those without (max U=151.5, p=0.88, for protein).
BMI, body mass index; CDC, Centers for Disease Control and Prevention; NHS, National Health Service; IDACI, Income Deprivation Affecting Children Index.

carbohydrates, the only food category with significant group differences, weaning style was more influential than exposure on preference ratings.

Finally, we investigated the influence of weaning method on health-related outcomes. BMI scores (percentile rank) differed significantly between groups (table 1)—lower BMI were associated with baby-led weaning in the whole sample. (This difference was also evident in the matched sample—NHS percentile rank (U=276.50, p=0.008) and CDC percentile rank (U=268.50, p=0.005)). As shown in table 1, the mean BMI percentile rank for the baby-led group was close to the expected average (percentile rank of 50) for both the NHS and CDC classification systems. In contrast, the mean percentile rank for the spoon-fed group was above the average level, indicating that more children in this group were likely to be classed as overweight.

BMI z-scores were also found to differ significantly between the weaning groups (see table 4). To investigate this further, we determined the number of children in each group classified as significantly underweight (z-score more than −2) and those who were obese (z-score of more than +2)—clinically the most concerning cases. Using this criterion, we found there to be an increased incidence of obese children in the spoon-fed group (n=8) as compared to the baby-led group (n=1). In contrast, more children in the baby-led group were classified as significantly underweight (n=3) compared to the spoon-fed group (n=0) (Fisher's exact test, p=0.02, two-tailed). A similar pattern of results was

Table 2 Mean preference ratings by weaning group (presented in order of liking for each group)*

Baby-led group (n=37; females=17)	Mean (SD)	Spoon-fed group (n=37; females=15)	Mean (SD)
Carbohydrates	1.82 (0.42)	Sweet foods	1.81 (0.59)
Savoury snacks	1.83 (0.59)	Savoury snacks	2.08 (0.63)
Sweet foods	1.89 (0.71)	Carbohydrates	2.12 (0.41)
Fruit	1.97 (0.58)	Fruit	2.15 (0.46)
Protein	2.03 (0.51)	Protein	2.38 (0.60)
Dairy	2.25 (0.89)	Dairy	2.44 (0.97)
Meals	2.33 (0.82)	Meals	2.62 (0.62)
Vegetables	2.74 (0.66)	Vegetables	2.87 (0.62)

Case-controlled, chronological age-matched pairs were formed.
All cases and controls were matched for age. In 11 cases, matches could be made using age alone—for each case, there was one control participant of the same age.
Where there were several control participants who matched a case on age, we selected the control participant using age and socioeconomic status (n=20).
Where more than one participant matched on age and socioeconomic status, we then matched on gender (n=1).
In some cases, no information on socioeconomic status was available so matches were made using age and gender (n=5).
There was no effect of gender in this matched sample (χ^2=0.22, p=0.82).
*Lower scores indicate greater liking.

Table 3 Mean exposure ratings by weaning group—means and SDs presented

Food category	Baby-led group (n=37; females=17)	Spoon-fed group (n=37; females=15)	p Value	Effect size (d)
Carbohydrates	4.59 (0.52)	4.07 (0.69)	0.001*	0.85
Savoury snacks	1.83 (0.59)	2.08 (0.63)	0.13	−0.41
Sweet foods	5.96 (0.72)	4.64 (0.79)	<0.0001*	1.78
Fruit	5.02 (0.69)	4.31 (0.45)	<0.0001*	1.22
Protein	4.97 (0.70)	4.48 (0.66)	0.003*	0.72
Dairy	4.37 (1.41)	4.10 (1.01)	0.30	0.22
Meals	5.69 (0.65)	5.02 (0.75)	<0.0001*	0.95
Vegetables	4.89 (0.83)	4.42 (0.67)	0.005*	0.62

Lower exposure scores indicate more frequent consumption.
*Difference remains significant after Bonferroni adjustment for multiple comparisons (*0.05/8=0.006).

found when child BMI was classified according to percentile rank (see table 4).

BMI (WHO z-score) was not correlated with socially desirable responding in the baby-led group (where self-report of height and weight measurements was used, $r_s=-0.13$, p=0.29). Also BMI (WHO z-score) did not correlate with socioeconomic status (IDACI score) ($r_s=-0.07$, p=0.51) or breastfeeding duration ($r_s=-0.10$, p=0.29) in the whole sample. (There was also no correlation between BMI scores and breastfeeding duration in the matched sample ($r_s=-0.11$, p=0.43)). The same pattern of results was found when using the BMI percentile rank measures. (No difference between the two weaning groups was found in the prevalence of picky eaters (table 1)).

Table 4 BMI by WHO z-scores and NHS/CDC percentiles by weaning group*

	Baby-led group (*n*=63)	Spoon-fed group (*n*=63)
WHO z-score†		
−3	1 (1.6%)	0 (0%)
−2	2 (3.2%)	0 (0%)
−1	5 (7.9%)	3 (4.8%)
0	39 (61.9%)	40 (63.5%)
1	15 (23.8%)	12 (19.0%)
2	1 (1.6%)	8 (12.7%)
3	0 (0%)	0 (0%)
NHS percentiles		
Underweight (<2)	3 (4.7%)	0 (0%)
Healthy weight (2–90)	51 (81.0%)	53 (84.1%)
Overweight (91–97)	9 (14.3%)	2 (3.2%)
Obese (98+)	0 (0%)	8 (12.7%)
CDC percentiles		
Underweight (0–4)	6 (9.5%)	1 (1.6%)
Healthy weight (5–85)	49 (77.8%)	47 (74.6%)
Overweight (86–95)	7 (12.7%)	8 (12.7%)
Obese (96+)	1 (1.6%)	7 (11.1%)

*Most participants had a BMI in the average/healthy range across measures.
†WHO have suggested a set of cut-offs based on single SD spacing. Thinness: less than −2SD, overweight: between +1SD and less than +2SD, obese: more than +2SD.
BMI, body mass index; CDC, Centers for Disease Control and Prevention; NHS, National Health Service.

DISCUSSION

Understanding the factors that contribute to healthy nutrition in early childhood is crucial as this could be the optimal time to modify food preferences so as to foster healthy diets in obesogenic food environments.[10] Our findings show that baby-led weaning has a positive impact on the liking for carbohydrates—foods that form the building blocks of healthy nutrition (ie, those found at the bottom of the food pyramid).[9] This is a significant finding since, to date, the factors thought to be most influential on early food preferences are sweetness and familiarity (exposure).[10] Consistent with previous research, the spoon-fed group preferred sweet foods most, whereas the baby-led group most preferred carbohydrates (even though significantly higher exposure to carbohydrates was reported in the spoon-fed group).

Children weaned using the baby-led method are more likely to encounter carbohydrates in their whole food format earlier than spoon-fed children as these foods are ideal early finger foods (eg, toast and pitta breads) so age of introduction may impact on behaviour. However, our data show that exposure per se did not influence preference for carbohydrates, so another factor must be driving preference here. Presenting carbohydrates to infants in their whole food format, such as toast, rather than a pureed form may highlight awareness of perceptual features (such as texture) that is masked when food is pureed. Previous research has shown that food presentation significantly influences food preferences,[23] so it is possible that differences in the presentation of foods across the two weaning groups impacted on preferences. It is also possible that carbohydrates are easier to masticate compared to some other foods such as meat (which may be easier to eat when pureed and spoon-fed). Interestingly, the baby-led group showed increased preference for all food categories except sweets compared to the spoon-fed group (although this was only significant for carbohydrates).

Our results also showed that baby-led weaning was associated with lower BMI (in terms of mean percentile rank) that could not be accounted for by differences in birth weight, parental BMI or socioeconomic status. The analysis of BMI z-scores revealed an increased incidence

of underweight (the baby-led children (3/63)) and an increased incidence of obesity (the spoon-fed children (8/63)). It should be noted that there was some missing data on BMI in the baby-led group (32%). However, in both groups, the vast majority of the children were of an average/healthy weight (see table 4). In contrast to past literature,[24] breastfeeding duration and BMI were not significantly associated. This discrepancy may be due to the fact that the vast majority of the mothers in this sample breastfed their babies and for much longer periods of time than might be expected from past research.[25] Nonetheless, duration of breastfeeding may have a mediating effect, which requires investigation in relation to the impact that weaning style has on BMI. No difference in the prevalence in picky eating was found across groups. Moreover, 93.5% of the baby-led group reported that their child had never experienced a choking incident (a serious concern for parents and practitioners).[2]

Our results suggest that baby-led weaning promotes healthy food preferences in early childhood that could protect against obesity. This finding is of note given the serious problems with childhood obesity facing many modern societies.[26] The baby-led approach was, however, associated with a higher incidence of underweight relative to the spoon-fed group. The factors underlying this require exploration in future research.

To the best of our knowledge, this is the first study to have examined the impact of weaning method on food preferences and health outcomes in early childhood. Future research should determine whether our findings hold for more specialist populations, such as babies born prematurely or with specific health difficulties. Moreover, careful consideration should be given to the classification of weaning method. In the present study, we relied on parents identifying themselves as having used baby-led weaning (and we checked the reliability of this self-report by asking some specific questions about their weaning practices). This gave rise to a dichotomous variable—either the parents used baby-led weaning or they did not. However, it may be more sensitive to consider weaning methods as a continuum where parents rate the percentage use of pureed foods in their child's diet over time.[5] In addition, previous studies have shown that parents who used the baby-led approach to weaning are less controlling and more willing to hand control over to the child when introducing solid foods.[6] Future research needs to address the contribution of this factor into any effect of weaning method on food preferences.

A large controlled prospective study is now required, which examines weaning practices in tandem with the other key factors, including BMI, milk feeding practices (breast vs bottle/formula fed), socioeconomic status, locus of control and picky eating. In particular, a study is needed that includes a greater proportion of children who have been formula/bottle fed in order to compare the relative impacts of weaning method and milk feeding practices on food preferences and health outcomes in early childhood.

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Competing interests Within the last five years ET and NP have received co-funding from Nutricia/Danone to support an ESRC CASE PhD studentship.

Ethics approval The study was approved by University of Nottingham Psychology Ethics Board.

Contributors ET and NP designed the study and secured the funding for it. ET collected and analysed the data and wrote the paper. NP contributed to the analysis and wrote the paper. ET is the guarantor for the study, and both authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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