Differences in dietary exposure between infants introduced to complementary foods using Baby-led weaning and traditional spoon feeding

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Abstract

Baby-led weaning (BLW) is a method of introducing solid foods to infants, which centres around the infant self-feeding family foods. BLW has grown in popularity over the last ten years but although research is starting to build around the safety and impact of the method, research examining intake is sparse. This is important because concerns have been raised by healthcare providers regarding the nutrient and energy sufficiency of BLW. The aim of the current research was to examine exposure to different food types based on different weaning approaches.

One hundred and eighty parents completed a 24-hour recall of the foods given to their babies aged 6-12 months. Respondents were split into those following strict BLW, loose BLW, and traditional spoon-feeding (TW). Recalls were examined to ascertain the number of times in twenty-four hours infants were given different types of foods, including iron-containing foods. The results were then compared between different weaning groups and age groups.

Several significant differences were found between the frequency of foods eaten by different weaning and age groups: in the youngest age group, strict BLW infants were more likely to be exposed to vegetables ($p = .000$) and protein ($p = .002$) than traditionally weaned babies, while at all age groups the traditionally weaned group had the highest exposure to composite meals. However, no significant differences were found in reported exposure to iron-containing foods between weaning groups at any age. Maternal age, education and milk feeding method were controlled for throughout the analyses. The findings add to a growing body of evidence that suggest a BLW approach may be safe and sufficient.

Introduction

The introduction of solid food to infants traditionally involves using purees or soft baby cereals spoon fed to the infant by a caregiver, gradually progressing through coarser textures until the infant is eating family foods at around 12 months. However, the last ten years has seen the growth in popularity of an alternate method of introducing solids, Baby-led weaning (BLW), which promotes the self-feeding of finger foods from about 6 months of age, completely skipping the traditional parent-led spoon-feeding stage of weaning (1). Anecdotally BLW is now used by many parents, although no formal measurement of the frequency of this weaning approach has been conducted.

Despite its growth in popularity, baby-led weaning is not part of official UK weaning guidelines due in part to the limited evidence base and lack of conclusive evidence for the efficacy or safety of the method (2). Observational small scale research suggests that baby-led weaning does not increase choking risk (3, 4), may promote better appetite control (5, 6), healthier weight trajectories (5, 7) and lower fussiness (5). However in the only randomised controlled trial of the approach, no difference was found in weight between those following a baby-led or traditional approach to solids, although this was based on infant weight at 12 months old rather than for older children (8).

One of the key areas where research needs to focus is the impact of weaning approach upon nutrient intake in infants. Health professionals have raised concerns that infants who are self-feeding may not consume sufficient energy or nutrients, in particular iron(6, 9), although parents do not share this anxiety(10, 11).

Data on food intake is sparse. In survey research with preschool children(7) those who had followed baby-led weaning were more likely to prefer carbohydrate-based food, compared to sweet foods preferred by those traditionally weaned. In New Zealand, a randomized controlled trial of a modified baby-led approach found that at 6-8 months of age infants who were following a strict baby-led approach consumed less iron, zinc and vitamin B12 in a weighed food study than traditionally weaned infants, although infants weaned with a mixed approach had nutrient intakes similar to the traditionally weaned group(12). Infants in the baby-led group also consumed more energy overall, including a higher fat intake, but guidance for this group was to offer a modified version of BLW

including energy dense, high fat foods every day because of the concerns of undernutrition which may have affected intake(8).

In later research from the same group, zinc intake and status were assessed at 12 months using a weighed food diary and plasma zinc concentration. No significant difference was found between the modified Baby-led weaning (BLISS) group and the traditionally weaned group(13). The most recent research from this group has found that at 12 months, those babies following BLW had a lower saturated fat intake than the control group but there were no differences between the groups at 24 months. However, most children in each group were consuming over the recommended amounts of sodium (68% of children) and sugar (75% of children)(14).

Given the increasing popularity of the baby-led approach coupled with concerns of health professionals and the lack of official guidance, evidence examining the intake of infants introduced to foods in different ways is clearly needed. The aim of this study was therefore to address this knowledge gap by recording and comparing the exposure to different foods of infants aged 6 – 12 months weaned using traditional spoon-feeding and BLW using a 24-hour recall.

Methodology

Participants

Parents living in the UK with an infant aged 6 – 12 months old who had started complementary foods took part. Exclusion criteria included inability to consent, significant infant health issues affecting introduction of solids (e.g. failure to thrive), and premature birth (<37 weeks gestation) or low birth weight (<2.5kg) as these can affect timing and progression of solids. Parents' ages ranged from 18 to 44, with a mean age of 32 (SD +/- 5.2), while babies ranged from 26 to 52 weeks, with a mean age of 38.1 weeks (SD +/- 8.2). Approval for this study was granted by a University Research Ethics Committee. All participants gave informed consent and all aspects of this study have been performed in accordance with the ethical standards set out in the 1964 Declaration of Helsinki.

Measures

Participants completed an online survey consisting of demographic information (age, level of education, employment, occupation), questions about feeding method from birth, the approach to the introduction to complementary foods and a 24-hour food recall task.

To gather information on self-identified weaning approach participants were given the following definition of the baby-led approach and asked whether they felt their method matched this strictly, loosely or not at all:

"BLW is the process of placing foods in front of your baby and letting them feed themselves – picking the food up themselves and putting it in their mouths unassisted, rather than being spoon-fed by a parent. This could involve them using a spoon themselves. Baby-led weaning tends to involve offering the baby family foods rather than offering pureed foods".

This self-identification was verified by asking follow up questions on how they were feeding their infants. Participants responded to how often their infant was spoon-fed by an adult [seven point scale: Always spoon-fed by adult through to Never spoon-fed by adult] and similarly for how often infants received pureed foods [seven point scale: Always pureed food through to Never pureed foods]. These questions were used to check whether participants' self-identified method matched their behaviour: Strict BLW was considered to include points 6 and 7 on the scale e.g. Never or Rarely, whilst Traditional weaning was considered to include points 1 and 2 on the scale e.g. Always or Mostly always. Loose BLW fell in the middle of the scale. Participants remained self classified as strict BLW only if they 'never or rarely' offered purees or spoon- fed their infants, remained self classified as loose BLW if they 'occasionally or sometimes' used purees and spoon-feeding, and traditional if they 'often, mostly or always' used purees and spoon-feeding. All participants remained in their identified group.

For the 24-hour diet recall participants were asked to list all the foods and drinks, including milk feeds of breast or formula milk, offered to their baby over the previous 24 hours. Participants were asked to give as much detail as they could about each type of food and drink consumed, such as brands and amount of food offered and the time of

day they were consumed. Participants were given an example of the level of detail the recall might contain. Those breastfeeding were asked to note how long their baby nursed, and those formula feeding or giving cow's milk (or alternatives) were asked to report quantities offered.

Dietary assessments using 24 hour recalls are widely used in nutrition intake studies, as they are cheap, relatively easy to administer and offer a "snapshot" of a participant's diet. Other benefits are that they allow grouping of types of food, such as sweetened beverages or green vegetables, and totals can then be aggregated and compared between groups. They are particularly useful for population or group studies, have been validated for this purpose and have also used with babies (15-18).

Procedure

The questionnaire was hosted via Surveymonkey. Adverts for the study containing brief information, inclusion criteria and researcher details were shared online in parenting forums (e.g. Mumsnet, Netmums), baby and feeding Facebook groups, and on Twitter. Permission was gained from web page/group moderators before sharing the adverts.

Potential participants clicked on the study link and were given full study information, including researcher contact details for further questions. Participants were also given details on how to request a paper copy of the questions and consent forms and how this could be returned to the researcher anonymously. The remainder of the questionnaire only loaded once consent items were completed, including giving the first three letters of postcode to ensure UK only completion. A debrief at the end of the questionnaire encouraged participants to seek advice from a healthcare provider if the survey had raised any concerns or questions about weaning, baby feeding, weight or general health, alongside a reminder of researcher contact details if needed.

Data Analysis

When the raw data were initially analysed, partially completed questionnaires and responses that had not fully complied with the 24-hour recall instructions were excluded.

The aim of the analysis was not to measure specific nutrient intake, but rather to compare exposure to different food groups i.e. how often the infant had eaten a certain

type of food, rather than an analysis of individual nutrient intake. This method of assessing intake had previously been used in a UK study focused on BLW and infant preferences(7).

All items reported were therefore classified into a food group (Table 1) adapted from similar research examining nutrient intake in infants and young children(7, 19, 20). Food groups were: carbohydrates, savoury snacks, sweet foods, proteins, dairy foods, vegetables, fruits, composite meals and iron-containing foods. Composite meals referred to jarred or homemade foods that contained a number of different items but the items were not specified e.g. 'chicken dinner'. Conversely if the respondent had written 'chicken breast, potatoes, carrots and peas' the separate food groups would have been counted.

The frequency of exposure for each food group over the 24-hour period was then calculated. Where multiple different foods were offered in the same meal, a count was made for every different item e.g. a meal consisting of potatoes, fish, cheese sauce, peas and carrots would have been noted as having 1 carbohydrate, 1 protein, 1 dairy, 2 vegetables and 1 iron-containing food.

A further calculation was made for number of iron-containing foods offered, following the classifications used by Cameron et al, 2015. These foods were also counted in their primary food groups e.g. strips of roast beef counted once in the protein category and again in the iron-rich foods category.

Data was analysed using SPSS v.22 (IBM). Participants were split into three weaning groups based on their self-identified response (strict BLW, loose BLW and traditional) and checked against frequency of spoon and puree use. Participants were also split into three groups based on infant age. Infants aged 6 – 8 months were grouped together (representing the early months of solids introduction), 9 – 10 months (representing the middle period) and 11 – 12 months (when infants should be moving towards eating family foods at each meal).

MANCOVA were then used to explore differences in exposure between the three different groups separately for each age group (controlling for maternal demographic

factors e.g. age, occupation and education). Post-hoc Bonferroni tests were carried out to clarify any significant differences between the groups.

Results

Participant characteristics

One hundred and eighty parents (178 mothers and 2 fathers) completed the study. Of those, fifty-six were classified as strict BLW (31.1%), eighty-eight loose BLW (48.9%) and thirty-six (20.0%) were using traditional spoon-feeding. Mean parental age was 32 (range 18 – 44). For further participant details see table 2.

In terms of infant background 83 infants were female (46.1%), 96 male (53.3%) and one was undeclared (0.6%), with a mean age of 38.1 weeks (SD: 8.197). Details of numbers in each weaning and age group are shown in table 3. Within each age category no significant difference in age was found between infants in the three weaning groups.

Influence of milk feeding

Participants were asked if they were currently breast, formula, or mixed breast and formula feeding for milk feeds. Given associations between milk feeding and later eating behaviour, the association between weaning group and milk feeding was examined using Chi Square. A significant association was found (X^2 = 24.136, p = .000). Table 4 shows that mothers who followed a strict baby-led style were more likely to be breastfeeding. Milk feeding type was therefore controlled for throughout further analyses.

For each age group, differences in frequency of food groups consumed were examined across the three weaning groups, using a MANCOVA, controlling for maternal demographic background (age, education), age of introduction to solids, and milk feeding type. Post hoc Bonferroni tests were used to explore differences between groups.

Infants 6 – 8 months

Significant differences were found in exposure to vegetables, protein and composite meals between the three weaning groups [see table 5, column 4]. Post hoc Bonferroni tests showed that for vegetable portions, those in the strict BLW group had significantly

higher exposure than the traditional group (p = .000). Those in the loose BLW group had higher exposure than those in the traditional group (p = .016). For protein, those in the strict BLW had a higher exposure compared to the traditional group (p = .002), whilst the loose BLW also consumed more than the traditional groups (p = .001). For composite meals, the strict BLW were offered significantly fewer portions than the traditional group (p = .002), whilst the loose BLW group also consumed less than the traditional group (p = .000). No further significant differences were seen.

Infants 9 – 10 months

Significant differences in exposure were only seen between the groups for number of milk feeds and dairy consumption (see table 5). Post hoc bonferonni tests showed that infants in the strict BLW group had significantly more milk feeds than those in the loose BLW group (p = .006), however the significant difference in dairy exposure between groups did not survive post-hoc testing. No further significant differences were seen.

Group 3 (11 – 12 months)

Significant differences were found between groups for exposure to savoury snacks, dairy products and composite meals (see table 5). For savoury snacks post-hoc bonferroni tests showed infants in the loose BLW group had significantly higher exposure than those in the strict BLW group (p = .015). Again for dairy, infants in the loose BLW group had significantly higher intake than those in the strict BLW group (p = .009). Composite meal exposure was significantly higher in the traditional group compared to the strict BLW group (p = .045). No further significant differences were seen.

Discussion

This study examined differences in exposure to different food groups over a 24-hour period for infants aged 6 – 12 months introduced to solids using strict baby-led weaning, a looser version of baby-led weaning and a traditional spoon-feeding approach. Overall, the findings showed several significant differences. Broadly, infants following a stricter BLW approach had increased exposure to key foods such as vegetables and proteins, whilst traditionally weaned infants had a greater reliance on composite meals. No significant differences were found in intake of iron-containing foods for any of the

groups. Although there are limitations, these findings will be of interest to those with concerns around nutrient intake in infants following a baby-led approach.

For the youngest infants aged 6 – 8 months, there were several significant differences in exposure. Vegetables were offered most often in the strict Baby-led weaning group and least in the traditional group. Although causation cannot be established, it may be that the baby-led approach encourages higher intake of vegetables. Infants following baby-led weaning are typically offered chunky finger foods, with foods like cooked broccoli stalks and carrot sticks being recommended as suitable first foods(1). Alternatively, parents who choose to follow BLW may be more likely to offer more vegetables, although maternal age and education were controlled for throughout the analysis.

Traditionally weaned infants reliant on commercial foods may be exposed to a lower vegetable intake due to the composition of commercial infant foods. A recent study which examined the contents of commercial infant food in the UK found that most first commercial pureed infant foods are based around fruits rather than vegetables, even when vegetables were in the product name. When vegetables were included in products, they tended to be sweet varieties such as carrots(21). Thus parents following a traditional approach, who may be more likely to rely on jars or pouches(23), may be offering vegetable foods that are higher in sugars, rather than less palatable green vegetables because of wider availability. Tendency for higher consumption of vegetables may therefore be a benefit of BLW as early and frequent exposure to the bitter tastes in vegetables may increase greater acceptance of these tastes when babies are older (22-25)

Protein exposure (excluding milk intake) was also significantly different between the groups, with the strict and loose BLW groups having a similar exposure of just under one portion a day and the traditional group having just .05 portion a day. Again this is probably due to the different types of foods encouraged in the different weaning methods. BLW babies may be offered a strip of omelette or piece of meat as part of a meal. Conversely spoon-fed babies may not be given high protein foods until later in the weaning process, perhaps because traditional first weaning foods may be based around fruit and vegetable purees or infant cereal. Indeed, no significant difference in protein exposure was found for older babies, with all increasing over time.

This finding challenges the assumption that baby-led weaned babies are not receiving nutrient-dense foods such as protein when solids are first introduced(6, 9). However, it should also be noted that babies can get most of their protein requirements from milk at this stage (26), with the recommended intake of breast or formula milk providing the majority of protein needed (27, 28). Milk should still form the major part of the diet through the first year, and breast milk intake at 7 months has been estimated at 875ml per day (93% of kcal required) (29). This means complementary foods would need to provide just 7% of total energy intake. Exposure to different tastes and textures is likely more important than volume at this stage.

Finally, in the youngest age group, the traditional group had a higher exposure to composite meals. Higher consumption of composite meals would be expected in the traditionally weaned group at this age because pureed family meals or baby food jars are often used in traditional spoon-feeding. In fact, composite meal exposure was highest in the traditional weaning group for all ages, following findings in previous research, which found parents using a traditional approach tended to use more commercial products (30).

This is important as concerns have been raised over a high intake of commercial baby food products (31-35). Specifically this may have implications for energy and sugar intake as commercial jarred baby food may provide portion sizes that provide more calories from solid foods than a child of this age requires(32). For babies aged 7-9 months, researchers found that 61% of products aimed at this age group contained more energy than necessary yet at the same time, many infant foods were not as energy dense as they should be, providing little energy but lots of bulk. Commercial baby foods may also contain excess sugar: one UK study found that sweet, spoonable foods contained twice as many sugars as breast milk and dry, non-fruit snacks, such as rusks, contained four times as much sugar(31). As noted above, commercial foods tend to be more similar in taste, with a reliance on sweet foods(22).

In the 9 – 10 month age group, significant differences between weaning groups were only seen for the number of milk feeds and dairy exposure. The highest number of milk feeds was seen in the strict BLW group. Over 86% of this group were breastfeeding,

with research showing breastfed infants tend to feed more frequently and irregularly than bottle-fed infants (30, 36-38). It is difficult to ascertain milk intake for breastfed infants, but volume at each feed is typically lower than for a formula-fed infant (39). Therefore this finding may reflect that those in the strict BLW group feed more frequently, rather than having greater intake. This would fit with findings however that those following a baby-led weaning approach tend to be more responsive in their overall feeding style (10). However, it may also indicate that those in the BLW group are following recommendations to move more gradually to a family diet. Further research could explore the proportion of energy intake attributed to milk through the weaning process. Dairy food exposure was also found to be significantly different, with the loose BLW and traditional weaning groups being exposed twice as many times as the strict BLW group, but the results were not significant when a Bonferroni post-hoc test was applied.

In the oldest 11 – 12 month group, significant differences were found in exposure to dairy products. Infants in the strict BLW group had the lowest exposure, with the loose BLW and traditional groups consuming over twice as many portions. One explanation for this difference is the popularity of dairy products aimed at infants including yoghurt and fromage frais, which are usually eaten with a spoon. Although babies of this age may be starting to use spoons themselves, it may be that parents following a strict BLW approach avoid the mess of this approach and prefer not to spoon feed the infant. Indeed, when the source of dairy was examined between the groups, the main sources of dairy products for the infants in the strict BLW group at this age was soft cheese on toast or in sandwiches, whereas for those in the traditional group, fromage frais and yogurt were more common offerings. Given the sugar content of yoghurts aimed at young children, (e.g. Petit Filous at almost 10% sugar by weight, which provides 45% of its energy), and the fact that breast milk or formula would be supplying most of the calcium needs at this age(36, 39), the lack of sweetened, commercial dairy products in the diets of BLW babies may not be such a bad thing.

A significant difference was also found in composite meals again for this age range, with traditionally weaned infants still being offered the highest amounts. This has the same concerns as for younger infants, with the additional issue that by twelve months of age infants should be moving towards eating a family diet, rather than relying on

specific baby foods. For example the NHS Start4Life website states that by the time a baby is 12 months old they should be eating the same foods as the rest of the family, but in smaller portions(40). Further research may wish to explore whether this difference remains for older infants.

Additional differences were seen for savoury snack exposure in this age group. Notably, it was the loose baby led group, which had the highest exposure to savoury snack items such as breadsticks, crackers and crisps. This could demonstrate one potential disadvantage of Baby-led weaning: finger foods could be interpreted as processed, carbohydrate-rich snack foods, of which there are many marketed especially to infants. However, these can be deceivingly high in sodium and often sugar, particularly if they are targeted at adults. It could also encourage preference for these tastes and one UK study that examined the later food preferences of BLW infants found a preference for carbohydrates (7), although no difference for carbohydrate exposure (classed as potatoes, bread, rice and pasta, rather than snack foods) arose in this study.

Potentially those unsure of BLW may be choosing a loose approach and offering ready prepared ‘finger foods’, or perceiving guidance to offer finger foods to mean that anything finger food shaped would be acceptable. Industry have also taken advantage of this, with high numbers of finger-food snack bags available (41). Greater information and awareness is needed for parents in choosing what products they give their infant and how often.

Notably, there were no differences in the exposure to iron-containing foods between weaning groups in any age category, challenging concerns of health professionals that infants following BLW will not be offered sufficient iron(6, 9). This of course does not mean that infants who are BLW are consuming sufficient iron, and further research is needed here, but it does suggest that insufficient iron intake in BLW infants may not be a problem. Indeed the strict BLW group even had a non-significant trend to be offered more iron rich foods. This may quite possibly have arisen due to concerns voiced that infants following the method might not be consuming enough iron.

There are limitations to this study, including the self-selecting nature of the respondents. Previous research has found that mothers who chose BLW are more likely to be older

and have a higher level of education than those following a traditional weaning approach, which may affect their choice of food(6, 30) but in this study, demographic background was not significantly different between weaning groups. Mothers following baby-led weaning were more likely to breastfeed as has been shown in most baby-led weaning research(2), and levels of breastfeeding amongst the sample were higher than average(42). Breastfeeding has been associated with lower levels of fussy eating(43) and a wider diet variety in childhood(44), therefore differences in intake might be seen with a more diverse sample. However, milk-feeding approach was controlled for throughout analyses.

Secondly, there are limitations with the methodology of 24-hour recalls. They may not be useful for accurate nutrient intake because participants generally do not always weigh food and participants may feel judged or only note selected food choices due to bias, leading to potential underreporting of total energy intake for example. They also rely on memory, albeit it only for the last 24 hours and are just a snapshot of a participant's diet (45, 46). However, 24 hour recalls have been validated against weighed food records and shown to be accurate(47, 48). They have been used previously in infant feeding research(18, 49, 50), although one review study found weighed food records the most accurate when compared to the doubly-labelled water method (a measurable biomarker) in recording energy intake in younger children aged 6 months to 4 years of age(48).

Limitations aside, the findings have important implications for those researching and supporting parents with the baby-led weaning approach. There is little evidence-based information to guide healthcare providers and parents in making the choice to support or use BLW but this research suggests that at least in this sample, little negative impact was seen on the food choices offered by parents, with baby-led weaning giving greater exposure to vegetables, coupled with lower reliance on commercial products. Therefore this study adds to the limited existing evidence base for the nutritional sufficiency of BLW as a method for complementary feeding. The findings around a higher use of snack foods for the loose BLW group are noteworthy and point to a need for further education around what constitutes a healthy baby-led approach. Simply because a food can be self-fed, does not make it a suitable food for an infant. Likewise, the lower incidence of dairy exposure may or may not be a concern for BLW babies, given the balance between need for calcium versus the high sugar content of many infant dairy

products. Further research is now needed to examine specific nutrient intake between weaning groups in order to extend the results of this study.

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 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. Rapley G, Murkett T. Baby-led weaning : helping your baby love good food. London: Vermilion; 2008.
2. Brown A, Jones SW, Rowan H. Baby-Led Weaning: The Evidence to Date. Curr Nutr Rep. 2017;6(2):148-56.
3. Brown A. 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. 2017.
4. Fangupo LJ, Heath AM, Williams SM, Erickson Williams LW, Morison BJ, Fleming EA, et al. A Baby-Led Approach to Eating Solids and Risk of Choking. Pediatrics. 2016;138(4).
5. Brown A, Lee MD. Early influences on child satiety-responsiveness: the role of weaning style. Pediatr Obes. 2015;10(1):57-66.
6. Cameron SL, Heath AL, Taylor RW. Healthcare professionals' and mothers' knowledge of, attitudes to and experiences with, Baby-Led Weaning: a content analysis study. BMJ Open. 2012;2(6).
7. Townsend E, Pitchford NJ. Baby knows best? The impact of weaning style on food preferences and body mass index in early childhood in a case-controlled sample. BMJ Open. 2012;2(1):e000298.
8. Daniels L, Heath AL, Williams SM, Cameron SL, Fleming EA, Taylor BJ, et al. Baby-Led Introduction to SolidS (BLISS) study: a randomised controlled trial of a baby-led approach to complementary feeding. BMC Pediatr. 2015;15:179.
9. D'Andrea E, Jenkins K, Mathews M, Roebothan B. Baby-led Weaning: A Preliminary Investigation. Can J Diet Pract Res. 2016;77(2):72-7.
10. Brown A, Lee M. Maternal control of child feeding during the weaning period: differences between mothers following a baby-led or standard weaning approach. Matern Child Health J. 2011;15(8):1265-71.
11. Arden MA, Abbott RL. Experiences of baby-led weaning: trust, control and renegotiation. Matern Child Nutr. 2014.
12. Morison BJ, Taylor RW, Haszard JJ, Schramm CJ, Williams Erickson L, Fangupo LJ, et al. How different are baby-led weaning and conventional complementary feeding? A cross-sectional study of infants aged 6-8 months. BMJ Open. 2016;6(5):e010665.
13. Daniels L, Taylor RW, Williams SM, Gibson RS, Samman S, Wheeler BJ, et al. Modified Version of Baby-Led Weaning Does Not Result in Lower Zinc Intake or Status in Infants: A Randomized Controlled Trial. J Acad Nutr Diet. 2018;118(6):1006-16 e1.
14. Williams Erickson L, Taylor RW, Haszard JJ, Fleming EA, Daniels L, Morison BJ, et al. Impact of a Modified Version of Baby-Led Weaning on Infant Food and Nutrient Intakes: The BLISS Randomized Controlled Trial. Nutrients. 2018;10(6).
15. Karvetti RL, Knuts LR. Validity of the 24-hour dietary recall. J Am Diet Assoc. 1985;85(11):1437-42.
16. Biro G, Hulshof KF, Ovesen L, Amorim Cruz JA, Group E. Selection of methodology to assess food intake. Eur J Clin Nutr. 2002;56 Suppl 2:S25-32.
17. Dietary Assessment Primer, 24-hour dietary recall (24hr) at a glance. National Institutes of Health, National Cancer Institute. (https://dietassessmentprimer.cancer.gov/) [Accessed on: 19 April 2017]. USA: National Cancer Institute; [Over view of various dietary assessment tools to allow

researchers to choose the best method for their research]. Available from: https://dietassessmentprimer.cancer.gov/profiles/recall/index.html.
18. Beaton E, Wright J, Devenish G, Do L, Scott J. Relative Validity of a 24-h Recall in Assessing Intake of Key Nutrients in a Cohort of Australian Toddlers. Nutrients. 2018;10(1).
19. Cameron SL, Taylor RW, Heath AL. Development and pilot testing of Baby-Led Introduction to SolidS--a version of Baby-Led Weaning modified to address concerns about iron deficiency, growth faltering and choking. BMC Pediatr. 2015;15:99.
20. Wardle J, Sanderson S, Leigh Gibson E, Rapoport L. Factor-analytic structure of food preferences in four-year-old children in the UK. Appetite. 2001;37(3):217-23.
21. Garcia AL, McLean K, Wright CM. Types of fruits and vegetables used in commercial baby foods and their contribution to sugar content. Matern Child Nutr. 2016;12(4):838-47.
22. Barends C, de Vries J, Mojet J, de Graaf C. Effects of repeated exposure to either vegetables or fruits on infant's vegetable and fruit acceptance at the beginning of weaning. Food Quality and Preference. 2013;29(2):157-65.
23. Coulthard H, Harris G, Emmett P. Long-term consequences of early fruit and vegetable feeding practices in the United Kingdom. Public Health Nutr. 2010;13(12):2044-51.
24. Hetherington MM, Schwartz C, Madrelle J, Croden F, Nekitsing C, Vereijken CMJL, et al. A step-by-step introduction to vegetables at the beginning of complementary feeding. The effects of early and repeated exposure. Appetite. 2015;84(Supplement C):280-90.
25. Lange C, Visalli M, Jacob S, Chabanet C, Schlich P, Nicklaus S. Maternal feeding practices during the first year and their impact on infants' acceptance of complementary food. Food Quality and Preference. 2013;29(2):89-98.
26. WHO. Feeding and nutrition of infants and young children. Fleischer Michaelsen K WL, Branca F and Robertson A, editor: WHO; 2003.
27. Ballard O, Morrow AL. Human milk composition: nutrients and bioactive factors. Pediatr Clin North Am. 2013;60(1):49-74.
28. Prentice P, Ong KK, Schoemaker MH, van Tol EA, Vervoort J, Hughes IA, et al. Breast milk nutrient content and infancy growth. Acta Paediatr. 2016;105(6):641-7.
29. Dewey KG, Finley DA, Lonnerdal B. Breast milk volume and composition during late lactation (7-20 months). J Pediatr Gastroenterol Nutr. 1984;3(5):713-20.
30. Brown A, Lee M. A descriptive study investigating the use and nature of baby-led weaning in a UK sample of mothers. Matern Child Nutr. 2011;7(1):34-47.
31. Garcia AL, Raza S, Parrett A, Wright CM. Nutritional content of infant commercial weaning foods in the UK. Archives of disease in childhood. 2013;98(10):793-7.
32. Crawley HW, S. Baby foods in the UK: First Steps Nutrition Trust; 2017.
33. Loughrill E, Wray D, Christides T, Zand N. Calcium to phosphorus ratio, essential elements and vitamin D content of infant foods in the UK: possible implications for bone health. Matern Child Nutr. 2016.
34. Loughrill E, Govinden P, Zand N. Vitamins A and E content of commercial infant foods in the UK: A cause for concern? Food Chem. 2016;210:56-62.
35. Loughrill E, Zand N. An investigation into the fatty acid content of selected fish-based commercial infant foods in the UK and the impact of commonly practiced re-heating treatments used by parents for the preparation of infant formula milks. Food Chem. 2016;197(Pt A):783-9.
36. Jenness R. The composition of human milk. Semin Perinatol. 1979;3(3):225-39.

37. Kent JC, Mitoulas LR, Cregan MD, Ramsay DT, Doherty DA, Hartmann PE. Volume and frequency of breastfeedings and fat content of breast milk throughout the day. Pediatrics. 2006;117(3):e387-95.
38. Kramer MS, Guo T, Platt RW, Vanilovich I, Sevkovskaya Z, Dzikovich I, et al. Feeding effects on growth during infancy. J Pediatr. 2004;145(5):600-5.
39. Martin CR, Ling PR, Blackburn GL. Review of Infant Feeding: Key Features of Breast Milk and Infant Formula. Nutrients. 2016;8(5).
40. PublicHealthEngland. Start 4 Life: Complementary feeding UK: Public Health England; 2018 [Available from: https://www.nhs.uk/start4life/baby/first-foods.
41. Technavio. 2017 [Available from: https://www.technavio.com/report/global-food-global-baby-puffs-and-snacks-market-2017-2021.
42. Health and Social Care Information Centre IR. Infant Feeding Survey 2010 2012 [Available from: https://data.gov.uk/dataset/infant-feeding-survey-2010.
43. Brown A, Lee M. An exploration of experiences of mothers following a baby-led weaning style: developmental readiness for complementary foods. Matern Child Nutr. 2013;9(2):233-43.
44. Perrine CG, Galuska DA, Thompson FE, Scanlon KS. Breastfeeding duration is associated with child diet at 6 years. Pediatrics. 2014;134 Suppl 1:S50-5.
45. Poslusna K, Ruprich J, de Vries JH, Jakubikova M, van't Veer P. Misreporting of energy and micronutrient intake estimated by food records and 24 hour recalls, control and adjustment methods in practice. Br J Nutr. 2009;101 Suppl 2:S73-85.
46. Prentice RL, Mossavar-Rahmani Y, Huang Y, Van Horn L, Beresford SA, Caan B, et al. Evaluation and comparison of food records, recalls, and frequencies for energy and protein assessment by using recovery biomarkers. Am J Epidemiol. 2011;174(5):591-603.
47. Bingham S, Gill C, Welch A, Day K, Cassidy A, Khaw K, et al. Comparison of dietary assessment methods in nutritional epidemiology: Weighed records v. 24 h recalls, food-frequency questionnaires and estimated-diet records. British Journal of Nutrition. 1994;72(4):619 - 43.
48. Burrows TL, Martin RJ, Collins CE. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. J Am Diet Assoc. 2010;110(10):1501-10.
49. Sharma S, Kolahdooz F, Butler L, Budd N, Rushovich B, Mukhina GL, et al. Assessing dietary intake among infants and toddlers 0--24 months of age in Baltimore, Maryland, USA. Nutrition Journal. 2013;12(1):52.
50. Muniandy ND, Allotey PA, Soyiri IN, Reidpath DD. Complementary feeding and the early origins of obesity risk: a study protocol. BMJ Open. 2016;6(11):e011635.

Table 1: Food group classifications

Group	Examples
Milk feeds	Breast, formula, cows milk, alternatives
Carbohydrates	Cereals, pasta, rice, potatoes or bread
Vegetables	All vegetables, including starchy varieties
Fruit	All fruits, whether tinned, fresh or frozen
Savoury snacks	Processed snacks such as baby crisps, breadsticks or crackers
Sweet foods	Desserts, chocolate, and puddings
Protein	Meat, fish poultry, eggs, tofu, pulses and legumes
Dairy	Milk, cheese and yoghurts from cow's or goat's milk
'Infant meals'	Composite meals where the individual components were pureed or where the individual components could not be discerned, such as commercial pureed baby food or a simple description such as "curry".
Iron containing foods	Beef, Chicken, Fish, Ham, Lamb, Bacon, Liver (including pâté), Luncheon sausage or other sausage, Pork, Salami, Processed meat sausages, Iron-fortified infant cereal, Baked beans, Lentils, Hummus, Chickpeas (other than hummus)

Table 2: Participant demographic background

Demographic	Group	N	%
Education	No formal education	2	1.1
	GCSE	3	1.7
	A Level	26	14.4
	Degree or equivalent	87	48.3
	Postgraduate qualification	61	33.9
Marital status	Married	136	75.6
	Widowed	1	0.6
	Divorced	2	1.1
	Separated	3	1.7
	Domestic partnership/civil union	31	17.2
	Single	6	3.3
Employment	Full time	31	17.2
	Part time	27	15.0
	Parental leave	91	50.6
	Not working	31	17.2
Occupation	Professional/managerial	80	44.4
	Skilled occupations	62	34.4
	Unskilled occupations	13	7.2
	Unemployed	0	0
	Stay at home parent	25	13.9

Table 3: Number of infants in each weaning and age group

Age group	**Weaning group**			
	Strict	Loose	Traditional	Overall N
Group 1: 6 – 8 months	19 (22.9%)	45 (54.2%)	19 (22.9%)	83
Group 2: 9 – 10 months	15 (33.3%)	22 (48.9%)	8 (17.8%)	45
Group 3: 11- 12 months	22 (42.3%)	21 (40.4%)	9 (17.3%)	52
Overall	56 (31.1%)	88 (48.9%)	36 (20.0%)	180

Table 4: Milk feeding style by weaning group

	Breast milk		Formula milk		Mixed		None *		Total
Weaning group	N	%	N	%	N	%	N	%	
Strict BLW	44	78.4%	7	12.5%	3	5.4%	2	3.6%	**56**
Loose BLW	55	62.5%	24	27.3%	5	5.7%	4	4.5%	**88**
Traditional	11	30.5%	19	52.8%	5	13.9%	1	2.8%	**36**
Total	**110**	**60.5%**	**50**	**27.8%**	**13**	**7.2%**	**7**	**3.9%**	**180**

- No breast or formula milk offered or noted on the recall

Table 5: Differences in food groups offered between weaning groups

Age group	Food group	Strict BLW Mean (SD)	Loose BLW Mean (SD)	Traditional Mean (SD)	Significance
6 – 8 months	Milk Feeds	6.05 (1.75)	5.62 (1.97)	4.68 (2.24)	F (2, 75) = 2.413, p = .096
	Carbohydrates	1.47 (.96)	1.65 (1.10)	1.11 (.81)	F (2, 75) = 1.895, p = .157
	Vegetables	2.58 (1.64)	1.78 (1.64)	.58 (.90)	F (2, 75) = 8.637, p = .000 [1]
	Fruit	1.68 (1.29)	1.50 (1.13)	1.68 (.75)	F (2, 75) = .275, p = .760
	Savoury snacks	.05 (.23)	.22 (.42)	.16 (.50)	F (2, 75) = 1.159, p = .319
	Sweet foods	.26 (.56)	.30 (.72)	.47 (.70)	F (2, 75) = .552, p = .578
	Protein	.89 (.81)	.85 (.83)	.05 (.23)	F (2, 75) = 8.939, p = .000 [2]
	Dairy	.53 (.61)	.75 (.78)	.74 (.93)	F (2, 75) = .567, p = .570
	Meals	.32 (.58)	.32 (.47)	1.05 (.91)	F (2, 75) = 9.646, p = .000 [3]
	Iron-rich foods	.74 (.73)	.67 (.66)	.47 (.77)	F (2, 75) = .759, p = .472
9 – 10 months	Milk Feeds	5.60 (2.53)	3.55 (1.50)	3.71 (.76)	F (2, 41) = 5.873, p = .006 [4]
	Carbohydrates	2.00 (1.20)	2.50 (.96)	2.14 (1.07)	F (2, 41) = 1.084, p = .360
	Vegetables	2.00 (1.73)	1.59 (1.40)	2.43 (2.30)	F (2, 41) = .739, p = .484
	Fruit	2.13 (1.41)	2.05 (1.29)	2.43 (1.13)	F (2, 41) = .227, p = .798
	Savoury snacks	.67 (1.23)	.68 (.72)	.71 (.76)	F (2, 41) = .006, p = .994
	Sweet foods	.27 (.46)	.50 (.60)	.43 (.54)	F (2, 41) = .825, p = .445
	Protein	1.53 (.99)	1.23 (1.48)	1.57 (.54)	F (2, 41) = .375, p = .690
	Dairy	.80 (.68)	1.68 (1.17)	1.71 (1.50)	F (2, 41) = 3.303, p = .050 [5]
	Meals	.33 (.49)	.64 (.66)	.86 (1.07)	F (2, 41) = 1.610, p = .212
	Iron rich foods	1.13 (.64)	1.14 (.71)	1.86 (.90)	F (2, 41) = 2.970, p = .062
11 – 12 months	Milk Feeds	4.00 (2.25)	3.53 (2.09)	2.89 (2.09)	F (2, 47) = .873, p = .425
	Carbohydrates	2.55 (1.01)	2.42 (.90)	2.11 (.78)	F (2, 47) = .691, p = .506
	Vegetables	1.77 (1.41)	1.79 (1.13)	1.11 (1.27)	F (2, 47) = .998, p = .376
	Fruit	2.18 (1.53)	2.89 (1.60)	2.11 (.93)	F (2, 47) = 1.469, p = .241
	Savoury snacks	.32 (.72)	1.05 (.91)	.67 (.71)	F (2, 47) = 4.349, p = .018 [6]
	Sweet foods	.45 (.60)	.53 (.61)	.11 (.33)	F (2, 47) = 1.714, p = .191
	Protein	1.55 (.91)	1.16 (.83)	.78 (.67)	F (2, 47) = 2.861, p = .067
	Dairy	1.14 (1.13)	2.47 (1.43)	2.22 (1.72)	F (2, 47) = 5.365, p = .008 [7]
	Meals	.27 (.55)	.58 (.69)	.89 (.60)	F (2, 47) = 3.437, p = .040 [8]
	Iron rich foods	1.45 (.67)	1.11 (.74)	1.33 (.50)	F (2, 47) = 1.389, p = .259

Superscripts denote post-hoc Bonferroni test results:

[1] Strict BLW had higher exposure than traditional group (p = .000). Loose BLW group had higher exposure than the traditional group (p = .016)

[2] Strict BLW group had higher exposure than traditional group (p = 0.16). Loose BLW also had higher exposure than traditional group (p = .002)

[3] Traditional group had higher exposure than both strict BLW (p = .002) and loose BLW (p = .000)

[4] Strict BLW had more milk feeds than the loose BLW group (p = .006)

[5] Differences in dairy consumption did not survive Bonferroni test.

[6] Loose BLW group had higher exposure than the strict BLW group (p = .015)

[7] Loose BLW group had higher exposure than the strict BLW group (p = .009)

[8] Traditional group had higher exposure than the strict BLW group (p = .045)