

Infant egg consumption during introduction to solid food remains low in the United Kingdom but increases with infant age and a baby-led weaning approach

Hannah Rowan | Amy Brown 

Centre for Lactation, Infant Feeding and Translation (LIFT), Swansea University, Swansea, UK

Correspondence

Amy Brown, Centre for Lactation, Infant Feeding and Translation, Faculty of Medicine, Health and Life Sciences, Swansea University, Swansea SA2 8PP, UK.
Email: a.e.brown@swansea.ac.uk

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Abstract

Background: As a nutritious food-providing protein, essential fatty acids, vitamin D, iodine and choline eggs have historically been central to an infant weaning diet. However, food poisoning scares and allergy concerns have contributed to low consumption among infants aged 6–12 months.

Methods: This paper presents a secondary data analysis of infant egg exposure and intake using three weaning data sets: a 7-day food frequency questionnaire ($n = 297$), a 24-h recall ($n = 180$) and a 3-day weighed food diary ($n = 71$). Egg introduction, frequency of consumption and intake in grams were analysed for infants aged 6–8, 9–10 and 11–12 months). Comparisons were made by whether infants were following a baby-led approach to weaning (where infants self-feed family foods) or a traditional approach where pureed foods are given alongside finger foods. Data were collected in the United Kingdom between 2015 and 2018.

Results: Our data showed that despite introduction being recommended from the start of weaning at 6 months of age by the Department of Health, just 54% of infants aged 6–8 months had ever been offered eggs. Average egg intake was one to two times per week, increasing with age. However, in terms of frequency and grams consumed, our data suggest a small increase in consumption compared with previous research, although limitations of our smaller sample size should be noted. Finally, a baby-led approach was associated with increased exposure and consumption; baby-led infants consumed eggs twice as frequently as spoon-fed infants.

Conclusions: The findings have important implications for public health messaging and for supporting families in introducing solid foods.

KEYWORDS

baby-led weaning, complementary feeding, eggs, infant diet, starting solids, weaning

Key points

- Despite introduction being recommended from the start of weaning at age 6 months, just 54% of infants aged 6–8 months had ever been offered eggs.
- Only 40% of infants aged 6–8 months and about two-thirds of those aged 9–12 months had consumed eggs in the last week. Those who had consumed eggs most commonly did so once or twice a week.

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- Infants following a baby-led weaning approach who self-feed family foods were introduced to eggs at an earlier stage of weaning and consumed eggs twice as frequently as spoon-fed infants.

INTRODUCTION

Eggs have been a human food source for millennia, providing a wide range of nutrients, including protein, essential fatty acids, vitamin D, iodine and choline,¹ and for this reason were often recommended as a nutritious weaning food for infants.² However, in the United Kingdom, health scares in relation to Salmonella in the 1980s led to a precipitous drop in egg consumption and the culling of millions of hens.^{3,4} Despite the widespread vaccination of laying hens against Salmonella leading to the Food Standards Agency stating in 2017 that even runny and raw eggs produced under the Red Lion scheme were safe for vulnerable populations such as pregnant women and infants,⁵ parent concerns remained.⁶

Additionally, conflicting advice regarding egg consumption and allergy development has caused confusion over the past 30 years. Guidance from the UK Department of Health during the 1990s advised families with a history of atopic allergy to wait until about 10 months to introduce potentially allergenic foods, including eggs.⁶ Although the Committee on Medical Aspects of Food Policy in 1994 stating that solid cooked eggs were suitable for a weaning diet from 6 to 9 months onwards,⁷ many parents still had allergy concerns and avoided introduction.⁸

Current UK advice outlined by the Scientific Advisory Committee on Nutrition (SACN) and supported by the UK Department of Health recommends introducing eggs from the start of the weaning process at about age 6 months.⁶ This recommendation reflected research providing a lack of compelling evidence to support the benefit of a later introduction of potentially allergenic foods coupled with growing evidence suggesting later introduction may in fact result in a higher risk of atopy and allergy.^{6,9–11} It is referenced in current weaning guidance aimed at parents,¹² yet parents still express concerns about introducing eggs and allergy development,^{13–15} despite overall risk of egg allergy among UK infants from birth to 2 years being just 2%.¹⁶

This confusion is perhaps understandable given changes in guidance over the years, most likely influenced by messaging from older family members and friends about weaning safety.¹⁷ Increased connectivity due to social media may also increase confusion due to different guidance or behaviours in other regions around the world. However, it continues to impact upon egg introduction, affecting nutrient

intake.¹ In the last UK Infant Feeding Survey (IFS) in 2010, 12% of mothers had not introduced eggs at all to their 8–10 month old infant, and even among those who had introduced eggs, 73% offered eggs less than once per week.¹³ Likewise, examination of 4-day food diaries in the 2011 UK Diet and Nutrition Survey of Infants and Young Children (DNSIYC) found that just 9% of infants consumed eggs over that period at age 6 months, increasing to 27% at 10 months. Even at 17 months of age, only 40% of infants had eaten eggs during the 4-day period.¹⁸

However, the lack of national-level surveys of infant and toddler dietary intakes for the past 10 years has left a significant gap in our knowledge of how intakes and dietary patterns have changed during this time. If we consider more recent data from mainly adult dietary intakes, the UK National Diet and Nutrition Survey has shown an increase in egg consumption of 23% between 2008–2009 and 2016–2017.¹⁹ Additionally, consumer purchase of eggs increased by 49% between 2008 and 2019.²⁰ If adults have increased their intake of eggs, has this also resulted in a change in confidence in offering them to infants?

Parallel to the increase in adult egg consumption over the past decade, we have also seen changes in parents' behaviour about introducing solid foods to their baby. Age of introduction to solids had gradually been increasing¹³ after the World Health Organization recommended in 2003 that infants be given solid foods at about age 6 months as against the previously recommended 4–6 months.²¹ Given the different developmental stage of babies at 6 months compared with 4 months in terms of being able to sit up and self-feed,²² increasing numbers of parents are now choosing to follow a baby-led approach to weaning where infants self-feed family foods rather than spoon-feeding special infant puree.^{23,24} UK Department of Health guidance also more clearly states that infants should be given family foods to self-feed from the start of weaning, moving away from a reliance on specially made infant pureed foods.¹²

Given the suitability of egg and egg-based dishes such as omelettes and quiche as finger foods for infants to self-feed, might these changes to recommendations and an increase in baby-led weaning also lead to an increase in egg consumption? The aim of this paper is therefore to examine egg consumption in a more recent data set, alongside comparing how egg consumption may differ between infants by weaning approach and maternal demographic background. How often are infants now eating eggs, in what form and who is offering them?

METHODS

Design

This is a secondary data analysis of three data sets examining infant diet at age 6–12 months. It utilises a food frequency questionnaire (FFQ), 24-h recall and 3-day weighed food diary alongside parental perceptions of infants' like or dislike of eggs. All data were collected in the United Kingdom between 2015 and 2018. For an overview of study methods, sample and procedure, see Figure 1.

Participants

UK parents aged above 18 years of infants aged 6–12 months who had started the weaning process took part in each study. Exclusion criteria included infant prematurity (gestation <37 weeks), low birth weight (<2.5 kg) and multiple food allergies, failure to thrive or other complex health issues that might affect diet. Approval for these studies was granted by the Swansea University College of Human and Health Research Ethics Committee. All parents provided informed consent prior to inclusion in the study, and each

study followed the principles of the Declaration of Helsinki (2013).

Measures

Study one consisted of an internet survey of parents with an infant aged 6–12 months. It included a 7-day FFQ, along with an assessment of exposure to foods (i.e., ever offered) and parental perceptions of their infants' enjoyment of each food.

Study two comprised a subset of participants from the first study and asked parents to complete a 24-h dietary recall for their infants. Parents listed the foods they offered their infants over 24 h, including broad details of quantity, for example, half a banana. Accurate weights/sizes were not given in this study allowing only exposure, not the exact amount consumed to be calculated. Further details of the method of this study have been published.²⁵

Study three consisted of a 3-day weighed food diary. Participants were asked to weigh every food they offered their infant before and after consumption for 3 days. From this exact intake of foods, energy and macro- and micronutrients could be calculated. Further details of the method of this study have been published.²⁶

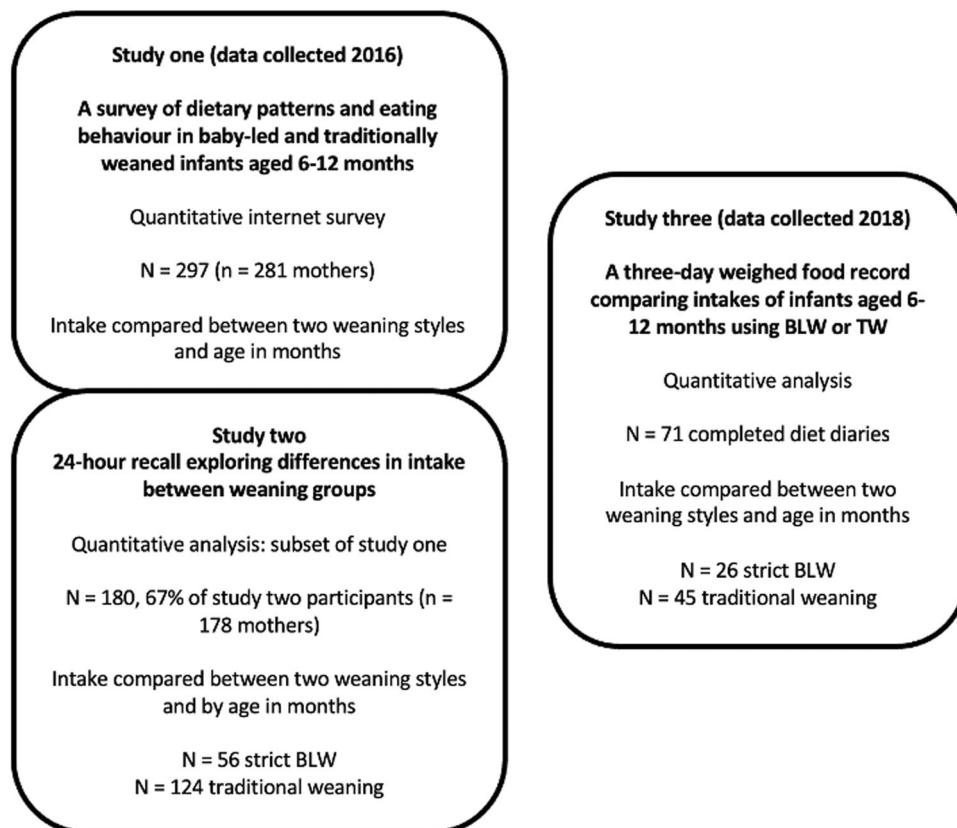


FIGURE 1 Schematic of studies. BLW, baby led weaning; TW, traditional weaning.

For each study, respondents completed a questionnaire, including demographic background (age, sex, education, ethnicity and employment status), infant characteristics (sex, age in weeks and parent-reported weight) and the method of introducing solid foods. Parents provided details of current infant diet but retrospectively recalled age and method of introduction to solid foods. To measure the method of introduction, parents were asked how they identified with the following statement:

‘Baby led weaning (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. BLW tends to involve offering the baby family foods rather than offering pureed foods’.

This self-identification was then verified by asking two follow-up questions on how frequently they used spoon-feeding with their infant or used purees. Each scale had a seven-point response option from 100% spoon-feeding/puree use to 100% self-feeding/whole foods. The answers were used to group participants into BLW infants (if completely self-fed or with occasional adult feeding) and the remaining infants classed as traditionally weaned infants.

Data analysis

Statistical analysis was performed using SPSS v. 28 (IBM). Infants were grouped into three age groups of 6–8, 9–10 and 11–12 months to reflect similar groupings in the IFS and DNSIYC. Data were then reanalysed from the three data sets to specifically extract and examine data in relation to egg consumption. Dietary data were examined for any inclusion of eggs or egg-based dishes. This included eggs in different forms (i.e., boiled, fried, scrambled and poached) and egg-based dishes such as quiche, frittata or omelette. It did not include dishes where eggs were a smaller part of cooked ingredients, that is, bread or cake.

Egg exposure (yes/no), perceived enjoyment and frequency of consumption (by 7-day food frequency, 24-h recall and 3-day weighed food diary) were examined and then compared for maternal demographic background, infant age and weaning approach (baby-led vs. spoon-fed) using χ^2 and multivariate analysis of variance (MANOVA). For the 3-day diet diary, the distribution of weighed egg and egg-product intake was tested for normality using the Kolmogorov–Smirnov test and found to be normally distributed. Analysis of variance (ANOVA) was then used to intake between age and weaning groups.

RESULTS

Study one included 297 participants, study two 180 and study three 71. Full demographic details are presented in Table 1.

Study one: parental survey

Egg introduction

Table 2 presents the number of infants who had been introduced to eggs for each age group. Infant age was significantly associated with ever having been offered eggs [$\chi^2(2, 278) = 43.6096, p < 0.001$], with egg introduction increasing with infant age. Overall, 54.4% ($n = 87$) of infants aged 6–8 months in the study had been offered eggs compared with 95.1% ($n = 58$) of those aged 12 months.

Looking at the potential association between parental demographic characteristics and introduction to egg, there was a significant association between work status and introduction [$\chi^2(4, 279) = 9.969, p = 0.041$]. Those in full-time work were least likely to offer egg, and those on maternity leave were most likely to offer egg. No significant association was found in exposure and maternal age, education or ethnicity.

There was a significant association between weaning approach and egg introduction [$\chi^2(1, 279) = 21.856, p < 0.001$]. Infants who were following a baby-led approach were more likely to have been introduced to egg and from an earlier age. Table 2 shows that those following a baby-led approach were almost twice as likely to have been offered eggs at 6–8 months.

Frequency of egg consumption

Participants indicated via the FFQ how often their baby had consumed eggs and egg dishes in the past 7 days. Table 3 presents the proportion of babies who had (a) consumed any egg or egg-based dish during that period and (b) the mean number of times they had consumed egg. The most common frequencies of consumption for the whole sample among those who had eaten eggs were once (14.1%), twice (17.8%) and thrice (10.8%) with a range from 0 to 10 times.

A MANOVA showed a significant association between infant age and frequency of egg consumption [$F(2, 295) = 9.226, p \leq 0.01$]. As Table 3 shows, older infants consumed eggs more frequently than younger infants. There was also an association between weaning group and egg consumption [$F(1, 295) = 30.409, p < 0.001$]. Table 3 shows that baby-led weaned infants ate eggs and egg dishes on average twice in the previous 7 days but traditionally weaned infants consumed eggs less than once.

TABLE 1 Participant demographics.

Demographics	Group	Study one (N = 297)		Study two (N = 180)		Study three (N = 71)	
		N	%	N	%	N	%
Age (years)	18–24	25	8.4	12	6.7	3	4.2
	25–34	181	61.0	113	62.7	40	56.3
	≥35	91	30.6	55	30.6	28	39.5
Education	No formal education	3	1.0	2	1.1	0	0.0
	GCSE	8	2.7	3	1.7	2	2.8
	A level	48	16.1	26	14.4	11	15.5
	Degree or equivalent	138	46.5	87	48.3	23	32.4
	Postgraduate qualification	98	33.0	61	33.9	35	49.3
Marital status	Married	225	75.7	136	75.6	49	69.0
	Widowed	2	0.7	1	0.6	0	0.0
	Divorced	2	0.7	2	1.1	0	0.0
	Separated	4	1.3	3	1.7	0	0.0
	Living with partner	51	17.2	31	17.2	22	31.0
	Single	11	3.7	6	3.3	0	0.0
Employment	Full time	46	15.5	31	17.2	4	5.6
	Part time	47	15.8	27	15.0	14	19.8
	Parental leave	141	47.5	90	50.0	47	66.1
	Not working	63	21.2	32	17.8	0	0.0
Ethnicity	Asian or Asian British	8	2.7	3	1.7	2	2.8
	Black, Black British, Caribbean or African	1	0.3	0	0	0	0
	Mixed or multiple	10	3.4	5	2.8	1	1.4
	White (British, Irish)	254	85.5	159	88.2	66	93.0
	White Gypsy/Irish Traveller	1	0.3	1	0.6	0	0
	White other	17	5.7	9	5	2	2.8
	Prefer not to disclose	6	2.0	3	1.7	0	0
Weaning group	Baby-led	72	24.2	57	31.7	26	36.6
	Spoon-fed	225	75.8	123	68.3	45	63.4

Perceived enjoyment of egg

Parents were asked to rate whether they perceived that their infant liked egg or egg-based dishes using three response options: 'likes', 'neither likes nor dislikes' or 'dislikes'. Overall for the whole sample, 71.3% of infants ($n = 139$) were perceived to like eggs, 17.9% ($n = 35$) neither like nor dislike eggs and 10.8% ($n = 21$) dislike eggs.

When examined by weaning group, 71.3% of infants following a baby-led approach ($n = 51$) were perceived to like eggs, 15.1% ($n = 10$) neither like nor dislike eggs and 7.6% ($n = 5$) dislike eggs. Comparatively 68.2% of infants

following a spoon-fed approach ($n = 88$) were perceived to like eggs, 19.4% ($n = 25$) neither like nor dislike eggs and 12.4% ($n = 16$) dislike eggs. However, this difference was not significant.

Study two: 24-h recall

In this study participants were asked to recall all food and drink their infants had consumed in the past 24 h. Overall, just 25 out of 180 infants (13.8%) had consumed eggs or egg-based dishes in that period (Table 4). Where eggs had been offered, popular offerings included

chopped egg, boiled egg, scrambled egg and omelette. There was no significant association with infant age [$\chi^2(1, 180) = 1.568, p = 0.457$].

When examining the data by weaning group although those in the baby-led group were more likely to have eaten eggs in the past 24 h, this was not a significant association [$\chi^2(1, 180) = 2.041, p = 0.153$]. There were no significant associations between consumption of eggs over the past 24 h and maternal demographic background.

Study three: 3-day diet diary

Finally in the 3-day diet diary, weighed intake of eggs was examined. Popular egg dishes offered to infants again included scrambled egg, omelette, quiche and boiled eggs. In this study 33.8% ($n = 24$) of infants had consumed eggs and egg-based dishes over the 3-day period (Table 5).

Although consumption increased with infant age, this association was not significant [$\chi^2(2, 71) = 2.753, p = 0.252$]. Likewise, no significant association was found for weaning group [$\chi^2(1, 71) = 1.326, p = 0.250$] despite higher consumption in the baby-led group. However, sample sizes were small. No significant association was observed between egg consumption and maternal demographic background.

In terms of mean grams of egg consumed, average consumption for those infants who consumed any egg was 27.66 g (standard deviation: 18.5) across the 3 days. A MANOVA found no significant difference in consumption by age group [$F(2, 24) = 2.487, p = 0.107$]. Likewise, no significant difference in intake was found by weaning group [$F(1, 24) = 0.116, p = 0.737$].

TABLE 2 Introduction to eggs for whole sample and by weaning approach.

Infant age (months)	Whole sample		Spoon-fed		Baby-led	
	N	%	N	%	N	%
6–8	87	54.4	60	46.5	27	87.1
9–10	49	86.0	36	83.7	13	92.9
11–12	58	95.1	33	94.3	25	96.1

TABLE 3 Frequency of egg and egg dish consumption in previous 7 days.

Infant age (months)	Whole sample			Spoon-fed			Baby-led		
	Any consumption		Mean frequency (SD)	Any consumption		Mean frequency (SD)	Any consumption		Mean frequency (SD)
N	%	N		%	N		%		
6–8	72	40.9	0.94 (1.39)	49	33.7	0.80 (1.3)	23	74.1	1.61 (1.62)
9–10	39	67.2	1.79 (1.96)	27	50.0	1.61 (1.97)	12	85.7	2.35 (1.86)
11–12	43	69.4	1.67 (1.53)	20	58.3	1.19 (1.32)	23	88.4	2.34 (1.57)

Abbreviation: SD, standard deviation.

DISCUSSION

This paper brings together findings from three interconnected studies examining dietary exposure, intake and preferences of infants aged 6–12 months. In this secondary analysis of the data, we focus specifically on egg intake, both in ‘whole egg’ form, such as boiled, scrambled or fried eggs, and as part of egg-based dishes such as omelettes, quiche and pancakes. The findings show that infants are being offered eggs as part of a weaning diet but that exposure and frequency of consumption increase with age. Notably, the method with which infants are being introduced to solid foods affected consumption; infants who followed a baby-led approach and were self-feeding were more likely to have been offered eggs and to consume them more frequently compared with those who were being spoon-fed.

In terms of exposure to eggs, almost all infants had been offered eggs by age 12 months. However, eggs were often delayed until the infant was older, with only just over half of those at the start of the weaning process at age 6–8 months having ever tried eggs or egg-based dishes, in spite of advice from the UK Department of Health stating that eggs can be offered from 6 months.²⁷ Comparing this frequency to other studies, parents of younger infants in our study (aged 6–8 months) were slightly less likely to have introduced egg to their baby. However, among our older infants, introduction was slightly higher. For example, in the 2011 DNSIYC, 31% of parents of infants aged 7–9 months and 19% of parents of infants aged 10–11 months had not introduced eggs.¹⁹ Comparatively in the 2010 IFS, 12% of parents with an infant aged 8–10 months had not introduced eggs.¹³

TABLE 4 Egg consumption recorded over the previous 24 h.

Infant age (months)	Whole sample		Spoon-fed		Baby-led		
	N	%	N	%	N	%	
6–8	41	15	16.1	8	11.6	7	29.2
9–10	40	6	15.0	4	13.8	2	18.2
11–12	47	4	8.5	2	8.0	2	9.1

TABLE 5 Mean egg intake in grams by age group amongst infants who consumed eggs.

Infant age (months)	Whole sample			Baby-led			Spoon-fed		
	N	%	Mean (SD)	N	%	Mean (SD)	N	%	Mean (SD)
6–8	4	23.5	17.5 (15.7)	2	33.3	15.0 (8.48)	2	18.2	20.0 (25.4)
9–10	7	28.0	20.0 (17.4)	3	27.3	18.0 (9.53)	4	28.6	21.5 (23.3)
11–12	13	44.8	34.9 (17.7)	6	66.7	39.3 (21.9)	7	35.0	31.1 (14.1)
All	24	33.8	27.66 (18.5)	11	42.3	29.0 (20.1)	13	28.9	26.4 (17.7)

Abbreviation: SD, standard deviation.

Although it should be noted that our data sets are small compared with the DNSIYC ($N=2683$) and IFS ($N=10,000$), it could be concluded that parents are increasingly more likely to introduce eggs to their baby by age 12 months but are possibly still delaying timing of introduction. Concerns about allergy development remain common,²⁸ potentially increased by the number of parents discussing such topic on social media and being exposed to myths or inaccurate or outdated information.²⁹

In terms of frequency of egg consumption, although most infants had been introduced to egg, frequency of consumption was relatively low. Just 40% of infants aged 6–8 months had eaten any eggs or egg-based dishes in the past week in our FFQ, increasing to about two-thirds in the older age groups. Mean consumption across all infants was fewer than two portions per week, although most infants who were eating eggs did consume them 1–3 times over the past week. When data from the 24-h recall were considered, just one in six infants had been offered egg or egg-based dishes the previous day. Finally, in the 3-day diet diary, about a quarter of infants aged 6–10 months had consumed egg, increasing to just under a half in infants aged 11–12 months.

However, these data suggest a slight increase compared with previous research. In the DNSIYC, eggs were reported to have been eaten by 8% of infants aged 4–6 months, 18% of those aged 7–9 months, 30% of those aged 10–11 months and 40% of 12–18 month old toddlers in the previous 4 days. Although our data use slightly different time points, they reflect a small increase in the frequency of consumption of eggs and egg-based dishes. Likewise, using a slightly different approach, the IFS explored how often babies were typically offered foods, finding that 73% of parents of infants aged 8–10 months gave eggs less than once a week, compared with 1–2 times a week in our data.¹³

For specific intake, data from our 3-day weighed food diary found a higher overall consumption of eggs than in the DNSIYC.¹⁹ Daily intake in the DNSIYC averaged 10 g at 4–6 months, 16 g at 7–9 months, 18 g at 10–11 months and 20 g at 12–18 months. In our study we reported the daily average intake of 17.5 g at 6–8 months, 20.0 g at 9–10 months and 34.9 g at 11–12 months. These differences may seem small, but when considered in an

infant weaning diet where milk remains the primary source of nutrition until age 12 months,³⁰ it is an interesting upward trend. Although it should be noted that our diet diary sample was small, this may also suggest that the recent increase in egg consumption in the general UK population is being seen in its youngest consumers, but more research is needed.

Considering what our egg consumption data reflect in real terms, a medium egg weighs between 53 and 63 g, which would provide around 80 calories (and associated macro- and micronutrients). This must be considered within guidelines for how much energy infants should receive from solid foods. The World Health Organization recommends that infants aged 6–9 months should have about 196 calories per day from solid foods, increasing to 455 calories per day at 10–12 months.³⁰ Our 6–8 month old babies who were consuming eggs ate the equivalent of about a third of an egg over 3 days. There is clearly room for this to increase, but that small amount of egg effectively represents about 3% of their overall calorie intake for those 3 days.

A small proportion of infants in the sample had not been offered eggs at all even by age 12 months when infants should ideally be eating three meals a day as part of a family diet. Our studies did not ask why eggs were not offered, although our data on perceived enjoyment suggest that potentially a small proportion of infants might not be offered eggs as they were perceived not to enjoy it. From a practical perspective it is important that parents are aware that when introducing new tastes to their baby it can take up to 8–10 exposures for an infant to accept and enjoy a new food.³¹ It is possible that concerns regarding allergies or food poisoning remain,¹³ but also potentially the increase in vegan diets and parents raising their children as vegans may play a role.³² Further research is needed.

A notable pattern in the data was how maternal working status affected egg consumption. Where a mother remained at home, on maternity leave or as a stay-at-home mother, her infant was more likely to have been introduced to eggs or was consuming more eggs compared with those who had returned to work. It is possible that this is linked to socio-economic status, but we did not find any association between other similar indicators such as age and education. Instead, it is

possible that by whom the infant is being cared for might affect consumption. Do nurseries avoid offering eggs to infants or have menus that are not egg based for other reasons (i.e., the relative convenience of toast or porridge for breakfast)? Do older family members who might be caring for a baby believe eggs should be avoided due to remembering previous egg scares? There is some evidence that older people are more likely to be concerned about food poisoning or reactions, including eggs.³³ This would be an interesting area of future research.

In each of our studies infants following a baby-led approach were more likely to have been offered and consumed a higher amount of egg and egg-based dishes compared with those who were being spoon-fed. In our FFQ younger baby-led infants were significantly more likely to have been introduced to eggs and consumed eggs almost twice as frequently compared with those who were spoon-fed. A similar trend occurred in the 24-h recall and diet diary but was not significant, potentially due to smaller samples.

These data are most likely explained in part by how whole eggs can be easily self-fed by infants, as a strip of omelette or chunk of hard-boiled egg for example. Although UK Department of Health guidance does recommend offering finger food from the start of weaning even if following a spoon-feeding approach, those following baby-led weaning would naturally have more opportunities to be exposed to finger foods and consume them more frequently.²⁵ Eggs do not lend themselves well to purees, particularly smooth purees that parents typically give at the start of weaning.

Diet variety also differs between baby-led and spoon-fed infants. Several studies have shown that baby-led infants eat a wider variety of 'family foods' and fewer commercial products,^{25,26,34,35} with one study also finding that infants following baby-led weaning consumed a higher percentage of foods also consumed by their mother, potentially meaning that they ate more foods such as eggs which those following a spoon-feeding approach might not see as 'baby' foods.³⁶ First foods for infants following a spoon-fed approach are also more likely to be fruits and vegetables or baby cereals, compared with a much wider variety for baby-led infants.³⁷

There is also the possibility that baby-led infants consume eggs more frequently as they are viewed to be less fussy and more adventurous in their eating style and food acceptance.³⁸⁻⁴⁰ At present there are no experimental studies testing food fussiness in infants by weaning style, and data rely on maternal report. There was no difference in infant perceived enjoyment of eggs between those following a baby-led and spoon-fed approach, but potentially views of baby-led infants being receptive to a wider range of foods might affect whether parents choose to introduce foods like eggs to their infant.

It may also be that parents following a baby-led approach are more aware of the importance of a varied diet, or the nutrient profile of eggs in part due to the tendency of mothers who choose to follow this approach being more likely to have a higher level of education and professional role.²³ However, our sample does represent a typically higher level of maternal education, age and occupational status than average across other weaning groups. We also found little association between egg use and maternal demographic background, suggesting that it is the method itself that may encourage intake.

Although to our knowledge this is the first study investigating consumption of eggs by UK infants weaned using different methods, there are limitations. First, the sample sizes were small, particularly the 3-day weighed diet diary; however, the sample sizes were balanced with the intensity of the study design to consider the burden on the mothers who took part. Because of the burden of completing this study, it is likely that participants were a highly motivated cohort, and indeed participants in all the studies had a higher-than-average level of education. This may have been exacerbated by deliberate recruitment of those following baby-led weaning, who are often older with a higher level of education.²³ Given that participants were recruited primarily over the internet by snowball sampling via social media, the samples may have been subject to selection bias and social desirability bias that may arise when parents report their children's diet.⁴¹ However, this method of recruitment has previously been used in this area of feeding and behavioural research.^{42,43} Infants with multiple food allergies were also excluded from all studies, and this may have skewed egg consumption as those with a known egg allergy may not have been represented. Additional data on family allergy/atopy would also add value to future studies.

As this analysis was undertaken as a secondary analysis of our existing data sets, we did not have some data that would have been useful for additional analyses. For example, in study one, although we had collected data on whether infants had ever consumed eggs, we did not have exact details of timing of introduction to eggs, only whether an infant in a given age range had consumed it or not. Additionally, all dietary assessment tools, such as the FFQ, 24-h recall and 3-day diet diary, have their own limitations, including memory errors when completing recalls and questionnaires, measurement inaccuracies in weighed food records, particularly when measuring leftovers, and the potential for food database errors.⁴⁴⁻⁴⁶ We also did not collect data on diet in other care settings, due to increased burden on participants and recall errors. Egg consumption in day care settings for younger infants would be a useful study. Participants also retrospectively recalled timing and method of introduction, albeit within a relatively short time frame. Although this is a common method used in

studies such as the UK IFS,¹⁴ there is the potential for inaccuracy. Longitudinal studies would be beneficial.

Limitations aside, these results have implications for those working with parents and young children. It seems that a proportion of parents still believe that eggs are not suitable weaning foods. They may be unaware of the food standard agency's recent change in advice to state that UK-produced 'Red Lion' eggs, including uncooked or runny eggs, are safe for babies and pregnant women.⁵ Confusion among parents also persists about the timing of solid foods and allergy development due to mixed messaging about early or delayed introduction.¹⁵ Eggs are a persistent source of confusion, with some families still viewing introduction before a year as 'dangerous'.¹⁶

In terms of guidance in relation to the timing of introducing allergenic foods, professional bodies have differing advice. The British Dietetic Association and the British Society for Allergy and Clinical Immunology have produced guidance for healthcare providers on possible introduction of allergens between 4 and 6 months, but is it important to note that this advice relates to infants at a high risk of allergy?⁴⁷ However, a benefit–risk assessment conducted by the UK SACN and the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment concluded that there were insufficient data to show that introducing peanut and egg between 4 and 6 months was more effective at reducing allergy than introduction at about 6 months. Conversely earlier introduction may reduce the protection offered by exclusive breastfeeding, increase choking risk and potentially expose infants to food poisoning.¹⁰

This confusion is exacerbated by inconsistencies in studies and their interpretations and dissemination in the media. Specifically in relation to egg introduction, many randomised controlled trials find no significant effect of early introduction at 4–6 months in preventing allergy.^{48,49} Perkin et al.⁵⁰ found a reduction in egg allergy for early introduction but only in their per-protocol analysis. Adherence rates in the study were low, with confounding due to high breastfeeding rates. However, another trial found that introducing eggs from 6 months reduced allergies compared with later introduction.⁵¹ Although there is moderate evidence that introduction at 4–6 months may reduce allergy in high-risk infants, limitations of the current data and balance of risk of early introduction, as noted earlier, mean that guidelines have not been changed.⁵²

Further data with regard to timing of introduction prior to 6 months are needed, but additionally greater awareness of the suitability, safety and efficacy of introducing eggs from 6 months is needed. By avoiding introducing eggs, parents are missing an opportunity to offer their infants a nutrient-dense, cost-effective weaning food, which has been shown to be an excellent source of nutrients for rapidly growing and developing children.⁵³ They may also inadvertently be increasing their

baby's risk of allergic reaction.¹⁰ Healthcare workers may wish to revisit their advice to parents of weaning infants, ensuring that their messaging considers the latest guidance on the benefits of introducing eggs sooner rather than later, from age 6 months.

Finally, it is possible that promoting a more baby-led approach to introducing solids, or encouraging greater use of finger foods, may aid in encouraging intake of eggs. A key question is whether parents who choose to adopt a baby-led approach are more likely to be knowledgeable and confident in offering eggs or whether the approach itself naturally encourages higher egg consumption. Indeed, given the growing evidence that a baby-led approach is associated with positive eating behaviours and weight trajectories,⁵⁴ greater attention is needed to understand whether a baby-led ethos may potentially be a way of promoting healthy outcomes. In the meantime, public health messaging may wish to focus on highlighting the importance of finger foods, including egg, in supporting infant acceptance of new tastes and textures.²³

AUTHOR CONTRIBUTIONS

Hannah Rowan was responsible for study design, data collection, data analysis, draft report writing and critical revisions. Amy Brown was responsible for study design, data analysis support, draft report writing and critical revisions.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ETHICS APPROVAL

Ethical approval was granted by the Research Ethics Committee at the College of Human and Health Sciences, Swansea University.

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ORCID

Amy Brown  <http://orcid.org/0000-0002-0438-0157>

PEER REVIEW

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AUTHOR BIOGRAPHIES

Hannah Rowan obtained her PhD in public health from Swansea University; she focuses on infant feeding, child nutrition and eating behaviours.

Amy Brown is Professor of Public Health, Swansea University; she obtained her PhD in psychology from Swansea University; she is interested in psychosocial influences on infant feeding.

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