Comparison of food and nutrient intake in infants aged 6-12 months, following baby-led or traditional weaning: A cross-sectional study

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Abstract

Background: A baby-led approach to weaning (BLW) encompasses self-feeding and self-selecting graspable foods, offering an alternative to traditional weaning (TW). This cross-sectional study explored adherence to characteristics of BLW and differences in food group exposure and nutrient intake between babies following either TW or BLW.

Methodology: Nutritional data were collected via multi-pass 24-hour recall, following parental completion of an online survey.

Results: Infants were grouped according to age (6-8 months; TW (n=36) and BLW (n=24)) and (9-12 months; TW (n=24) and BLW (n=12)). BLW babies were more likely to be breast fed (P=0.002), consumed a higher percentage of foods also consumed by their mother (P=0.008) and were fed less purees (P<0.001) at 6-8 months. TW babies were spoon fed more (P=<0.001) at all ages. At 6-8 months, total intake (from complementary food plus milk) of iron (P=0.021), zinc (P=0.048), iodine (P=0.031), vitamin B12 (P=0.002) and vitamin D (P=0.042) and both vitamin B12 (P=0.027) and vitamin D (P=0.035) from complementary food alone was higher in babies following TW. Compared to TW, BLW babies aged 6-8 months had a higher percentage energy intake from fat (P=0.043) and saturated fat (P=0.026) from their milk. No differences in nutrient intake were observed amongst infants aged 9-12 months. Few differences were observed between groups in their number of exposures to specific food groups..

Conclusions: TW infants had higher intakes of key micronutrients at 6-8 months but there were few differences in nutritional intake at 9-12 months, or food group exposure between babies following TW or BLW. BLW appears to be socially desirable and guidance for parents is required, along with larger, longer-term studies, which explore the potential impact of BLW in later childhood.

Key words: Infant feeding, solid foods, complementary feeding, dietary intake, weaning, baby-led weaning

Background

Complementary feeding is the introduction of solid foods to infants, alongside their usual milk (breast or formula) starting when milk alone is no longer sufficient to meet the nutritional requirements of infants [(1)]. The World Health Organisation (WHO) recommend that complementary feeding should be timely, adequate and safe with foods being properly fed, consistent with a child's appetite and satiety [(2)]. Commonly termed 'weaning', complementary feeding should be initiated at around 6 months of age, to avoid growth faltering and iron deficiency [(3, 4, 5)]. In the UK, a traditional approach to weaning (TW) usually involves spoon feeding purees then graduating to more textured foods and some finger foods before joining in with the family diet by 12 months of age [(6)]. Alternatively, a baby-led approach to weaning (BLW), encompasses offering healthy foods, sharing family mealtimes, self-feeding, and self-selecting foods, in addition to offering graspable foods from the outset, which babies may pick up with their hands [(7, 8)]. Proponents of BLW suggest the method allows the baby to choose what and how much to eat, therefore, responding to appetite, developing motor skills and due to only whole foods being given, to learning about the varied texture and flavour of individual foods [(9)]. Despite the rise in popularity of BLW, this style of weaning is not supported by current guidance for parents in the UK [(6)] and health professionals have raised concerns about whether BLW leads to inadequate intakes of iron, zinc and energy and an increase in the risk of choking [(5, 10)]. Choking risk was largely discounted in studies by Fangupo et al. (2016) [(11)] and Brown (2018) [(12)]. A review of the evidence base underlying current recommendations for feeding children up to 5 years of age was published by the UK Scientific Advisory Committee on Nutrition (SACN) in early 2018 [(4)]. The report highlighted several benefits of BLW and concluded that BLW did not appear to decrease energy or micronutrient intakes, but did result in earlier self-feeding, less food fussiness and greater enjoyment of food [(4)]. However, there are a scarcity of studies exploring differences in nutrient intake, eating behaviours, long-term patterns of eating or longer-term health parameters between weaning approaches [(9, 13, 14, 15)].

The definition of BLW for use in research is also not clear [(9)]. BLW appears to be an approach, rather than simple method and consists of several underlying principles [(7, 14)]. Previous studies have focussed on identifying BLW by asking parents to self-classify their approach to weaning (TW or BLW) or by asking parents to estimate the percentage of foods spoon fed (rather than self fed) or in pureed food (rather than whole or finger foods), with BLW classed as those who use ≤10% spoon feeding and ≤10% pureed foods [(16, 17, 18, 19, 20)]. All definitions are subjective, and it may be challenging for parents to estimate in terms of percentages.

To date there have only been two studies in the UK, which directly compare exposure or dietary intake of babies following TW or BLW [(20, 21)]. As diet in this age group is key to development, further studies are required to help provide evidence for policy makers, health professionals and parents. This study adds to this body of evidence by exploring dietary intake in infants aged 6-12 months and the extent to which families follow key BLW characteristics such as self-feeding and consuming whole or finger foods.

Methods

Participant recruitment and data collection

Ethical approval for the study was granted by (removed for blinding). Participants were the main caregiver of infants aged 6-12 months, recruited by placing adverts on parenting forums, weaning and parenting Facebook groups at three time-points: 4th Oct-30th Nov 2019, 22nd June and 7th July 2020 and 1st Nov – 1st December 2020. Participants were self-selecting. Some additional parents were included from a second study, recruited in June 2019 (prior to initiation of solid foods) with nutritional data collected 4th Oct-30th Nov 2019 when their babies were aged 6-12 months. Questionnaires were housed on the JISC survey platform [22] and completed online. All participants were presented with an information sheet at the start of the electronic study, where the nature of the questionnaire and how the data would be used was explained. Participants consented to take part in the study, but clicking 'yes' they had read the information sheet and 'yes' they wanted to take part. After consenting, they were presented with questions relating to their age, occupation, education, home ownership, marital status, height, weight, pre-pregnancy weight (if applicable), parity, singleton/multiple birth and their baby's (age, birthweight). A milk feeding history was recorded for the baby, along with a validated retrospective infant feeding behaviour questionnaire [23] and questions relating to the way in which babies were fed their normal milk and solid food. Additionally, measures of weaning style included asking the caregiver the percentage of time infants were spoon fed and percentage of times infants were fed puree, consistent with other studies [16, 17, 18, 19, 20, 24] and a yes/no answer to the following statement: "*Baby-led weaning is the process of placing foods in front of your baby and letting them feed themselves – picking the food up and putting it in their mouths unassisted, rather than being spoon-fed by an adult" – Do you follow a baby-led weaning approach?*" similar to Rowan, Lee & Brown (2019) [21].

Participants were asked to provide a phone number which was used by a researcher to complete a multi-pass 24-hour recall with both the caregiver and the baby, following a standardised methodology [25]. The number of foods eaten by the baby were counted and the % of those foods that were the same as those consumed by the caregiver was calculated. Caregivers were also asked whether an adult family member was eating (meal or snack) at the same time as the baby was eating (regardless of whether the same food was consumed), whether each food given to the baby was spoon-fed or self-fed and whether each food was provided as a puree or as a whole/finger food, pre-loaded spoon or dipper (a firm food used to eat a soft one, e.g. toast fingers to eat hummus).

Caregivers were aged over 18 and resident in the UK. Babies were aged 6-12 months of age. Some circumstances can cause delayed weaning or feeding difficulties in children, therefore, babies born prematurely (≤37 weeks gestation) or suffering a disability, health problem or congenital abnormality affecting feeding were also excluded from the study. Infants with allergies were not excluded.

Nutritional analysis

All 24-hour recalls (foods and individual recipes) were entered into Nutritics [26] by the lead researcher. Foods with full nutritional analysis (with respect to nutrients of interest) were selected where available, otherwise new foods were inputted per 100g using data from grocery (e.g. ASDA, Tesco, Sainsbury's;) [20] or manufacturer's websites (e.g. Ella's Kitchen, Heinz). Where micronutrient data was not available from either Nutritics, manufacturer or grocery website, new recipes were created using % ingredients (usually baby foods which list the % of each ingredient). Portion size data (teaspoons, tablespoons, jar/container sizes or fractions of adult portion sizes) was provided by participants. When portion size estimation was missing or unclear, portion sizes recommended in Nutritics (for example, weights of teaspoons or tablespoons of food) or estimated using manufacturers data, Food Portion Size handbook [27] or the First Steps Nutrition Trust Guide [28] were used.

To assess milk feeding, the brand and volume of formula milk consumed was recorded and converted into number of grams. It was assumed formula milk was made up according to the pack instructions. The amount of breast milk consumed by breastfed infants was estimated in grams, in a similar way to the BLISS trial [29] using breast milk volumes reported by Dewey et al. (1991) [30] and Committee on Nutritional Status During Pregnancy and Lactation (1991) [31]. These values were dependent on the age of the infant; 5.0-7.5 months (769g breastmilk per day, assuming complementary feeding has commenced), 7.6-10.9 months (637g) and 11-12 months (445g). Where infants were mixed fed, the no. of grams of breastmilk was calculated by subtracting the no. of grams of formula reported, from the estimated average daily intake of breastmilk above [30]. The use of vitamin, mineral or other supplements were recorded and included in the analyses. The nutrient content of human milk was available in Nutritics, originally from …??

Food group analysis

To explore the frequency of exposure, foods were grouped similar to Townsend & Pitchford (2011) [32], Alpers et al.(2019) [20], Rowan et al. (2019) [21] (Table 5). Wherever individual ingredients were listed as part of a meal, in a recipe or recipe title, individual ingredients were recorded in each relevant food group. Homemade dishes with no recipe or an ambiguous title, e.g. 'homemade bolognaise' then this was listed as a homemade composite dish.

Calculations and statistical analysis

Percentage energy from macronutrients were calculated using metabolisable energy conversion factors; carbohydrate (16 kJ/g), protein (17 kJ/g), fat (37 kJ/g), saturated fat (37 kJ/g) and free sugars (16 kJ/g) [33].

A simplified NS-SEC code [34] was assigned to both the participant and their partner based on their occupation. These were combined and the highest occupation class used to classify each household. Data were exported to SPSS Statistics for Windows, version 24.0[35] and checked for potential outliers. Tests for normality were carried out using Shapiro-Wilk test and Kolmogorov-Smirnov tests. Chi-squared and Fishers Exact tests were carried out on frequency data. Independent samples t-test and were carried out where data were continuous and parametric. Mann-Whitney-U tests were carried out where data were continuous or ordinal and non-parametric. A significance level of $P<0.05$ has been use throughout.

Results

<u>Maternal and infant characteristics</u>

A total of 319 respondents completed the online survey about infant feeding and complementary feeding, all of whom were the baby's mother. Of the 189 respondents who left a phone number, 102 completed a 24-hour recall and are the focus of this analysis. Six infants were later excluded (three were aged over 12 months, two were born prematurely and one recall was incomplete), leaving 96 mother-infant pairs who met the study criteria. Of these, 60 were classed as TW and 36 as following BLW. Infants following BLW were spoon-fed ≤10% of the time and were fed purees ≤10% of the time as self-reported by parents [16, 17, 18, 19, 20, 24]. Mothers were aged 25-45 years with a mean (SD) of 33.3 (4.0) years. There were no significant differences in the age or other demographic characteristics of mothers between weaning groups (Table 1).

Most of the infants in the study had been breastfed at some time since birth (96.9%) and 55.2% were currently consuming only breast milk via their milk feeds, whilst 28.1% and 16.7% were formula or mixed (a mixture of breast and formula) fed respectively at the time of the study (Table 2). There were significant differences between the TW and BLW groups in the proportion of infants who were currently breastfed (41.7% and 77.8% respectively, P=0.002), breastfeeding duration (73.3%in TW compared to 86.1% in BLW group at 6 months of age, P=0.026) and volume of milk consumed (although this was based on estimates for breastfed infants). A significantly higher proportion of mothers following TW, compare to those following BLW, reported dairy allergy in their baby. (16.9% versus 2.9% respectively, P=0.040). Five categories of infant feeding behaviour were included (general appetite, food responsiveness, enjoyment of food, satiety responsiveness, slowness in eating) but there were no significant differences between weaning groups for any behaviour prior to initiation of weaning. No other differences were observed, including choking incidences although this was higher in the TW group (20.0% compared to 8.3% in the BLW group, NS).

Characteristics of weaning style

Characteristics of a BLW style were also explored (Table 3). The group following a BLW style were significantly more likely to self-report following BLW (P<0.001 in all groups), consumed a higher percentage of foods that were also consumed by their mother at 6-8 months only (P=0.008) (following the family diet) and were significantly less likely to be spoon fed (P<0.001 in all groups), or fed purees (P<0.001 at 6-8months) as recorded on the 24-hour recalls.

Nutritional intake

Estimated nutrient intake from food, milk and total intake was compared between those babies following TW and BLW (Table 4). There were no significant differences in energy intake between the groups, although TW babies consumed more energy from food (NS) and BLW babies consumed more energy from milk (NS) at 6-8 months. Average energy intakes exceeded the estimated average requirement (EAR), but are very similar to those observed by Alpers et al. (2019). At 6-8 months, TW and BLW babies received 52% and 58% of their energy intake from milk, respectively. At 9-12 months this was 42% in both groups. BLW babies aged 6-8 months and all BLW babies combined consumed more fat, percentage energy from fat, saturated fat and percentage energy from saturated fat from their milk. A higher percentage of total energy intake from fat (P=0.042) and saturated fat (P=0.006) was observed amongst BLW babies when babies of all ages were grouped together.

Total iron intake (food and milk combined) and total zinc intake was higher in TW babies aged 6-8 months (P=0.021 and P=0.048 respectively) and all babies following TW (P=0.008 and P=0.040 respectively). Iodine intake was significantly higher only in younger babies following TW compared to the BLW group (P=0.031). All babies following TW and younger babies following TW had higher total intakes of vitamin B12 than those following BLW (P=0.002 at both 6-8 and 9-12 months). Vitamin B12 intake was also higher from complementary foods only amongst all TW babies combined (P=0.027) and TW babies in the younger age group (P=0.006). Vitamin D intake estimated from milk alone was higher amongst all TW babies (P=0.034) and from both total intake (P=0.042) and from food alone (P=0.035) in 6-8-month-olds.

Babies in both groups exceeded the EAR for energy and the reference nutrient intake (RNI) for protein, sodium, vitamin A, vitamin B12 and vitamin C at both 6-8 and 9-12 months. Babies in all groups consumed below the RNI for iron with 44.4% of younger TW babies and 62.5% younger BLW babies falling below the lower reference nutrient intake (LRNI) (see supplementary data). All BLW babies together and those aged 6-8 months fell below the RNI for zinc with 25% of younger

BLW babies and 5.6% of younger TW babies falling below the LRNI (see supplementary data). Younger babies following BLW consumed below the RNI for calcium but no babies in the study fell below the LRNI.

Few differences were observed between groups in their number of reported exposures to specific food groups (Table 5) and exposure to oily fish, processed meats, sugary foods, alternatives to dairy and commercially produced meals and snacks were low across all groups. Most babies were exposed to more than one iron-containing food on the day of measurement. Younger babies (6-8 months) following TW had significantly higher exposures to oily fish (P=0.037), fortified infant cereal (P=0.035), dairy or dairy-based desserts (P=0.036) and commercially produced infant meals; (P=0.005). Older babies (aged 9-12 months) following BLW were exposed to more protein-containing foods (P=0.042) and dairy/dairy-based desserts (P=0.022).

Discussion

This study, which aimed to compare infant feeding characteristics and nutritional intake between babies following either a TW or BLW approach, found significant differences in the way in which babies fed. When looking at total daily intake, younger babies (6-8 months) following TW consumed more iron, zinc, iodine and vitamin D than BLW babies, whilst younger BLW infants consumed more fat and saturated fat via their milk than their TW counterparts. Considering complementary foods alone, only the intakes of vitamin B12 and vitamin D were significantly higher in younger TW infants. Younger TW infants had more exposures to iron-fortified infant cereal and commercially produced baby foods. Differences in both nutritional intake and food group exposure disappeared by 9-12 months.

BLW is not well defined. Loosely, it encompasses the form and delivery of food to the baby, offering family foods, sitting in on meals, waiting until 6 months to introduce solids and milk feeding on demand [7, 36] but adherence to these principles was not consistent between groups. Whilst the BLW group were more likely to adhere to all the measures of BLW weaning style in this study, parents categorised as following the TW approach were most likely to self-report following ‘predominantly TW’ or ‘predominantly BLW’ rather than identifying with a purely TW approach. As 55% of the TW group, overall, also answered ‘yes’ to the BLW statement [21], indicating following BLW, this could indicate aspiration to or social desirability of BLW. When exposure to the family diet was measured (similarity between infant and maternal foods), all groups demonstrated relatively low similarity (<33%) but was significantly higher in the younger BLW group. These findings contrast with Brown and Lee (2011) [16] who found that BLW was associated with greater self-reported participation in mealtimes and exposure to family foods than TW. A lack of consistency between differing measures of BLW suggest that families may pick and choose which parts of a weaning style suit them best and differences become less significant amongst older babies. Sachs (2011) [36] suggested that many of the defining principles of BLW such as sharing family foods and mealtimes correspond with current Public Health England/NHS weaning advice which encourages parents and infants to sit together for family mealtimes and for the infant to move towards family foods by 12 months [6]. As a result, there may be less distinct differences between BLW and TW than when BLW was first described [7] and that differences mostly persist amongst younger babies. Self-reported spoon feeding ≤10% most closely predicted weaning style as used in this study but even then, BLW babies were still spoon fed 16.2% of the time on their recall.

Three previous studies have explored nutrient intake and weaning style; Alpers et al. (2019) [20] in the UK and Morison et al. (2016) [37] and Williams-Erickson et al. (2018) [15] in New Zealand. The overall quality of evidence is low [38]. Two studies found higher intakes of fat amongst BLW babies (from food only in the UK study) [20, 37]). The present study found intakes of both fat, saturated fat and percentage intakes of fat and saturated fat were higher in younger and combined BLW groups. Younger babies consumed more breast/formula milk and less food than older babies. A diet of predominantly breast/formula milk is more likely to have a higher fat content than a diet of predominantly solid food[2]. There was also a high proportion of breastfed babies in the BLW group and breastmilk has a slightly higher fat content (4.1g in human milk versus 3.6g in formula milk) in UK databases, which may account for some of the observed difference [26 39]. Fat intakes of 30-45% energy are thought to be prudent by the WHO but the UK do not currently have guidelines for children under 2 years of age. Intakes of fat in this study do not appear to be concerning [2, 33]. Estimated energy intakes were high in this study, likely due to over estimation of portion sizes and underestimation of food lost to the floor or clothing, but values were similar to Alpers et al. (2019) [20] who also used 24-hour recall. If portion sizes are over-estimated, however, this further accentuates the likelihood that dietary reference values (DRVs) for micronutrients are not met.

Health professionals commonly raise the concern that BLW will be associated with lower intakes of iron [5, 9, 39, 40] which has been observed amongst younger babies in this study. This concern stems from BLW infants consuming less traditional weaning foods such as fortified baby cereals. These are very high in iron but are not contingent with BLW, as they are not graspable and appropriate as finger foods [38]. Fortified baby foods are not usually part of the family diet so lower consumption would be expected when following BLW. In the current study exposure was very low across both groups but significantly higher in younger babies following TW. Iron status is determined by both in utero reserves and dietary intake but qualitative data from the UK has shown that many families believe ‘food before one is just for fun’ and so may not understand the importance of iron-containing foods during complementary feeding [42]. Infants in this study consumed Weetabix® and Ready Break® slightly softened or cooked and cut into fingers so it could be that parents are including fortified foods but actively avoiding commercially available baby foods, which may be less acceptable to families who have a higher social class and/or food knowledge and wish to avoid pre-packaged and processed baby food [43]. This may be apparent in the current study where the majority of participants were educated to degree level and were of high SES. Observed differences in iron intake between younger babies following TW and BLW were only apparent when both food and milk were combined. This indicates an accumulation of small differences via the type of milk consumed and amount of, if not number of exposures to, iron-containing foods. Infant formula contains 10 times more iron (0.7mg/100ml) than mature human breastmilk (0.07mg/100g) as the non-haem iron in formula milk is less bioavailable (10%) than the haem iron in breastmilk (50%) [26, 41]. This difference is reflected in UK DRVs, which are set at a value appropriate for formula fed infants and higher than necessary for breastfed infants [43]. Breast fed babies may have adequate or at least equivalent intakes of iron and the failure to meet DRVs may be of more concern amongst formula fed infants, even though intakes appear higher. Studies exploring haematological parameters of iron (including plasma ferritin, iron store depletion, early functional iron deficiency) in infants following either BLW or TW found no differences between groups whether parents had received dietary support to include iron-containing foods or not [44, 29]. Daniels et al. (2018) [29] suggested this was due to babies being offered high iron foods as part of their intervention study but Rowan et al. (2019) [21] found no significant differences in exposure to iron-containing foods in their UK babies following one of three groups: strict BLW, Loose BLW or TW. Differences in estimated iron intake at 6-8 months, in this study, could be due to BLW babies eating smaller amounts of food because they are younger and self-feeding at a slower pace. Iron intakes amongst infants are often problematic and stronger, more targeted guidance/advice on iron-containing foods for all babies may be required [36, 37, 39].

Like iron, intakes of zinc were significantly lower in younger BLW babies and intakes of both zinc and calcium were below the RNI among BLW babies aged 6-8.5 months. Calcium is also less bioavailable in formula milk (40%) than breast milk (66%) and so requires a higher DRV [45]. An Estimated Average Requirement (EAR) of 240mg/day would be adequate for breastfed babies whilst an EAR of 400 would be required for those formula fed. Daniels et al. (2018) [46] found no differences in zinc intake between BLW and TW infants in their randomised-controlled intervention trial which encouraged consumption of iron-rich foods. Foods containing iron are often those which are also high in zinc so guidance to increase intakes of iron would also increase zinc consumption.

Vitamin D intake in this study is a crude estimate. The vitamin D content of breastmilk varies between fore and hind milk and is correlated to maternal plasma 25(OH)D concentrations [20, 47]. There is no vitamin D or vitamin B12 in breast milk in UK databases whilst formula milk is fortified [26, 41]. Babies who are breast fed or receiving less than 500ml per day of formula milk should be given 8-10µg of vitamin a day, usually as drops [48]. Only 43.5% of breastfed babies and 12.5% of formula/mixed-fed babies receiving less than 500ml of formula on the day of measurement were given a supplement on the day of measurement, although like other studies, some parents reported usually or sometimes giving supplements, just not on the day the recall was carried out [20, 49].

Finally, older BLW infants were exposed to dairy and protein-containing foods more often. Higher than recommended intakes of protein may be significant as higher intakes of protein may contribute to increased weight gain over time [50].

It is acknowledged that there are several limitations to this study. Firstly, all data is self-reported and estimates of intake from breastmilk were based on average estimated values. Although there were no significant differences between the weaning groups in maternal demographic characteristics, this sample is not representative of the UK population with 82.5% or respondents in higher managerial occupations and 80.4% holding a university degree (compared with 27% nationally) [50]. This is a common feature of infant feeding surveys [20, 21, 32]. Although internet samples may be diverse [51] health-conscious women with higher levels of education, higher incomes are more likely to participate in online surveys of this nature with breastfeeding women over-represented (55.7% offering only breastmilk at 6 months in this sample, compared to 1% nationally) [41, 52]. As BLW is more likely to follow on from breastfeeding [9], the proportion of BLW followers is likely to be considerably over-estimated [53]. Whilst having a more homogenous sample naturally controls for some predictors of a healthy diet, such as socioeconomic status and education, allowing differences due to weaning style to become more apparent, this also emphasises the need for a nationally representative randomly sampled survey to explore the prevalence of BLW in the UK population.

This study used 24-hour recall to estimate nutrient intake. Many people who completed the online survey did not consent to a researcher calling them to complete a 24-hour recall, although there were no significant demographic differences between those who provided this data and those who did not (data not shown). Although data were recorded by trained researchers, 24-hour recalls have been demonstrated to overestimate energy intake in infants by around 13%, compared with 3 day weighed food records (which over-estimate by 5%). This is consistent with the high energy intakes observed here [54] . The most likely cause of this is over-estimation of portion sizes or over-estimation of milk consumption [54]. Responses may have been subject to respondent bias, incorrect estimations of portion sizes provided, the amount actually eaten [55, 56] and the respondent's memory [56].

Conclusion

The literature comparing TW and BLW is limited and this study adds to a growing picture created by similar small studies in the UK and New Zealand. Although the overall quality of evidence across the range of available studies may be low, there appear to be few persisting differences in nutritional intake or food group exposure between TW and BLW babies and the perceived risk of choking is not supported by the data. As more parents choose to adopt BLW-based approaches to complementary feeding, health professionals should be less concerned with risk and focus more on the longer-term health implications. Larger, longer and more nationally representative samples are needed for this.

Transparency Declaration':

"The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported. The reporting of this work is compliant with STROBE[2] guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned (please add in the details of any organisation that the trial or protocol has been registered with and the registration identifiers) have been explained.

References

1. PAHO (2003) Guiding principles for complementary feeding of the breastfed child. Pan American Health Organization. Available from: https://www.who.int/nutrition/publications/guiding_principles_compfeeding_breastfed.pdf (Accessed 16th March 2021)
2. WHO (2003) Complementary feeding: report of the global consultation: Summary of guiding principles, 2003. Available from: https://apps.who.int/iris/bitstream/handle/10665/42739/924154614X.pdf?sequence=1&isAllowed=y (Accessed 16th March 2021)
3. Department of Health (2003). Infant Feeding Recommendation. Available from: https://webarchive.nationalarchives.gov.uk/20120503221049/http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4097197 (Accessed 1st May 2021)
4. Scientific Advisory Committee on Nutrition (2018) Feeding in the first year of life. Available from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725530/SACN_report_on_Feeding_in_the_First_Year_of_Life.pdf
5. Cameron SL, Heath AL, & Taylor RW (2012) How feasible is Baby-led Weaning as an approach to infant feeding? A review of the evidence. *Nutrients*, **4**, 1575–1609.
6. NHS. Weaning (2020) Available from https://www.nhs.uk/start4life/weaning/ (Accessed 20th April 2021)
7. Rapley G & Murkett T. *Baby-led weaning. helping your baby to love good food.* Chatham: Random House; 2008
8. Rapley G. (2011) Baby-led weaning: transitioning to solid foods at the baby's own pace. *Community practitioner : the journal of the Community Practitioners' & Health Visitors' Association*, **84**, 20–23.
9. Brown A, Jones SW & Rowan H (2017) Baby-Led Weaning: The Evidence to Date. *Current nutrition reports*, **6**, 148–156.
10. Daniels L, Heath AL, Williams SM, Cameron SL, Fleming EA, Taylor BJ, Wheeler BJ, Gibson RS, & Taylor RW (2015).Baby-Led Introduction to SolidS (BLISS) study: a randomised controlled trial of a baby-led approach to complementary feeding. *BMC pediatrics*, **15**, 179.
11. Fangupo LJ, Heath AM, Williams SM, Williams-Erickson LW, Morison BJ, Fleming EA, Taylor BJ, Wheeler BJ & Taylor RW (2016) A Baby-Led Approach to Eating Solids and Risk of Choking. *Pediatrics*, ***138***. Available from https://doi.org/10.1542/peds.2016-0772

12. Brown A (2018) No difference in self-reported frequency of choking between infants introduced to solid foods using a baby-led weaning or traditional spoon-feeding approach. *J Hum Nutr Diet*, ***31***, 496–504.

13. Pang WW & McCrickerd K (2021) The impact of feeding experiences during infancy on later child eating behaviours. *Curr Opin Clin Nutr Metab*, **24**, 246–251.

14. Morison BJ, Heath AM, Haszard JJ, Hein K, Fleming EA, Daniels L, Erickson EW, Fangupo LJ, Wheeler BJ, Taylor BJ & Taylor RW (2018) Impact of a Modified Version of Baby-Led Weaning on Dietary Variety and Food Preferences in Infants. *Nutrients*, **10**, 1092.

15. Williams Erickson L, Taylor RW, Haszard JJ, Fleming EA, Daniels L, Morison BJ, Leong C, Fangupo LJ, Wheeler, BJ, Taylor BJ, Te Morenga L, McLean RM & Heath, AM (2018). Impact of a Modified Version of Baby-Led Weaning on Infant Food and Nutrient Intakes: The BLISS Randomized Controlled Trial. *Nutrients*, **10**, 740.

16. Brown A & Lee M (2011) Maternal control of child feeding during the weaning period: differences between mothers following a baby-led or standard weaning approach. *Matern Child Health J*, **15**, 1265–1271.

17. Brown A & Lee, M (2011) A descriptive study investigating the use and nature of baby-led weaning in a UK sample of mothers. *Matern Child Nutr*, **7**, 34–47.

18. Brown A & Lee M (2013) An exploration of experiences of mothers following a baby-led weaning style: developmental readiness for complementary foods. *Matern Child Nutr*, ***9***, 233–243.

19. Brown A & Lee MD (2015) Early influences on child satiety-responsiveness: the role of weaning style. *Pediatr Obes*, ***10***, 57–66.

20. Alpers B, Blackwell V & Clegg ME (2019) Standard *v.* baby-led complementary feeding: a comparison of food and nutrient intakes in 6-12-month-old infants in the UK. *Public Health Nutr*, **22**, 2813–2822.

21. Rowan H, Lee M & Brown A (2019) Differences in dietary composition between infants introduced to complementary foods using Baby-led weaning and traditional spoon feeding. *J Hum Nutr Diet*, **32**, 11–20.

22. JISC (2020) Online surveys. Available from https://www.jisc.ac.uk/

23. Llewellyn CH, van Jaarsveld CH, Johnson L, Carnell S & Wardle J (2011) Development and factor structure of the Baby Eating Behaviour Questionnaire in the Gemini birth cohort. *Appetite*, **57**, 388–396.

24. Brown A (2016) Differences in eating behaviour, well-being and personality between mothers following baby-led vs. traditional weaning styles. *Matern Child Nutr*, **12**, 826–837.

25. Johnson RK, Driscoll P & Goran MI (1996) Comparison of multiple-pass 24-hour recall estimates of energy intake with total energy expenditure determined by the doubly labeled water method in young children. *J Am Diet Assoc*, **96**, 1140–1144.

26. Nutritics (2019) Nutritics Education (v5.64). Dublin. Available from https://www.nutritics.com.

27. Food Standards Agency (2002). *Food portion sizes*. London: The Stationary Office.

28. First Steps Nutrition Trust (2019) *Eating well: The first year A guide to introducing solids and eating well up to baby's first birthday.* Available from https://static1.squarespace.com/static/59f75004f09ca48694070f3b/t/5ceed06a15fcc07f8822270b/1559154825802/Eating_well_first_year_April19_for_web.pdf (Accessed 20th April 2021)

29. Daniels L, Taylor RW, Williams SM, Gibson RS, Fleming EA., Wheeler BJ, Taylor BJ, Haszard JJ, & Heath AM (2018) Impact of a modified version of baby-led weaning on iron intake and status: a randomised controlled trial. *BMJ open*, **8**. Available from: https://doi.org/10.1136/bmjopen-2017-019036

30. Dewey, KG, Heinig MJ, Nommsen LA, Peerson JM & Lönnerdal B (1992) Growth of breast-fed and formula-fed infants from 0 to 18 months: the DARLING Study. *Pediatrics*, **89**, 1035–1041.

31. Committee on Nutritional Status During Pregnancy and Lactation. Milk volume. *Nutrition during lactation* (pp. 80-105). Washington (DC): National Academy of Sciences; 1991

32. Townsend E, Pitchford NJ. Baby knows best? (2012) The impact of weaning style on food preferences and body mass index in early childhood in a case-controlled sample. BMJ Open. **6**. Available from: doi:10.1136/bmjopen-2011-000298

33. Scientific Advisory Committee on Nutrition. Dietary Reference Values for Energy. London: The Stationary Office; 2011

34. Office for National Statistics (2010) ONS Occupational Coding Tool. Available from https://onsdigital.github.io/dp-classification-tools/standard-occupational-classification/ONS_SOC_occupation_coding_tool.html (Accessed 20th April 2021)

35. 'IBM SPSS Statistics for Windows, version XX (IBM Corp., Armonk, N.Y., USA

36. Sachs M (2011) Baby-led weaning and current UK recommendations--are they compatible? *Matern Child Nutr*, **7**, 1–2. https://doi.org/10.1111/j.1740-8709.2010.00278.x

37. Morison BJ, Taylor RW, Haszard JJ, Schramm CJ, Williams Erickson L, Fangupo LJ, Fleming EA, Luciano A & Heath AL (2016) How different are baby-led weaning and conventional complementary feeding? A cross-sectional study of infants aged 6-8 months. *BMJ open*, **6**. Available from: https://doi.org/10.1136/bmjopen-2015-010665

38. D'Auria E, Bergamini M, Staiano A, Banderali G, Pendezza E, Penagini F, Zuccotti GV, Peroni DG & Italian Society of Pediatrics (2018) Baby-led weaning: what a systematic review of the literature adds on. *Ital J Pediatr*, **44**, 49.
39. D'Andrea E, Jenkins K, Mathews M, Roebothan B (2016) Baby-led Weaning: A Preliminary Investigation. Can J Diet Pract Res, 77, 72-7. doi: 10.3148/cjdpr-2015-045
40. Urkia-Susin I, Rada-Fernandez de Jauregui D, Orruño E, Maiz E, Martinez O (2021) A quasi-experimental intervention protocol to characterize the factors that influence the acceptance of new foods by infants: mothers' diet and weaning method. Dastatuz project. *BMC Public Health*, 21, 918 doi:10.1186/s12889-021-10967-7
41. Finglas PM, Roe MA, Pinchen HM, Berry R, Church SM, Dodhia SK, Farron-Wilson M & Swan G. McCance and Widdowson's The Composition of Foods, Seventh summary edition. The Royal Society of Chemistry, Cambridge; 2015
42. Arden MA & Abbott RL (2015) Experiences of baby-led weaning: trust, control and renegotiation. *Matern Child Nutr*, **11**, 829–844
43. Wardle J, Parmenter K & Waller J (2000) Nutrition knowledge and food intake. *Appetite*, **34**, 269–275
44. Dogan E, Yilmaz G, Caylan N, Turgut M, Gokcay G & Oguz MM (2018) Baby-led complementary feeding: Randomized controlled study. *Pediatr Int*, **60**, 1073–1080
45. COMA. Dietary reference values for food energy and nutrients for the United Kingdom. 1st Ed, London: HSMO; 1991
46. Daniels L, Williams SM, Gibson RS, Taylor RW, Samman S & Heath AM (2018) Modifiable "Predictors" of Zinc Status in Toddlers. *Nutrients*, **10**, 306
47. Við Streym S, Højskov CS, Møller UK, Heickendorff L, Vestergaard P, Mosekilde L & Rejnmark L (2016) Vitamin D content in human breast milk: a 9-mo follow-up study. *Am J Clin Nutr*, **103**, 107–114
48. NHS (2020) Vitamin D (Vitamins and minerals). Available from https://www.nhs.uk/conditions/vitamins-and-minerals/vitamin-d/ (Accessed 6th May 2021)
49. Hemmingway A, Fisher D, Berkery T, Murray DM & Kiely ME (2021) Adherence to the infant vitamin D supplementation policy in Ireland. *Eur J Clin Nutr*, **60**, 1337–1345
50. Pearce J & Langley-Evans SC (2013) The types of food introduced during complementary feeding and risk of childhood obesity: a systematic review. *Int J Obes*, **37**, 477–485
51. Office for National Statistics. (2021). 2011 Census: Key Statistics for England and Wales, March 2011. Available from https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populatio

nestimates/bulletins/2011censuskeystatisticsforenglandandwales/2012-12-11#toc (Accessed 20th April 2021).

52. Gosling S, Vazire S, Srivastava S & John OP (2004) Should we trust web-based studies? A comparative analysis of six preconceptions about internet questionnaires. *Am* Psychol, **59**, 93-104

53. McAndrew F, Thompson J, Fellows L, Large A, Speed M & Renfrew MJ. Infant Feeding Survey 2010. Health and Social Care Information Centre; London, UK, 2012.

54. Fisher JO, Butte NF, Mendoza PM, Wilson TA, Hodges EA, Reidy KC & Deming D (2008) Overestimation of infant and toddler energy intake by 24-h recall compared with weighed food records. *Am J Clin Nutr*, **88**, 407–415

55. Young LR, Nestle MS (1995) Portion sizes in dietary assessment: issues and policy implications. *Nutr Rev*. **53**,149-58.

56. Naska A, Lagiou A & Lagiou P (2017) Dietary assessment methods in epidemiological research: current state of the art and future prospects. *F1000Research*, *6*, 926. (accessed 15th May 2021)

Comparison of food and nutrient intake in infants aged 6-12 months, following baby-led or traditional weaning: A cross-sectional study

Abstract

Background: A baby-led approach to weaning (BLW) encompasses self-feeding and self-selecting graspable foods, offering an alternative to traditional weaning (TW). This cross-sectional study explored adherence to characteristics of BLW and differences in food group exposure and nutrient intake between babies following either TW or BLW.

Methodology: Nutritional data were collected via multi-pass 24-hour recall, following parental completion of an online survey.

Results: Infants were ~~recorded as early~~grouped according to age (6-8 months; TW (n=36) and BLW (n=24)) ~~or late~~and (9-12 months; TW (n=24) and BLW (n=12)) ~~stage of weaning~~. BLW babies were more likely to be breast fed (P=0.002), consumed a higher percentage of foods also consumed by their mother (P=0.008) and were fed less purees (P<0.001) at 6-8 months. TW babies were spoon fed more (P=<0.001) at all ~~st~~ages. At 6-8 months, total intake (from complementary food plus milk) of iron (P=0.021), zinc (P=0.048), iodine (P=0.031), vitamin B12 (P=0.002) and vitamin D (P=0.042) and both vitamin B12 (P=0.027) and vitamin D (P=0.035) from complementary food alone was higher in babies following TW. Compared to TW, BLW babies aged 6-8 months had a higher percentage energy intake from fat (P=0.043) and saturated fat (P=0.026) from their milk. No differences in nutrient intake were observed amongst infants aged 9-12 months. Few differences were observed between groups in their number of exposures to specific food groups.

Conclusions: TW infants had higher intakes of key micronutrients at 6-8 months but there were few differences in nutritional intake at 9-12 months, or food group exposure between babies following TW or BLW. BLW appears to be socially desirable and guidance for parents is required, along with larger, longer-term studies, which explore the potential impact of BLW in later childhood.~~TW babies have better nutrient intakes in early weaning, but this difference quickly disappears. As spoon feeding is a key difference between styles, nutrient dense foods, which can be self-fed, should be encouraged~~.

Key words: Infant feeding, solid foods, complementary feeding, dietary intake, weaning, baby-led weaning

Background

Complementary feeding is the introduction of solid foods to infants, alongside their usual milk (breast or formula) starting when milk alone is no longer sufficient to meet the nutritional requirements of infants [1]. The World Health Organisation (WHO) recommend that complementary feeding should be timely, adequate and safe with foods being properly fed, consistent with a child's appetite and satiety [2]. Commonly termed 'weaning', complementary feeding should be initiated at around 6 months of age, to avoid growth faltering and iron deficiency [3, 4, 5]. In the UK, a traditional approach to weaning (TW) usually involves spoon feeding purees then graduating to more textured foods and some finger foods before joining in with the family diet by 12 months of age [6]. Alternatively, a baby-led approach to weaning (BLW), encompasses offering healthy foods, sharing family mealtimes, self-feeding, and self-selecting foods, in addition to offering graspable foods from the outset, which babies may pick up with their hands [7, 8]. Proponents of BLW suggest the method allows the baby to choose what and how much to eat, therefore, responding to appetite, developing motor skills and due to only whole foods being given, to learning about the varied texture and flavour of individual foods [9]. Despite the rise in popularity of BLW, this style of weaning is not supported by current guidance for parents in the UK [6] and health professionals have raised concerns about whether BLW leads to inadequate intakes of iron, zinc and energy and an increase in the risk of choking [5, 10]. Choking risk was largely discounted in studies by Fangupo et al.~~,~~ (2016) [11] and Brown (2018) [12]. A review of the evidence base underlying current recommendations for feeding children up to 5 years of age was published by the UK Scientific Advisory Committee on Nutrition (SACN) in early 2018 [4]. The report highlighted several benefits of BLW and concluded that BLW did not appear to decrease energy or micronutrient intakes, but did result in earlier self-feeding, less food fussiness and greater enjoyment of food [4]. However, there are~~is~~ a scarcity of studies exploring differences in nutrient intake, eating behaviours, long-term patterns of eating or longer-term health parameters between weaning approaches [9, 13, 14, 15].

The definition of BLW for use in research is also not clear [9]. BLW appears to be an approach, rather than simple method and consists of several underlying principles [7, 14]. Previous studies have focussed on identifying BLW by asking parents to self-classify their approach to weaning (TW or BLW) or by asking parents to estimate the percentage of foods spoon fed (rather than self fed) or in pureed food (rather than whole or finger foods), with BLW classed as those who use ≤10% spoon feeding and ≤10% pureed foods [16, 17, 18, 19, 20]. All definitions are subjective, and it may be challenging for parents to estimate in terms of percentages.

To date there have only been two studies in the UK, which directly compare exposure or dietary intake of babies following TW or BLW [20, 21]. As diet in this age group is key to development, further studies are required to help provide evidence for policy makers, health professionals and parents. This study adds to this body of evidence by exploring dietary intake in infants aged 6-12 months and the extent to which families follow key BLW characteristics such as self-feeding and consuming whole or finger foods.

Methods

Participant recruitment and data collection

Ethical approval for the study was granted by (removed for blinding). Participants were the main caregiver of infants aged 6-12 months, recruited by placing adverts on parenting forums, weaning and parenting Facebook groups at three time-points: 4th Oct-30th Nov 2019, 22nd June and 7th July 2020 and 1st Nov – 1st December 2020. Participants were self-selecting. Some additional parents were included from a second study, recruited in June 2019 (prior to initiation of solid foods) with nutritional data collected 4th Oct-30th Nov 2019 when their babies were aged 6-12 months. Questionnaires were housed on the JISC survey platform [22] and completed online. All participants were presented with an information sheet at the start of the electronic study, where the nature of the questionnaire and how the data would be used was explained. P~~P~~articipants consented to take part in the study, but clicking 'yes' they had read the information sheet and 'yes' they wanted to take part. After consenting, they were presented with questions~~Questions included demographic questions~~ relating to their ~~caregiver~~ ~~(~~age, occupation, education, home ownership, marital status, height, weight, pre-pregnancy weight (if applicable), parity, singleton/multiple birth~~)~~ and their baby's (age, birthweight). A milk feeding history was recorded for the baby, along with a validated retrospective infant feeding behaviour questionnaire [23] and questions relating to the way in which babies were fed their normal milk and solid food. Additionally, measures of weaning style included asking the caregiver the percentage of time infants were spoon fed and percentage of times infants were fed puree, consistent with other studies [16, 17, 18, 19, 20, 24] and a yes/no answer to the following statement: "*Baby-led weaning is the process of placing foods in front of your baby and letting them feed themselves – picking the food up and putting it in their mouths unassisted, rather than being spoon-fed by an adult" – Do you follow a baby-led weaning approach?*" similar to Rowan, Lee & Brown (2019) [21].

Participants were asked to provide a phone number which was used by a researcher to complete a multi-pass 24-hour recall with both the caregiver and the baby, following a standardised methodology [25]. The number of foods eaten by the baby were counted and the % of those foods that were the same as those consumed by the caregiver was calculated. Caregivers were also asked whether an adult family member was eating (meal or snack) at the same time as the baby was eating (regardless of whether the same food was consumed), whether each food given to the baby was spoon-fed or self-fed and whether each food was provided as a puree or as a whole/finger food, pre-loaded spoon or dipper (a firm food used to eat a soft one, e.g. toast fingers to eat hummus).

Caregivers were aged over 18 and resident in the UK. Babies were aged 6-12 months of age. Some circumstances can cause delayed weaning or feeding difficulties in children, therefore, babies born prematurely (≤37 weeks gestation) or suffering a disability, health problem or congenital abnormality affecting feeding were also excluded from the study. Infants with allergies were not excluded.

Nutritional analysis

All 24-hour recalls (foods and individual recipes) were entered into Nutritics [26] by the lead researcher. Foods with full nutritional analysis (with respect to nutrients of interest) were selected where available, otherwise new foods were inputted per 100g using data from grocery (e.g. ASDA, Tesco, Sainsbury's;) [20] or manufacturer's websites (e.g. Ella's Kitchen, Heinz). Where micronutrient data was not available from either Nutritics, manufacturer or grocery website, new recipes were created using % ingredients (usually baby foods which list the % of each ingredient). Portion size data (teaspoons, tablespoons, jar/container sizes or fractions of adult portion sizes) was provided by participants. When portion size estimation was missing or unclear, portion sizes recommended in Nutritics (for example, weights of teaspoons or tablespoons of food) or estimated using manufacturers data, Food Portion Size handbook [27] or the First Steps Nutrition Trust Guide [28] were used.

To assess milk feeding, the brand and volume of formula milk consumed was recorded and converted into number of grams. It was assumed formula milk was made up according to the pack instructions. The amount of breast milk consumed by breastfed infants was estimated in grams, in a similar way to the BLISS trial [29] using breast milk volumes reported by Dewey et al. (1991) [30] and Committee on Nutritional Status During Pregnancy and Lactation (1991) [31]. These values were dependent on the age of the infant; 5.0-7.5 months (769g breastmilk per day, assuming complementary feeding has commenced), 7.6-10.9 months (637g) and 11-12 months (445g). Where infants were mixed fed, the no. of grams of breastmilk was calculated by subtracting the no. of grams of formula reported, from the estimated average daily intake of breastmilk above [30]. The use of vitamin, mineral or other s~~S~~upplements were recorded and included in the analyses. The nutrient content of human milk was available in Nutritics, originally from …??

Food group analysis

To explore the frequency of exposure, foods were grouped similar to Townsend & Pitchford (2011) [32], Alpers et al.~~,~~(2019) [20], Rowan et al. (2019) [21] (Table 5). Wherever individual ingredients were listed as part of a meal, in a recipe or recipe title, individual ingredients were recorded in each relevant food group. Home~~-~~made ~~composite~~ dishes with no recipe or an ambiguous title, e.g. 'homemade bolognaise' then this was listed as a homemade composite dish.

Calculations and statistical analysis

Percentage energy from macronutrients were calculated using metabolisable energy conversion factors; carbohydrate (16 kJ/g), protein (17 kJ/g), fat (37 kJ/g), saturated fat (37 kJ/g) and free sugars (16 kJ/g) ~~were calculated using metabolisable energy conversion factors~~ [33].

A simplified NS-SEC code [34] was assigned to both the participant and their partner based on their occupation. These were combined and ~~to create~~ the highest occupation class used to classify ~~of~~ each household.

Data were exported to SPSS Statistics for Windows, version –24.0[35] and checked for potential outliers. Tests for normality were carried out ~~on nutritional data~~ using Shapiro-Wilk test and Kolmogorov-Smirnov tests. Chi-squared and Fishers Exact tests were carried out on frequency data. Independent samples t-test and were carried out where data were continuous and parametric. Mann-Whitney-U tests were carried out where data were continuous or ordinal and non-parametric. A significance level of P<0.05 has been use throughout. ~~Ethical approval for the study was granted by (removed for blinding).~~

Results

Maternal and infant characteristics

A total of 319 respondents completed the online survey about infant feeding and complementary feeding, all of whom were the baby's mother. Of the 189 respondents who left a phone number, 102 completed a 24-hour recall and are the focus of this analysis. Six infants were later excluded (three were aged over 12 months, two were born prematurely and one recall was incomplete), leaving 96 mother-infant pairs who met the study criteria. Of these, 60 were classed as ~~following traditional weaning~~TW and 36 as following ~~baby-led weaning~~BLW. Infants following ~~baby-led weaning~~BLW were spoon-fed ≤10% of the time and were fed purees ≤10% of the time as self-reported by parents [16, 17, 18, 19, 20, 24]. Mothers were aged 25-45 years with a mean (SD) of 33.3 (4.0) years. There were no significant differences in the age or other demographic characteristics of mothers between weaning groups (Table 1).

Most of the infants in the study had been breastfed at some time since birth (96.9%) and 55.2% were currently consuming only breast milk via their milk feeds, whilst 28.1% and 16.7% were formula or mixed (a mixture of breast and formula) fed respectively at the time of the study (Table 2). There were significant differences between the ~~traditional~~ TW and BLW~~baby-led~~ groups in the proportion of infants who were currently breastfed (41.7% and 77.8% respectively, P=0.002), breastfeeding duration (73.3%~~86.1%~~ in TW compared to ~~73.3%~~86.1% in BLW group at 6 months of age, P=0.026) and volume of milk consumed (although this was based on estimates for breastfed infants). A significantly higher proportion of mothers following TW, compare to those following BLW, reported dairy allergy in their baby.~~Mothers following traditional weaning were more likely to report that their~~

~~baby had a dairy allergy~~ (16.9% versus 2.9% respectively, P=0.040). Five categories of infant feeding behaviour were included (general appetite, food responsiveness, enjoyment of food, satiety responsiveness, slowness in eating) but there were no significant differences between weaning groups for any behaviour prior to initiation of weaning. No other differences were observed, including choking incidences although this was higher in the TW group (20.0% compared to 8.3% in the BLW group, NS).

Characteristics of weaning style

Characteristics of a ~~baby-led weaning~~BLW style were also explored (Table 3). The group following a ~~baby-led weaning~~BLW style were significantly more likely to self-report following ~~a baby-led style~~BLW (P<0.001 in all groups), consumed a higher percentage of foods that were also consumed by their mother at 6-8 months only (P=0.008) (following the family diet) and were significantly less likely to be spoon fed (P<0.001 in all groups), or fed purees (P<0.001 at 6-8months) as recorded on the 24-hour recalls.

Nutritional intake

Estimated n~~N~~utrient intake from food, milk and total intake was compared between those babies following TW and BLW (Table 4). There were no significant differences in energy intake between the groups, although TW babies consumed more energy from food (NS) and BLW babies consumed more energy from milk (NS) at 6-8 months. Average e~~E~~nergy intakes ~~were higher than recommended~~exceeded the estimated average requirement (EAR), but are very similar to those observed by Alpers et al.~~,~~ (2019). At 6-8 months, TW and BLW babies received 52% and 58% of their energy intake from milk, respectively. At 9-12 months this was 42% in both groups. BLW babies aged 6-8 months and all BLW babies combined consumed more fat, percentage energy from fat, saturated fat and percentage energy from saturated fat from their milk. A higher percentage of total energy intake from fat (P=0.042) and saturated fat (P=0.006) was observed amongst BLW babies when babies of all ages were grouped together.

Total iron intake (food and milk combined) and total zinc intake was higher in TW babies aged 6-8 months (P=0.021 and P=0.048 respectively) and all babies following TW (P=0.008 and P=0.040 respectively). Iodine intake was significantly higher only in younger babies following TW compared to the BLW group (P=0.031). All babies following TW ~~(P=0.002)~~ and younger babies following TW ~~(P=0.002)~~ had higher total intakes of vitamin B12 than those following BLW (P=0.002 at both 6-8 and 9-12 months). Vitamin B12 intake was also higher from complementary foods only amongst all TW babies combined (P=0.027) and ~~younger~~ TW babies in the younger age group (P=0.006). Vitamin D intake estimated from milk alone was higher amongst all TW babies (P=0.034) and from both total intake (P=0.042) and from food alone (P=0.035) in 6-8-month-olds.

Babies in both groups exceeded the EAR for energy and the reference nutrient intake (RNI) for protein, sodium, vitamin A, vitamin B12 and vitamin C at both 6-8 and 9-12 months. Babies in all groups consumed below the RNI for iron with 44.4% of younger TW babies and 62.5% younger BLW babies falling below the lower reference nutrient intake (LRNI) (see supplementary data). All BLW babies together and those aged 6-8 months fell below the RNI for zinc with 25% of younger BLW babies and 5.6% of younger TW babies falling below the LRNI (see supplementary data). Younger babies following BLW consumed below the RNI for calcium but no babies in the study fell below the LRNI.

Few differences were observed between groups in their number of reported exposures to specific food groups (Table 5) and exposure to oily fish, processed meats, sugary foods, alternatives to dairy and commercially produced meals and snacks were low across all groups. Most babies were exposed to more than one iron-containing food on the day of measurement. Younger babies (6-8 months) following TW had significantly higher exposures to oily fish (P=0.037), fortified infant cereal (P=0.035), dairy or dairy-based desserts (P=0.036) and commercially produced infant meals; (P=0.005). Older babies (aged 9-12 months) following BLW were exposed to more protein-containing foods (P=0.042) and dairy/dairy-based desserts (P=0.022).

Discussion

This study, which aimed to compare infant feeding characteristics and nutritional intake between babies following either a ~~traditional or baby-led approach to weaning~~TW or BLW approach, found significant differences in the way in which babies fed. When looking at total daily intake, younger babies (6-8 months) following TW consumed more iron, zinc, iodine and vitamin D than BLW babies, whilst younger BLW infants consumed more fat and saturated fat via their milk than their TW counterparts. Considering complementary foods alone, only the intakes of vitamin B12 and vitamin D were significantly higher in younger TW infants. Younger TW infants had more exposures to iron-fortified infant cereal and commercially produced baby foods. Differences in both nutritional intake and food group exposure disappeared by 9-12 months.

~~A baby-led approach to weaning~~BLW is not well defined. Loosely, it encompasses the form and delivery of food to the baby, offering family foods, sitting in on meals, waiting until 6 months to introduce solids and milk feeding on demand [7, 36] but adherence to these principles was not consistent between groups. Whilst the BLW group were more likely to adhere to all the measures of BLW weaning style in this study, parents categorised as following the TW approach were most likely to self-report following 'predominantly TW' or 'predominantly BLW' rather than identifying with a purely TW approach. As 55% of the TW group, overall, also answered 'yes' to the ~~baby-led weaning~~BLW statement [21], indicating following BLW, this could indicate aspiration to or social desirability of BLW. When exposure to the family diet was measured (similarity between infant and maternal foods), all groups demonstrated relatively low similarity (<33%) but was significantly higher in the younger BLW group. These findings contrast with Brown and Lee (2011) [16] who found that BLW was associated with greater self-reported participation in mealtimes and exposure to family foods than TW. A lack of consistency between differing measures of BLW suggest that families may pick and choose which parts of a weaning style suit them best and differences become less significant amongst older babies. Sachs (2011) [36] suggested that many of the defining principles of BLW such as sharing family foods and mealtimes correspond with current Public Health England/NHS weaning advice which encourages parents and infants to sit together for family mealtimes and for the infant to move towards family foods by 12 months [6]. As a result, there may be less distinct differences between BLW and TW than when BLW was first described [7] and that differences mostly persist amongst younger babies. Self-reported spoon feeding ≤10% most closely predicted weaning style as used in this study but even then, BLW babies were still spoon fed 16.2% of the time on their recall.

Three previous studies have explored nutrient intake and weaning style; Alpers et al.~~,~~ (2019) [20] in the UK and Morison et al.~~,~~ (2016) [37] and Williams-Erickson et al.~~,~~ (2018) [15] in New Zealand. The overall quality of evidence is low [38]. Two studies found higher intakes of fat amongst BLW babies (from food only in the UK study) [20, 37]). The present study found intakes of both fat, saturated fat and percentage intakes of fat and saturated fat were higher in younger and combined BLW groups. Younger babies consumed more breast/formula milk and less food than older babies. A diet of predominantly breast/formula milk is more likely to have a higher fat content than a diet of predominantly solid food[2]., ~~largely due to the type of milk consumed.~~ There was also a high~~er~~ proportion of breastfed babies in the BLW group and breastmilk has ~~and more energy consumed via milk in the BLW groups. Higher intakes of milk amongst younger babies and~~ a slightly higher fat content (4.1g in human milk versus 3.6g in ~~human milk/~~formula milk) in UK databases, which may account for some of the observed difference [26 39]. Fat intakes of 30-45% energy are ~~recommended~~ thought to be prudent by the WHO but ~~have not been adopted by SACN for children under 2 years of age~~the UK do not currently have guidelines for children under 2 years of age. Intakes of fat in this study do not appear to be concerning [2, 33]. Estimated energy intakes were high in this study, likely due to over estimation of portion sizes and underestimation of food lost to the floor or clothing, but values were similar to Alpers et al.~~,~~ (2019) [20] who also used 24-hour recall. If portion sizes are over-estimated, however, this further accentuates the likelihood that dietary reference values (DRVs) for micronutrients are not met.

Health professionals commonly raise the concern that BLW will be associated with lower intakes of iron [5, 9, 39, 40] which has been observed amongst younger babies in this study. This concern stems from BLW infants consuming less traditional weaning foods such as ~~Foods high in iron such as~~

fortified baby cereals. These are very high in iron but are not contingent with ~~baby-led weaning~~BLW, as they are not graspable and appropriate as finger foods [38]. Fortified baby foods are not usually part of the family diet so lower consumption would be expected when following BLW. In the current study exposure was ~~actually~~ very low across both groups but significantly higher in younger babies ~~traditionally weaned~~following TW. Iron status is determined by both in utero reserves and dietary intake but qualitative data from the UK has shown that many families believe ‘food before one is just for fun’ and so may not understand the importance of iron-containing foods during complementary feeding [42]. Infants in this study consumed Weetabix® and Ready Break® slightly softened or cooked and cut into fingers so it could be that parents are including fortified foods but actively avoiding commercially available baby foods, which may be less acceptable to families who have a higher social class and/or food knowledge and wish to avoid ~~ultra-processed~~pre-packaged and processed baby food [43]. This may be apparent in the current study where the majority of participants were educated to degree level and were of high SES. Observed differences in iron intake between younger babies following TW and BLW were only apparent when both food and milk were combined. This indicates an accumulation of small differences via the type of milk consumed and amount of, if not number of exposures to, iron-containing foods. Infant formula contains 10 times more iron (0.7mg/100ml) than mature human breastmilk (0.07mg/100g) as the non-haem iron in formula milk is less bioavailable (10%) than the haem iron in breastmilk (50%) [26, 41]. This difference is reflected in UK DRVs, which are set at a value appropriate for formula fed infants and higher than necessary for breastfed infants [43]. Breast fed babies may have adequate or at least equivalent intakes of iron and the failure to meet DRVs may be of more concern amongst formula fed infants, even though intakes appear higher. Studies exploring haematological parameters of iron (including plasma ferritin, iron store depletion, early functional iron deficiency) in infants following either BLW or TW found no differences between groups whether parents had received dietary support to include iron-containing foods or not [44, 29]. Daniels et al.~~,~~ (2018) [29] suggested this was due to babies being offered high iron foods as part of their intervention study but Rowan et al.~~,~~ (2019) [21] found no significant differences in exposure to iron-containing foods in their UK babies following one of three groups: strict BLW, Loose BLW or TW. ~~Early d~~Differences in estimated iron intake at 6-8 months, in this study, could be due to BLW babies eating smaller amounts of food because they are younger and self-feeding ~~may be~~ at a slower pace. Iron intakes amongst infants are often problematic and stronger, more targeted guidance/advice on iron-containing foods for all babies may be required [36, 37, 39].

Like iron, intakes of zinc were significantly lower in younger BLW babies and intakes of both zinc and calcium were below the RNI among BLW babies aged 6-8.5 months. Calcium is also less bioavailable in formula milk (40%) than breast milk (66%) and so requires a higher DRV [45]. An Estimated Average Requirement (EAR) of 240mg/day would be adequate for breastfed babies whilst an EAR of 400 would be required for those formula fed. Daniels et al.~~,~~ (2018) [46] found no differences in zinc intake between BLW and TW infants in their ~~RCT~~ randomised-controlled intervention trial which encouraged consumption of iron-rich foods. Foods containing iron are often those which are also high in zinc so guidance to increase intakes of iron would also increase zinc consumption.

Vitamin D intake in this study is a crude estimate. The vitamin D content of breastmilk varies between fore and hind milk and is correlated to maternal plasma 25(OH)D concentrations [20, 47]. There is no vitamin D or vitamin B12 in breast milk in UK databases whilst formula milk is fortified [26, 41]. Babies who are breast fed or receiving less than 500ml per day of formula milk should be given 8-10µg of vitamin a day, usually as drops [48]. Only 43.5% of breastfed babies and 12.5% of formula/mixed-fed babies receiving less than 500ml of formula on the day of measurement were given a supplement on the day of measurement, although like other studies, some parents reported usually or sometimes giving supplements, just not on the day the recall was carried out [20, 49].

Finally, older BLW infants were exposed to dairy and protein-containing foods more often. Higher than recommended intakes of protein may be significant as higher intakes of protein may contribute to increased weight gain over time [50].

It is acknowledged that there are several limitations to this study. Firstly, all data is self-reported and estimates of intake from breastmilk were based on average estimated values. Although there were no significant differences between the weaning groups in maternal demographic characteristics, this sample is not representative of the UK population with 82.5% or respondents in higher managerial occupations and 80.4% holding a university degree (compared with 27% nationally) [50]. This is a common feature of infant feeding surveys [20, 21, 32]. Although internet samples may be diverse [51] health-conscious women with higher levels of education, higher incomes are more likely to participate in online surveys of this nature with breastfeeding women over-represented (55.7% offering only breastmilk at 6 months in this sample, compared to 1% nationally) [41, 52]. As BLW is more likely to follow on from breastfeeding [9], the proportion of BLW followers is likely to be considerably over-estimated [53]. Whilst having a more homogenous sample naturally controls for some predictors of a healthy diet, such as socioeconomic status and education, allowing differences due to weaning style to become more apparent, this also emphasises the need for a nationally representative randomly sampled survey to explore the prevalence of ~~baby-led weaning~~BLW in the UK population.

This study used 24-hour recall to estimate nutrient intake. Many people who completed the online survey did not consent to a researcher calling them to complete a 24-hour recall, although there were no significant demographic differences between those who provided this data and those who did not (data not shown). Although data were recorded by trained researchers, 24-hour recalls have been demonstrated to overestimate energy intake in infants by around 13%, compared with 3 day weighed food records (which over-estimate by 5%). This is consistent with the high energy intakes observed here [54] ~~- and~~ The most likely cause of this is over-estimation of portion sizes or over-estimation of milk consumption [54]. ~~R~~responses may have been subject to respondent bias, incorrect estimations of portion sizes provided, the amount actually eaten [55, 56] and the respondent's memory [56].

Conclusion

The literature comparing TW and BLW is limited and this study adds to a growing picture created by similar small studies in the UK and New Zealand. Although the overall quality of evidence across the range of available studies may be low ~~[55]~~, there appear to be few persisting differences in nutritional intake or food group exposure between TW and BLW babies and the perceived risk of choking is not supported by the data. As more parents choose to adopt BLW-based approaches to complementary feeding, health professionals should be less concerned with risk and focus more on the longer-term health implications. Larger, longer and more nationally representative samples are needed for this.

Transparency Declaration':

"The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported. The reporting of this work is compliant with STROBE[2] guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned (please add in the details of any organisation that the trial or protocol has been registered with and the registration identifiers) have been explained.

References

1. PAHO (2003) Guiding principles for complementary feeding of the breastfed child. Pan American Health Organization. Available from: https://www.who.int/nutrition/publications/guiding_principles_compfeeding_breastfed.pdf (Accessed 16th March 2021)
2. WHO (2003) Complementary feeding: report of the global consultation: Summary of guiding principles, 2003. Available from: https://apps.who.int/iris/bitstream/handle/10665/42739/924154614X.pdf?sequence=1&isAllowed=y (Accessed 16th March 2021)
3. Department of Health (2003). Infant Feeding Recommendation. Available from: https://webarchive.nationalarchives.gov.uk/20120503221049/http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4097197 (Accessed 1st May 2021)
4. Scientific Advisory Committee on Nutrition (2018) Feeding in the first year of life. Available from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725530/SACN_report_on_Feeding_in_the_First_Year_of_Life.pdf
5. Cameron SL, Heath AL, & Taylor RW (2012) How feasible is Baby-led Weaning as an approach to infant feeding? A review of the evidence. *Nutrients*, **4**, 1575–1609.
6. NHS. Weaning (2020) Available from https://www.nhs.uk/start4life/weaning/ (Accessed 20th April 2021)
7. Rapley G & Murkett T. *Baby-led weaning. helping your baby to love good food.* Chatham: Random House; 2008
8. Rapley G. (2011) Baby-led weaning: transitioning to solid foods at the baby's own pace. *Community practitioner : the journal of the Community Practitioners' & Health Visitors' Association*, **84**, 20–23.
9. Brown A, Jones SW & Rowan H (2017) Baby-Led Weaning: The Evidence to Date. *Current nutrition reports*, **6**, 148–156.
10. Daniels L, Heath AL, Williams SM, Cameron SL, Fleming EA, Taylor BJ, Wheeler BJ, Gibson RS, & Taylor RW (2015).Baby-Led Introduction to SolidS (BLISS) study: a randomised controlled trial of a baby-led approach to complementary feeding. *BMC pediatrics*, **15**, 179.
11. Fangupo LJ, Heath AM, Williams SM, Williams-Erickson LW, Morison BJ, Fleming EA, Taylor BJ, Wheeler BJ & Taylor RW (2016) A Baby-Led Approach to Eating Solids and Risk of Choking. *Pediatrics*, ***138***. Available from https://doi.org/10.1542/peds.2016-0772

12. Brown A (2018) No difference in self-reported frequency of choking between infants introduced to solid foods using a baby-led weaning or traditional spoon-feeding approach. *J Hum Nutr Diet*, ***31***, 496–504.
13. Pang WW & McCrickerd K (2021) The impact of feeding experiences during infancy on later child eating behaviours. *Curr Opin Clin Nutr Metab*, **24**, 246–251.
14. Morison BJ, Heath AM, Haszard JJ, Hein K, Fleming EA, Daniels L, Erickson EW, Fangupo LJ, Wheeler BJ, Taylor BJ & Taylor RW (2018) Impact of a Modified Version of Baby-Led Weaning on Dietary Variety and Food Preferences in Infants. *Nutrients*, **10**, 1092.
15. Williams Erickson L, Taylor RW, Haszard JJ, Fleming EA, Daniels L, Morison BJ, Leong C, Fangupo LJ, Wheeler, BJ, Taylor BJ, Te Morenga L, McLean RM & Heath, AM (2018). Impact of a Modified Version of Baby-Led Weaning on Infant Food and Nutrient Intakes: The BLISS Randomized Controlled Trial. *Nutrients*, **10**, 740.
16. Brown A & Lee M (2011) Maternal control of child feeding during the weaning period: differences between mothers following a baby-led or standard weaning approach. *Matern Child Health J*, **15**, 1265–1271.
17. Brown A & Lee, M (2011) A descriptive study investigating the use and nature of baby-led weaning in a UK sample of mothers. *Matern Child Nutr*, **7**, 34–47.
18. Brown A & Lee M (2013) An exploration of experiences of mothers following a baby-led weaning style: developmental readiness for complementary foods. *Matern Child Nutr*, ***9***, 233–243.
19. Brown A & Lee MD (2015) Early influences on child satiety-responsiveness: the role of weaning style. *Pediatr Obes*, ***10***, 57–66.
20. Alpers B, Blackwell V & Clegg ME (2019) Standard *v*. baby-led complementary feeding: a comparison of food and nutrient intakes in 6-12-month-old infants in the UK. *Public Health Nutr*, **22**, 2813–2822.
21. Rowan H, Lee M & Brown A (2019) Differences in dietary composition between infants introduced to complementary foods using Baby-led weaning and traditional spoon feeding. *J Hum Nutr Diet*, **32**, 11–20.
22. JISC (2020) Online surveys. Available from https://www.jisc.ac.uk/
23. Llewellyn CH, van Jaarsveld CH, Johnson L, Carnell S & Wardle J (2011) Development and factor structure of the Baby Eating Behaviour Questionnaire in the Gemini birth cohort. *Appetite*, **57**, 388–396.
24. Brown A (2016) Differences in eating behaviour, well-being and personality between mothers following baby-led vs. traditional weaning styles. *Matern Child Nutr*, **12**, 826–837.

25. Johnson RK, Driscoll P & Goran MI (1996) Comparison of multiple-pass 24-hour recall estimates of energy intake with total energy expenditure determined by the doubly labeled water method in young children. *J Am Diet Assoc*, **96**, 1140–1144.

26. Nutritics (2019) Nutritics Education (v5.64). Dublin. Available from https://www.nutritics.com.

27. Food Standards Agency (2002). *Food portion sizes*. London: The Stationary Office.

28. First Steps Nutrition Trust (2019) *Eating well: The first year A guide to introducing solids and eating well up to baby's first birthday.* Available from https://static1.squarespace.com/static/59f75004f09ca48694070f3b/t/5ceed06a15fcc07f8822270b/1559154825802/Eating_well_first_year_April19_for_web.pdf (Accessed 20th April 2021)

29. Daniels L, Taylor RW, Williams SM, Gibson RS, Fleming EA., Wheeler BJ, Taylor BJ, Haszard JJ, & Heath AM (2018) Impact of a modified version of baby-led weaning on iron intake and status: a randomised controlled trial. *BMJ open*, **8**. Available from: https://doi.org/10.1136/bmjopen-2017-019036

30. Dewey, KG, Heinig MJ, Nommsen LA, Peerson JM & Lönnerdal B (1992) Growth of breast-fed and formula-fed infants from 0 to 18 months: the DARLING Study. *Pediatrics*, **89**, 1035–1041.

31. Committee on Nutritional Status During Pregnancy and Lactation. Milk volume. *Nutrition during lactation* (pp. 80-105). Washington (DC): National Academy of Sciences; 1991

32. Townsend E, Pitchford NJ. Baby knows best? (2012) The impact of weaning style on food preferences and body mass index in early childhood in a case-controlled sample. BMJ Open. **6**. Available from: doi:10.1136/bmjopen-2011-000298

33. Scientific Advisory Committee on Nutrition. Dietary Reference Values for Energy. London: The Stationary Office; 2011

34. Office for National Statistics (2010) ONS Occupational Coding Tool. Available from https://onsdigital.github.io/dp-classification-tools/standard-occupational-classification/ONS_SOC_occupation_coding_tool.html (Accessed 20th April 2021)

35. 'IBM SPSS Statistics for Windows, version XX (IBM Corp., Armonk, N.Y., USA

36. Sachs M (2011) Baby-led weaning and current UK recommendations--are they compatible? *Matern Child Nutr*, **7**, 1–2. https://doi.org/10.1111/j.1740-8709.2010.00278.x

37. Morison BJ, Taylor RW, Haszard JJ, Schramm CJ, Williams Erickson L, Fangupo LJ, Fleming EA, Luciano A & Heath AL (2016) How different are baby-led weaning and conventional complementary feeding? A cross-sectional study of infants aged 6-8 months. *BMJ open*, **6**. Available from: https://doi.org/10.1136/bmjopen-2015-010665

38. D'Auria E, Bergamini M, Staiano A, Banderali G, Pendezza E, Penagini F, Zuccotti GV, Peroni DG & Italian Society of Pediatrics (2018) Baby-led weaning: what a systematic review of the literature adds on. *Ital J Pediatr*, **44**, 49.

39. D'Andrea E, Jenkins K, Mathews M, Roebothan B (2016) Baby-led Weaning: A Preliminary Investigation. Can J Diet Pract Res, 77, 72-7. doi: 10.3148/cjdpr-2015-045

40. Urkia-Susin I, Rada-Fernandez de Jauregui D, Orruño E, Maiz E, Martinez O (2021) A quasi-experimental intervention protocol to characterize the factors that influence the acceptance of new foods by infants: mothers' diet and weaning method. Dastatuz project. *BMC Public Health*, 21, 918 doi:10.1186/s12889-021-10967-7

41. Finglas PM, Roe MA, Pinchen HM, Berry R, Church SM, Dodhia SK, Farron-Wilson M & Swan G. McCance and Widdowson's The Composition of Foods, Seventh summary edition. The Royal Society of Chemistry, Cambridge; 2015

42. Arden MA & Abbott RL (2015) Experiences of baby-led weaning: trust, control and renegotiation. *Matern Child Nutr*, **11**, 829–844

43. Wardle J, Parmenter K & Waller J (2000) Nutrition knowledge and food intake. *Appetite*, **34**, 269–275

44. Dogan E, Yilmaz G, Caylan N, Turgut M, Gokcay G & Oguz MM (2018) Baby-led complementary feeding: Randomized controlled study. *Pediatr Int*, **60**, 1073–1080

45. COMA. Dietary reference values for food energy and nutrients for the United Kingdom. 1st Ed, London: HSMO; 1991

46. Daniels L, Williams SM, Gibson RS, Taylor RW, Samman S & Heath AM (2018) Modifiable "Predictors" of Zinc Status in Toddlers. *Nutrients*, **10**, 306

47. Við Streym S, Højskov CS, Møller UK, Heickendorff L, Vestergaard P, Mosekilde L & Rejnmark L (2016) Vitamin D content in human breast milk: a 9-mo follow-up study. *Am J Clin Nutr*, **103**, 107–114

48. NHS (2020) Vitamin D (Vitamins and minerals). Available from https://www.nhs.uk/conditions/vitamins-and-minerals/vitamin-d/ (Accessed 6th May 2021)

49. Hemmingway A, Fisher D, Berkery T, Murray DM & Kiely ME (2021) Adherence to the infant vitamin D supplementation policy in Ireland. *Eur J Clin Nutr*, **60**, 1337–1345

50. Pearce J & Langley-Evans SC (2013) The types of food introduced during complementary feeding and risk of childhood obesity: a systematic review. *Int J Obes*, **37**, 477–485

51. Office for National Statistics. (2021). 2011 Census: Key Statistics for England and Wales, March 2011. Available from https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populatio

nestimates/bulletins/2011censuskeystatisticsforenglandandwales/2012-12-11#toc (Accessed 20th April 2021).

52. Gosling S, Vazire S, Srivastava S & John OP (2004) Should we trust web-based studies? A comparative analysis of six preconceptions about internet questionnaires. *Am* Psychol, **59**, 93-104

53. McAndrew F, Thompson J, Fellows L, Large A, Speed M & Renfrew MJ. Infant Feeding Survey 2010. Health and Social Care Information Centre; London, UK, 2012.

54. Fisher JO, Butte NF, Mendoza PM, Wilson TA, Hodges EA, Reidy KC & Deming D (2008) Overestimation of infant and toddler energy intake by 24-h recall compared with weighed food records. *Am J Clin Nutr*, **88**, 407–415

55. Young LR, Nestle MS (1995) Portion sizes in dietary assessment: issues and policy implications. *Nutr Rev*. **53**,149-58.

56. Naska A, Lagiou A & Lagiou P (2017) Dietary assessment methods in epidemiological research: current state of the art and future prospects. *F1000Research*, *6*, 926. (accessed 15th May 2021)

Table 1. Maternal demographic characteristics.

	All (n=96) Mean (s.d) Frequency n (%)	TW (n=60) Mean (s.d) Frequency n (%)	BLW (n=36) Mean (s.d) Frequency n (%)	P value (Chi-squared test unless otherwise indicated)
Age (mean)	33.3 (4.0)	33.4 (4.3)	33.0 (3.6)	0.635¥
Age category				
18-25	1 (1.0)	1 (1.7)	0 (0.0)	0.485
26-30	21 (21.9)	14 (23.3)	7 (19.4)	
31-35	54 (56.3)	30 (50.0)	24 (66.7)	
36-40	14 (14.6)	11 (18.3)	3 (8.3)	
>40	6 (6.3)	4 (6.7)	2 (5.6)	
Currently on leave	72 (75.0)	43 (71.7)	29 (80.6)	0.234$
Status				
Single	5 (5.2)	4 (6.7)	1 (2.8)	0.571
Cohabiting	16 (16.7)	11 (18.3)	5 (13.9)	
Married	75 (78.1)	45 (75.0)	30 (83.3)	
Education				
No formal/GCSE	2 (2.1)	1 (1.7)	1 (2.8)	0.712
Further education	17 (17.7)	12 (20)	5 (13.9)	
Graduate/postgraduate	77 (80.2)	47 (78.3)	30 (83.3)	
Home ownership				
Owned (self or family)	78 (81.3)	47 (78.3)	31 (86.1)	0.366
Rented	13 (13.5)	8 (13.3)	5 (13.9)	
Council property	4 (4.2)	4 (6.7)	0 (0.0)	
Army/housing association	1 (1.0)	1 (1.7)	0 (0.0)	
Household social class				
Higher managerial (I)	79 (82.3)	46 (76.7)	33 (91.7)	0.195
Intermediate occupations (II)	11 (11.5)	8 (13.3)	3 (8.3)	
Routine/manual occupations (III)	4 (4.2)	4 (6.7)	0 (0.0)	
Long-termed unemployed/unwaged (IV)	2 (2.1)	2 (3.3)	0 (0.0)	
Singleton birth	96 (9%)	59 (98.3)	37 (100.0)	0.619
Primiparous	57 (59.4)	36 (60.0)	21 (58.3)	0.520$
Ethnicity				
White British	81 (84.4)	51 (85.0)	30 (83.3)	0.690
Other White	6 (6.3)	4 (6.7)	2 (5.6)	
Black/Black British	1 (1.0)	0 (0.0)	1 (2.8)	
Asian/Asian British	4 (4.2)	3 (5.0)	1 (2.8)	
Other Mixed Race	4 (4.2)	2 (3.3)	2 (5.6)	
BMI (kg/m2)	27.6 (6.1)*	27.4 (6.2)	27.9 (6.0)	0.606¥
Pre-pregnancy BMI (kg/m2)	26.3 (5.9)^	26.3 (6.3)	26.3 (5.3)	0.820¥
Weaning Confidence	27 (28.1)	12 (20.0)	15 (41.7)	0.089
Very confident	57 (59.4)	38 (63.3)	19 (52.8)	

Confident	11 (11.5)	9 (15.0)	2 (5.6)
Anxious	1 (1.0)	1 (1.7)	0 (0.0)
Very anxious			

TW Traditional Weaning group, BLW Baby-led weaning group, s.d standard deviation, BMI Body Mass Index.

*n=93 where three respondents did not know their height

^n=87 as three participants did not know their height and six did not know their pre-pregnancy weight

¥ = Mann-Whitney U test

$ Fisher's Exact Test

*P value <0.050 indicates significance

Table 2. Infant characteristics, milk feeding and feeding behaviour.

	All (n=96) Mean (s.d) Frequency n (%)	TW (n=60) Mean (s.d) Frequency n (%)	BLW (n=36) Mean (s.d) Frequency n (%)	P value
Baby age (months)	8.4 (1.3)	8.6 (1.4)	8.1 (1.2)	0.076[¥]
Baby age category				
6-8.5 months	60 (62.5)	36 (60.0)	24 (66.7)	0.333
9-12 months	36 (37.5)	24 (40.0)	12 (33.3)	
Birthweight (kg)[±]	3.501 (0.490)	3.509 (0.480)	3.488 (0.522)	0.907[¥]
Parents reporting dairy allergy[ǂ]	11 (11.8)[ǂ]	10 (16.9)	1 (2.9)	0.040*[$]
Special diet				
Vegan	1 (1.0)	0 (0.0)	1 (2.8)	0.127
Vegetarian	2 (2.1)	0 (0.0)	2 (5.6)	
Pescatarian	5 (5.2)	4 (6.7)	1 (2.8)	
No special diet	88 (91.7)			
Current feeding				
Breastfed	53 (55.2)	25 (41.7)	28 (77.8)	0.002*
Formula fed	27 (28.1)	21 (35.0)	6 (16.7)	
Mixed fed	16 (16.7)	14 (23.3)	2 (5.6)	
Ever breastfed	93 (96.9)	57 (95.0)	36 (100.0)	0.240[$]
Volume milk consumed (estimated, mls)	659 (132)	645 (137)	683 (121)	0.035*[¥]
Percentage breast fed babies taking a vitamin D supplement (or supplement containing vitamin D)	23 (43.4)	13 (52.0)	10 (35.7)	0.180[$]
Breastfeeding Duration				
≥26 weeks	75 (78.1)	44 (73.3)	31 (86.1)	0.026*
12-26 weeks	7 (7.3)	6 (10.0)	1 (2.8)	
4-11 weeks	3 (3.1)	0 (0.0)	3 (8.3)	
Less than 4 weeks	8 (8.3)	7 (11.7)	1 (2.8)	
Never breastfed	3 (3.1)	3 (5.0)	0 (0.0)	
Parent reported one or more choking incidents	15 (15.6)	12 (20.0)	3 (8.3)	0.106
Infant feeding behaviour				
General appetite	3.74 (0.97)	3.65 (1.00)	3.89 (0.89)	0.275[¥]
Food responsiveness	2.33 (0.68)	2.34 (0.70)	2.31 (0.65)	0.840[¥]
Enjoyment of food	3.80 (0.35)	3.80 (0.31)	3.80 (0.41)	0.666[¥]
Slowness in eating	2.73 (0.49)	2.70 (0.51)	2.78 (0.45)	0.541[¥]
Satiety responsiveness	1.99 (0.65)	2.02 (0.65)	1.94 (0.66)	0.469[¥]

P value is chi-squared test unless otherwise indicated

*P<0.05 denotes significance

sd, standard deviation

± n = 95 (one mother did not report her baby's birthweight)

ƶ n = 93 (3 parents did not indicate yes or no to allergy)

[$] Fishers exact test

¥ = Mann-Whitney U test

Table 3: Self-reported and interviewer-recorded adherence to characteristics of baby-led weaning.

	Total			6-8 months			9-12 months		
	TW (n=60) Mean (s.d) Frequency n (%)	BLW (n=36) Mean (s.d) Frequency n (%)	P value	TW (n=36) Mean (s.d) Frequency n (%)	BLW (n=24) Mean (s.d) Frequency n (%)	P value	TW (n=24) Mean (s.d) Frequency n (%)	BLW (n=12) Mean (s.d) Frequency n (%)	P value
Self-reported measures of weaning style									
Answered 'yes' to weaning statement*	33 (55.0)	35 (97.2)	<0.001	22 (61.1)	23 (95.8)	0.002	11 (45.8)	12 (100.0)	0.001[$]
Self-reported BLW approach									
Traditional	9 (15.0)	0 (0.0)	<0.001	4 (11.1)	0 (0.0)	<0.001	5 (20.8)	0 (0.0)	0.001
Predominantly traditional	25 (41.7)	2 (5.6)		15 (41.7)	1 (4.2)		10 (41.7)	1 (8.3)	
Predominantly baby-led	24 (40.0)	12 (33.3)		15 (41.7)	7 (29.2)		9 (37.5)	5 (41.7)	
Baby-led	2 (3.3)	22 (61.1)		2 (5.6)	16 (66.7)		0 (0.0)	6 (50.0)	
Percentage foods as puree									
0%	10 (16.7)	22 (61.1)	<0.001	6 (16.7)	15 (62.5)	<0.001	4 (16.7)	7 (58.3)	0.058
10%	11 (18.3)	14 (38.9)		3 (8.3)	9 (37.5)		8 (33.3)	5 (41.7)	
25%	14 (23.3)	0 (0.0)		11 (30.6)	0 (0.0)		3 (12.5)	0 (0.0)	
50%	13 (21.7)	0 (0.0)		9 (25.0)	0 (0.0)		4 (16.7)	0 (0.0)	
75%	7 (11.7)	0 (0)		4 (11.1)	0 (0.0)		3 (12.5)	0 (0.0)	
90%	5 (8.3)	0 (0)		3 (8.3)	0 (0.0)		2 (8.3)	0 (0.0)	
100%	0 (0.0)	0 (0)		0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	
Percent foods spoon-fed									
0%	0 (0.0)	16 (44.4)	<0.001	(0.0)	12 (50.0)	<0.001	0 (0.0)	4 (33.3)	<0.001
10%	0 (0.0)	20 (55.6)		0 (0.0)	12 (50.0)		0 (0.0)	8 (66.7)	
25%	23 (38.3)	0 (0.0)		15 (41.7)	0 (0.0)		8 (33.3)	0 (0.0)	
50%	15 (25.0)	0 (0.0)		7 (19.4)	0 (0.0)		8 (33.3)	0 (0.0)	
75%	13 (21.7)	0 (0.0)		8 (22.2)	0 (0.0)		5 (20.8)	0 (0.0)	
90%	5 (8.3)	0 (0.0)		2 (5.6)	0 (0.0)		3 (12.5)	0 (0.0)	
	4 (6.7)	0 (0.0)		4 (11.1)	0 (0.0)		0 (0.0)	0 (0.0)	
Age solids introduced (weeks)^	23.9 (2.1)	24.2 (2.5)	0.694[¥]	23.8 (2.0)	24.2 (2.7)	0.840[¥]	24.1 (2.1)	24.3 (2.4)	0.595[¥]
Measures of weaning style indicated by 24-hour recall									
Similarity (% foods consumed by baby, also consumed by mother)	25.9 (22.1)	42.1 (29.5)	0.008	22.6 (21.9)	44.5 (33.0)	0.008[¥]	30.8 (21.8)	37.1 (21.2)	0.398[¥]
Percentage of foods spoon fed	47.4 (32.2)	16.2 (28.4)	<0.001	50.0 (33.0)	19.1 (33.3)	<0.001[¥]	43.6 (31.1)	10.2 (14.3)	<0.001[¥]

Percentage of foods pureed	18.1 (20.1)	7.9 (19.8)	0.001	23.8 (21.9)	10.3 (23.7)	0.001¥	9.5 (13.4)	3.2 (5.4)	0.212¥
Percentage of foods eaten whilst adult eating (meal or snack)	74.6 (32.3)	84.2 (27.3)	0.155	76.9 (31.7)	89.9 (24.4)	0.057¥	71.2 (33.6)	72.6 (30.3)	0.882¥

P values are chi-squared unless otherwise indicated, a value of P<0.05 denotes significance

s.d, standard deviation

*Full statement: *"Baby-led weaning is the process of placing foods in front of your baby and letting them feed themselves - picking the food up and putting it in their mouths unassisted, rather than being spoon-fed by an adult. Do you use a baby-led approach?"*

TW Traditional Weaning group, BLW Baby-Led Weaning group

^ n = 54 due to the online surveys initially omitting this question in error

ǂ n = 81

$ Fishers exact test

¥ = Mann-Whitney U test

Table 4. Comparison of nutrient total nutrient intake, intake from milk alone and from complementary food alone, between traditional and baby-led weaning groups

			Total					6-8 months					9-12 months				
			TW (n=60)		BLW (n=36)			TW (n=36)		BLW (n=24)			TW (n=24)		BLW (n=13)		
Energy/Nutrient	DRV		Mean	SD	Mean	SD	P value	Mean	SD	Mean	SD	P value	Mean	SD	Mean	SD	P value
Energy (kJ/day)	2853†	Total	3844	756	3760	655	0.585^{+}	3688	742	3559	629	0.487^{+}	4078	730	4164	523	0.720^{+}
		Food	2022	877	1813	794	0.300	1786	792	1517	714	0.210	2375	896	2403	605	0.922^{+}
		Milk	1822	449	1948	327	0.055	1902	475	2042	296	0.160	1703	386	1760	315	0.320
Carbohydrate (g/day)	No RNI	Total	104.9	24.0	98.9	20.7	0.218^{+}	99.9	23.3	93.8	19.7	0.293^{+}	112.3	23.6	109.2	19.4	0.692^{+}
		Food	58.5	26.1	51.1	22.6	0.256	51.8	23.2	43.6	21.0	0.179	68.7	27.2	66.2	18.0	0.781^{+}
		Milk	46.4	12.7	47.7	9.0	0.449	48.2	13.6	50.1	9.0	0.468	43.7	11.0	42.9	7.2	0.972
Protein (g/day)	14.3†	Total	29.7	9.0	28.4	9.6	0.436	28.3	9.7	25.4	9.5	0.205	31.7	7.7	34.1	7.2	0.358^{+}
		Food	21.1	9.7	19.5	10.0	0.422	19.4	10.0	16.2	9.6	0.174	23.7	8.6	26.2	7.4	0.400^{+}
		Milk	8.5	2.3	8.8	1.5	0.257	8.9	2.4	9.3	1.5	0.331	8.0	1.9	8.0	1.4	0.942
Fat (g/day)	No RNI	Total	42.1	10.6	43.2	7.5	0.307	40.8	11.3	41.5	7.5	0.516	44.0	9.3	46.6	6.6	0.407^{+}
		Food	18.1	11.3	16.5	9.6	0.628	15.6	11.3	13.6	8.8	0.566	21.8	10.7	22.4	8.7	0.856^{+}
		Milk	24.0	6.0	26.7	4.6	0.009*	25.2	6.2	27.9	4.0	0.036*	22.3	5.3	24.2	4.9	0.201
Saturated fat (g/day)	No RNI	Total	17.8	4.8	19.2	4.1	0.054	17.6	5.2	18.4	3.8	0.305	18.0	4.3	21.0	4.3	0.066^{+}
		Food	6.9	4.9	6.9	4.9	0.952	6.3	5.0	5.5	4.6	0.566	8.0	4.8	9.7	4.6	0.300^{+}
		Milk	10.8	2.8	12.3	2.2	0.008*	11.3	2.9	12.9	2.0	0.032*	10.0	2.6	11.2	2.4	0.166
Free sugars (g/day)	No RNI	Total	4.1	5.7	2.4	3.8	0.294	3.2	4.5	1.2	1.1	0.398	5.4	7.1	5.0	5.6	0.933
		Food	4.1	5.7	2.4	3.8	0.294	3.2	4.5	1.2	1.1	0.398	5.4	7.1	5.0	5.6	0.933
		Milk	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	1.000
Fibre (g/day)	No RNI	Total	8.5	3.9	7.4	3.3	0.227	7.4	3.2	6.7	3.1	0.444^{+}	10.1	4.4	8.6	3.4	0.298
		Food	7.1	3.7	6.6	3.0	0.568	6.0	2.9	5.9	2.8	0.894^{+}	8.7	4.1	7.9	3.1	0.545^{+}
		Milk	1.4	1.8	0.8	1.6	0.033*	1.4	1.9	0.8	1.7	0.084	1.4	1.7	0.7	1.4	0.188
Iron (mg/day)	7.8^	Total	6.5	3.7	4.6	2.8	0.008*	6.2	3.8	4.4	3.0	0.021*	7.0	3.6	5.2	2.4	0.169
		Food	3.9	2.1	3.2	1.8	0.109	3.5	1.9	2.8	1.7	0.073	4.4	2.3	4.1	1.9	0.709^{+}
		Milk	2.7	2.9	1.4	2.1	0.055	2.7	3.0	1.6	2.4	0.134	2.6	2.7	1.1	1.3	0.189
Zinc (mg/day)	5.0^	Total	5.6	1.7	4.9	1.6	0.040*	5.6	1.9	4.6	1.6	0.048*	5.7	1.4	5.5	1.5	0.809^{+}
		Food	2.8	1.2	2.5	1.3	0.336^{+}	2.6	1.2	2.1	1.2	0.125^{+}	3.1	1.2	3.4	1.1	0.432^{+}

		Milk	2.8	1.5	2.4	0.9	0.167	3.0	1.6	2.5	1.0	0.323	2.6	1.2	2.1	0.7	0.242
Calcium (mg/day)	525^	Total	608	244	539	206	0.232	593	265	486	206	0.094	632	213	646	166	0.840+
		Food	308	204	275	185	0.472	279	201	207	165	0.128	353	205	409	149	0.169
		Milk	300	142	265	98	0.361	314	156	279	111	0.621	279	119	237	61	0.394
Iodine (mg/day)	60^	Total	107.0	41.8	91.3	37.5	0.099	104.0	38.3	82.9	33.9	0.031*	111.5	47.1	108.1	40.0	0.973
		Food	41.8	35.7	36.2	34.5	0.364	35.9	28.0	24.6	24.1	0.097	50.7	44.1	59.3	41.1	0.460
		Milk	65.2	32.0	55.1	20.2	0.177	68.1	34.4	58.0	22.3	0.422	60.9	28.3	48.8	14.0	0.201
Sodium (mg/day)	400^	Total	475	222	494	228	0.677	397	171	427	208	0.856	593	240	629	212	0.659+
		Food	360	228	394	288	0.586	274	175	313	210	0.619	488	241	532	222	0.603+
		Milk	116	43	108	27	0.676	123	47	114	29	0.740	105	35.6	97.4	20.5	0.619
Vitamin A (µg/day)	350^	Total	851	329	812	299	0.586	844	301	845	274	0.989+	862	372	746	347	0.421
		Food	448	337	394	288	0.560	419	306	405	274	0.940	491	381	372	327	0.440
		Milk	403	109	418	74	0.292	425	116	440	68	0.449	371	91.2	375	66.7	0.570
Vitamin B12 (µg/day)	0.35-0.4^	Total	1.9	1.1	1.2	0.9	0.002*	1.9	1.2	1.0	0.9	0.002*	1.8	1.0	1.6	0.7	0.561+
		Food	1.4	1.0	1.0	0.8	0.027*	1.5	1.0	0.8	0.7	0.006*	1.4	1.0	1.4	0.7	0.663
		Milk	0.45	0.56	0.2	0.4	0.074	0.5	0.6	0.2	0.5	0.126	0.4	0.5	0.2	0.4	0.303
Vitamin C (mg/day)	25^	Total	76.2	28.6	73.2	32.7	0.445	75.8	32.2	69.7	35.7	0.365	76.9	22.9	80.1	25.5	0.703+
		Food	34.0	23.1	38.5	28.3	0.482	31.7	20.6	32.9	29.9	0.763	37.5	26.6	49.8	21.8	0.174+
		Milk	42.2	25.3	34.7	18.5	0.296	44.1	27.7	36.9	20.6	0.517	39.4	21.4	30.4	13.0	0.375
Vitamin D (µg/day)	8.5-10	Total	6.4	4.9	5.0	5.7	0.060	6.0	5.3	4.5	6.0	0.042*	6.9	4.2	5.9	5.1	0.552+
		Food	3.0	3.7	3.0	4.0	0.185	2.5	3.2	2.4	4.1	0.035*	3.7	4.4	4.2	3.8	0.546
		Milk	3.4	4.6	2.0	4.2	0.034*	3.6	4.9	2.1	4.7	0.065	3.2	4.2	1.7	3.4	0.275
Percentage total energy intake from																	
Carbohydrate	-	Total	43.8	6.0	42.0	4.4	0.133+	43.6	6.8	42.2	4.9	0.386+	44.1	4.5	41.8	3.4	0.130+
		Food	23.8	8.0	21.0	6.9	0.083+	22.2	8.2	19.0	7.0	0.120	26.2	7.0	25.1	4.4	0.613+
		Milk	20.0	6.2	21.0	5.6	0.407+	21.4	6.1	23.2	5.3	0.243+	17.9	5.9	16.7	3.2	0.533+
Protein	-	Total	13.0	2.6	12.6	3.1	0.483+	12.9	2.9	11.9	3.3	0.077	13.2	2.3	13.9	2.3	0.347
		Food	9.1	3.3	8.5	3.7	0.376+	8.7	3.5	7.4	3.8	0.164+	9.7	2.9	10.6	2.5	0.351+
		Milk	3.9	1.2	4.1	1.1	0.358+	4.2	1.1	4.6	1.0	0.217+	3.5	1.2	3.3	0.7	0.615+
Fat	-	Total	40.5	5.5	42.7	4.4	0.042+*	40.8	6.1	43.2	4.0	0.066	40.0	4.5	41.6	5.0	0.342+
		Food	16.5	8.1	15.4	7.4	0.650	14.8	8.4	13.2	6.8	0.673	18.9	7.1	19.8	6.9	0.729+
		Milk	24.0	7.6	27.3	7.7	0.045+*	26.0	7.5	30.0	7.2	0.043+*	21.1	6.9	21.8	5.5	0.752+

Saturated fat	-	Total	17.2	3.3	19.0	2.5	0.006+*	17.6	3.3	19.2	2.6	0.060	16.5	3.3	18.6	2.5	0.060+
		Food	6.3	3.8	6.4	3.9	0.922	5.9	3.9	5.3	3.8	0.077	7.0	3.7	8.5	3.2	0.246+
		Milk	10.8	3.6	12.6	3.6	0.021+*	11.7	3.6	13.9	3.5	0.026+*	9.5	3.2	10.1	2.7	0.571
Free Sugars	-	Total	1.6	2.1	1.0	1.4	0.301	1.4	1.9	0.5	0.5	0.423	2.0	2.4	1.9	2.1	0.933
		Food	1.6	2.1	1.0	1.4	0.301	1.4	1.9	0.5	0.5	0.423	2.0	2.4	1.9	2.1	0.933
		Milk	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	1.000

Indicates significance (P<0.050)

† Average values for boys & girls aged 7-12 months, mixed fed or unknown milk feeding type, SACN, 2011

^ COMA, 1991

¥ NHS, 2021

- There are currently no recommended intakes of carbohydrate and fat for babies and infants. Families should, instead, be moving towards a diet which resembles dietary guidelines by age 2.

P value = Mann-Whitney-U test unless otherwise indicated

+ = t-test

Table 5. Mean number of exposures to each food group. Traditional versus baby-led weaning.

	Total					6-8 months					9-12 months				
	TW (n=60)		BLW (n=36)			TW (n=36)		BLW (n=24)			TW (n=24)		BLW (n=12)		
Food group	Mean	SD	Mean	SD	P value	Mean	SD	Mean	SD	P value	Mean	SD	Mean	SD	P value
Protein-containing foods	1.48	1.05	1.83	2.25	0.149	1.33	1.07	1.58	1.41	0.562	1.71	1.00	2.33	0.65	0.042*
Processed meats	0.13	0.39	0.14	0.54	0.632	0.11	0.40	0.04	0.20	0.518	0.17	0.38	0.33	0.89	0.917
Oily fish	0.12	0.32	0.00	0.00	0.034*	0.17	0.38	0.00	0.00	0.037*	0.04	0.20	0.00	0.00	0.480
Starchy foods	2.45	1.19	2.61	1.15	0.470	2.19	1.28	2.50	1.25	0.306	2.83	0.92	2.83	0.94	1.000
Fortified infant cereal	0.18	0.39	0.08	0.28	0.181	0.25	0.44	0.04	0.20	0.035*	0.08	0.28	0.17	0.39	0.460
Fortified adult cereal	0.33	0.48	0.28	0.45	0.572	0.31	0.47	0.29	0.46	0.909	0.37	0.50	0.25	0.45	0.460
Fruits	2.25	1.47	2.19	1.69	0.578	2.11	1.14	2.08	1.64	0.482	2.46	1.87	2.42	1.83	0.973
Vegetables	3.12	2.44	3.78	2.50	0.211	3.03	2.20	3.63	2.60	0.469	3.25	2.82	4.08	2.35	0.287
Dairy/dairy-based desserts	1.77	1.59	1.72	1.77	0.710	1.78	1.53	1.00	1.32	0.036*	1.75	1.7	3.17	1.70	0.022*
Alternatives to dairy	0.35	0.80	0.08	0.37	0.052	0.25	0.65	0.13	0.45	0.364	0.50	0.98	0.00	0.00	0.063
Commercial infant meals	0.60	0.91	0.14	0.35	0.009*	0.78	1.02	0.13	0.34	0.005*	0.33	0.64	0.17	0.39	0.517
Homemade infant meals	0.38	0.61	0.17	0.38	0.085	0.36	0.59	0.13	0.34	0.097	0.42	0.65	0.25	0.45	0.532

Iron-containing foods	1.53	0.97	1.42	0.94	0.636	1.53	0.94	1.21	0.83	0.201	1.54	1.02	1.83	1.03	0.373
Savoury snacks	0.67	0.75	0.58	0.87	0.351	0.47	0.61	0.54	0.93	0.732	0.96	0.86	0.67	0.78	0.333
Sweet foods	0.12	0.32	0.22	0.59	0.463	0.08	0.28	0.13	0.34	0.601	0.17	0.38	0.42	0.90	0.495

Mean represents average number of exposures to each food group listed.

P value = Mann-Whitney-U test.

* P value < 0.05.

Supplementary Table 6. Percentage infants falling below the LRNI for key nutrients.

		6-8 months			9-12 months		
Nutrient	LRNI	TW (n=36) n (%)	BLW (n=24) n (%)	P value	TW (n=24) n (%)	BLW (n=12) n (%)	P value
Protein	8.8/9.7†	0 (0.0)	0 (0.0)	1.000	0 (0.0)	0 (0.0)	1.000
Iron	4.2^	16 (44.4)	15 (62.5)	0.197	6 (25.0)	5 (41.7)	0.446
Zinc	3.0^	2 (5.6)	6 (25.0)	0.050	1 (4.2)	0 (0.0)	1.000
Calcium	240^	0 (0.0)	0 (0.0)	-	0 (0.0)	0 (0.0)	-
Iodine	40^	0 (0.0)	0 (0.0)	-	0 (0.0)	0 (0.0)	-
Sodium	200^	1 (2.8)	4 (16.7)	0.147	0 (0.0)	0 (0.0)	-
Vitamin A	150^	0 (0.0)	0 (0.0)	-	0 (0.0)	0 (0.0)	-
Vitamin B12	0.25^	3 (8.3)	7 (29.2)	0.073	2 (8.3)	0 (0.0)	-
Vitamin C	6^	0 (0.0)	0 (0.0)	-	0 (0.0)	0 (0.0)	-

LRNI, Lower Reference Nutrient Intake

P value = Chi-squared unless otherwise indicated

*Indicates significance (P<0.050)

† Average values for boys & girls, 7-9 months and 10-12 months, mixed fed or unknown milk feeding type.

^ COMA, 1991

- There are currently no LRNI for energy, carbohydrate, fat, saturated fat, fibre, free sugars or vitamin D for babies and infants.