# DOES EARLY INTRODUCTION OF solid FEEDING LEAD TO EARLY CESSATION OF BREASTFEEDING? A secondary analysis of three cohort studies

Running title: Early complementary foods and breastfeeding

Angelina Lessa1, Ada Garcia1, Pauline Emmett2, Sarah Crozier3, Sian Robinson3

Keith M Godfrey3,4, Charlotte M Wright5

1Department of Human Nutrition School of Medicine, Nursing and Dentistry, University of Glasgow

2 Centre for Child and Adolescent Health, Population Health Sciences, Bristol Medical School, University of Bristol

3 MRC Lifecourse Epidemiology Unit, University of Southampton

4 NIHR Southampton Biomedical Research Centre, University of Southampton and University Hospital Southampton NHS Foundation Trust

5 Department of Child Health, School of Medicine, Nursing and Dentistry, University of Glasgow

**Corresponding author:** Charlotte M. Wright, Royal Hospital for Children, Office Block CO/2, QE Hospital Campus, Govan, Glasgow G51 4TF

charlotte.wright@glasgow.ac.uk

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**Contributor Statement**

AL undertook all the analyses and produced the first draft. PE SR and KG worked on the design, and analysis of their cohorts’ infant data. CW, AG and AL planned the analysis and PE, SR and SC advised on the data available, enabled us to access it and commented on the paper in draft. CW created the final draft and all the authors have read and approved it. This publication is the work of the authors and will serve as guarantors for the contents of this paper.

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**Ethical approval**

The ALSPAC study was granted Ethical approval by the Local Research Ethics Committee and ALSPAC Ethics and Law Committee. The SWS was approved by Southampton and South West Hampshire Local Research Ethics Committee. The IFS-2010 was approved by the Ethics, Department of Health Sciences at the University of York.

**ABSTRACT:**

Mixed milk feeding increases the likelihood of breastfeeding cessation, but it is not known if solid feeding (SF) has the same effect. We have identified 10,407 infants breastfed for at least 8-10 weeks from 3 large UK studies (Avon Longitudinal Study of Parents and Children (ALSPAC; born 1990-91), Southampton Woman’s Survey (SWS;1998-2008), Infant Feeding Survey 2010 (IFS; 2010) to investigate the associations between early SF and breastfeeding cessation.

In the earliest study (ALSPAC) 67% had started SF before age 4 months, but in the latest (IFS) only 23% had started before 4 months.

Solid food introduction before four months was associated with stopping breastfeeding before six months in all three cohorts, with little effect of adjustment for maternal sociodemographic characteristics (Poisson regression, adjusted prevalence ratios: ALSPAC 1.55 (95%CI 1.4-1.8), SWS 1.13 (1.0-1.3), IFS 1.10 (1.1-1.3)). Using Cox regression, adjusted hazard ratios for breastfeeding cessation compared to SF after 5months were 2.07 (1.8-2.4) for SF before 4 and 1.51 (1.3-1.8) at 4-5 months for ALSPAC, and 1.25 (1.1-1.5) and 1.15 (1.0-1.3) for SWS.

Earlier introduction of solids was associated with a shorter duration of breastfeeding, particularly in cohorts where earlier introduction of solids was the norm, with a dose response relationship which was not explained by background social characteristics. As mothers most commonly introduced solids in the month prior to the then recommended age, continuing to recommend deferring solids to the age of 6 months is important to support sustained breastfeeding.

**Keywords:** Breast feeding, Lactation, Complementary Feeding, Infant, Cohort study, ALSPAC

**KEY MESSAGES**

* It is well recognised that intake of breast milk is displaced by use of infant formula milk and that this is an important cause of early breastfeeding cessation, but it is less clear whether early introduction of solid foods has the same effect.
* This paper studied breastfeeding mothers in three large representative UK cohorts completed in the last 25 years and found that mothers most commonly introduced solids in the month prior to the recommended age at that time.
* In all three cohorts introduction of solid foods before 5 months was associated with a shorter duration of breastfeeding and those starting solid foods before 4 months were more likely to stop breastfeeding prematurely.

**INTRODUCTION**

Breastfeeding is important throughout the first year of life, with positive health outcomes in the short ([Horta, 2013](#_ENREF_11)) and long-term ([Kramer et al., 2008](#_ENREF_13)). These protective effects are most pronounced in low and middle income countries, but are also important in high income countries ([Victora et al., 2016](#_ENREF_25)). For this reason, in 2002 the World Health Organization (WHO) recommended breastfeeding exclusively for 6 months, followed by continued breastfeeding with complementary feeding up to 2 years or beyond ([Kramer and Kakuma, 2002](#_ENREF_14)). This position was endorsed by United Kingdom (UK) Department of Health in 2003 ([Health., 2003](#_ENREF_9)), thus deferring the recommended onset of solid feeding (SF) by 2 months from the previous recommendation of 4-6 months. Early on it was suggested that this later introduction of SF could be harmful ([Fewtrell et al., 2010](#_ENREF_7)), but a recent detailed review has found no evidence for this ([SACN, 2018](#_ENREF_21)). Most recently a draft European review has concluded that there is no nutritional benefit from starting solids before 6 months([EFSA, 2019](#_ENREF_6)). Equally, the review suggested that there was no evidence of harm in developed countries, but did not consider the possible impact of early solid feeding on exposure to breast milk.

The use of formula milk has long been known to impact on the duration of breastfeeding ([Hornell et al., 2001](#_ENREF_10), [Maijaliisa Erkkola et al., 2009](#_ENREF_15)); The early introduction of solid foods into the infant's diet will lead to some displacement of breast milk ([Wells et al., 2012](#_ENREF_26)) and thus may increase the likelihood of early termination of breastfeeding ([Noble and Emmett, 2006](#_ENREF_18)). However systematic reviews addressing the influence of other foods and drinks on breastfeeding patterns have not identified enough evidence to draw conclusions about a link between exposure to SF and breastfeeding duration ([Szajewska et al., 2006](#_ENREF_23)) ([Becker and Remmington, 2014](#_ENREF_2)). . Our aim therefore was to undertake a secondary analysis of three large population-based datasets to explore the extent to which starting solids early predicts shorter breastfeeding duration.

**METHODS**

This was a secondary analysis using three large UK longitudinal and population-based studies, from which we identified children who were still receiving breast milk at an age when the introduction of solids could potentially interfere with continued breastfeeding.

The Avon Longitudinal Study of Parents and Children (ALSPAC) studied infants born between 1991-92 ([Boyd et al., 2013](#_ENREF_3), [Fraser et al., 2013](#_ENREF_8)), the Southampton Woman’s Survey (SWS) studied infants born between 1998 and 2007 ([Inskip et al., 2006](#_ENREF_12)) and the Infant Feeding Survey 2010 (IFS) was a UK-wide survey conducted with mothers who gave birth in 2010 ([McAndrew et al., 2012](#_ENREF_17)).

Table 1 compares the main characteristics of the three studies. The ALSPAC and SWS recruited woman who lived in two specific geographical areas in Southern England before they gave birth. In ALSPAC, pregnant women resident in Avon, UK with expected dates of delivery 1st April 1991 to 31st December 1992 were invited to take part in the study. The number of pregnancies enrolled was 14,541 (at least one questionnaire returned or a clinic attended by 19/07/99). Of these pregnancies, there were 14,062 live births and 13,988 children who were alive at 1 year of age. Mothers provided information about themselves and their children via postal questionnaires at 4 weeks, 6 and 15 months after giving birth.[[1]](#footnote-1)

In the SWS, women were recruited before pregnancy, and for those who subsequently became pregnant the resulting children were surveyed at ages 6 months and 1 and 2 years during home visits.

The IFS survey took a representative sample of mothers from all 4 countries of the United Kingdom, with births recorded during August and October 2010. This survey collected data through questionnaires sent to the mothers at infant ages 6, 26 and 38 weeks. In the IFS many mothers dropped out before the 8-month survey point and not all of these had complete breastfeeding information, so the sample included were only those with data from the 8-month survey with complete breastfeeding information([McAndrew et al., 2012](#_ENREF_17))..

**Measures**

Although each study used different questionnaires and survey techniques, for this analysis it was possible to extract comparable infant feeding variables from each dataset, albeit with some minor differences. For the present analysis we included children who were breastfed for at least 8 weeks. In the SWS and ALSPAC cohorts, duration of any breastfeeding and was recorded in completed calendar months, so that children still breastfeeding after 2 completed months were included. In the IFS breastfeeding duration was recorded only in discrete age categories (10 weeks or less, more than 10 weeks and up to 4 months, more than 4 months and up to 5 months, and so on), so infants still breastfeeding at 10 weeks were included. Duration of breastfeeding was recorded till age 24 months for SWS, 15 months for ALSPAC and 9 months for IFS. For all three cohorts the principle outcome of continued breastfeeding at 6 months was used. For SWS and ALSPAC this was defined as 6 months and above, while for IFS it was defined as more than 5 months and up to 6 months, or longer. For ALSPAC and SWS the duration of any breastfeeding was also considered.

The main independent variable for all data sets was the age of SF introduction recorded in weeks. Three possible confounders, which are well known predictors of both breastfeeding duration and solids feeding, were available; two of these, mother’s age and social class, were in all three datasets, while educational level was available for ALSPAC and SWS, although grouped slightly differently. Social class was collected according to the woman’s original employment (Office of Population Censuses Surveys 1990), with 6 ranked groupings used in ALSPAC and SWS, but only 4 for IFS (table 2).

**Analysis**

All statistical analyses were performed using IBM SPSS Statistics 22.0. (IBM corp, 2013).

For all analyses the predictor variable, age of solid food introduction was grouped into three categories: less than 4 months, four to less than five, and five calendar months or more.

To evaluate the effect of solid food introduction on breastfeeding cessation by 6 months Poisson regression with robust variance was used to calculate the prevalence ratio for breastfeeding cessation before 6 months in all three cohorts and the crude and adjusted prevalence ratio obtained from a multivariable analysis.

In addition, in the ALSPAC and SWS datasets survival analysis of the breastfeeding duration variable was undertaken. A new variable to indicate breastfeeding cessation was created, coded 1 (one) for those children who stopped breastfeeding after a known duration and 0 (zero) for those who continued to breastfeed up to the end of the study period (age 24 months for SWS, 15 months for ALSPAC).. Children still being breastfed at the end of the study period, were considered censored cases and contributed proportionally to the median breastfeeding time.

The estimate of breastfeeding median and 95% confidence interval were estimated using the Kaplan Mayer non-parametric estimator. The log rank test was applied to verify the equality of survival distributions between the subgroups of categorical variables, also using Kaplan Mayer non-parametric estimator. In the next step, the risk of breastfeeding cessation from solid food introduction was estimated using Cox’s proportional hazards models to obtain crude and adjusted hazard ratios and their respective confidence intervals, both unadjusted and adjusted for confounding variables. multivariable analyses, All available confounders were included, as they are all well-known predictors of both breastfeeding duration and SF. The proportionality of hazard assumption between the categories of all independent variables was assessed by checking the –ln [-ln(survival)] vs ln(survival time) graphic, derived from survival curves.. The variables that remained parallel over time were assumed to be time-independent and retained in the final Cox model.

**RESULTS**

After applying the inclusion criteria, there were 10,407 infants with breastfeeding duration of 2 months or more: 6,079 from ALSPAC, 1,500 from SWS and 2,828 from IFS; 59% 52% and 56% of these were breastfed to age 6 months or beyond in ALSPAC, SWS and IFS, respectively (table 1). The age of first SF varied markedly between the cohorts with 68% of the ALSPAC sample starting before 4 months, and only 20% and 21%% in the SWS and IFS (table 1). The socio-economic characteristics of the mothers are also shown in supplementary table 1.

In all three cohorts there were univariate associations between breastfeeding duration and age at introduction of solids, as well as with social class, maternal age and educational level (table 2). Using Poisson regression the risk of stopping breastfeeding before 6 months was highest in those starting solids before 4 months and lowest in those deferring until age 5 months and beyond, with little effect of adjustment for maternal sociodemographic characteristics (table 3).

For the ALSPAC and SWS datasets, Kaplan Mayer survival curves demonstrated differences in breastfeeding duration between the 3 subgroups of solid food introduction (log rank test P =0.001 and P<0.001 respectively) (figure 1). The assumption of proportional hazards was not violated. Using Cox’s proportional hazards modelling for ALSPAC and SWS, the hazard ratios for breastfeeding cessation remained higher for children who started solid food before or during the fourth month, with little effect of adjustment for potential sociodemographic confounders (table 4).

**DISCUSSION**

This analysis demonstrates a consistent association between age of first solid feeding and duration of breastfeeding in three different UK cohorts, studied across the period when the recommended age of first SF in the UK increased from 4-6 to 6 months. It has long been recognised that breastfed infants are generally introduced to solids later ([Wright et al., 2004](#_ENREF_27)) and it could easily be assumed that this association reflects confounding, as breastfeeding mothers are generally more affluent and better educated and may well show different adherence to feeding recommendations. However, in our analyses, restricted only to mothers who breastfed for at least 2 months with adjustment for education and occupational class, a dose response association was still found in all three cohorts. A limitation is that we could not adjust for other possible confounders, such as general health seeking behaviour, but as these are themselves likely to show some social gradient, the absence of attenuation after adjustment for socio demographic characteristics suggests that these may not have greatly modified the effect.

Early breastfeeding cessation has been described in the literature as a result of many factors, including health care, socioeconomic, biological, psychological and cultural factors ([Ruowei Li, 2008](#_ENREF_20), [Oakley et al., 2014](#_ENREF_19), [Cohen et al., 2018](#_ENREF_4)). Two recent systematic reviews and a meta-analysis ([Mangrio et al., 2018](#_ENREF_16), [Cohen et al., 2018](#_ENREF_4)) examined various factors associated with breastfeeding initiation and duration, but only focused on socio-demographic factors. Earlier studies have described an association between early solid food introduction and cessation of breastfeeding ([Simard et al., 2005](#_ENREF_22), [Noble and Emmett, 2006](#_ENREF_18)). Noble and Emmett found reduced milk intake associated with solid food introduction in a subsample of breastfed ALSPAC children with food intake recorded, but this was a cross-sectional analysis so total breastfeeding duration was not considered. The present study thus set out to examine this association in large pre-existing cohorts which already held the relevant data, taking a prospective approach and exploring the extent to which this association can be explained by socio-demographic factors.

This study had limitations inherent in a secondary analysis of data which were not collected expressly for this purpose, or for between cohort comparison. The different surveys reported sociodemographic factors differently and solid feeding and breastfeeding information was not collected at exactly the same age or with exactly the same wording. For example, in the SWS, the age for SF was reported in retrospect, and the modal reported age was exactly four months. It seems likely that some of these may actually have started SF just before 4 months, but we had to treat this as 4-5 months for this analysis. We were also not able to use survival analysis for all three studies, but we could apply Poisson analysis to all three.

A strength of our analysis is that, while the three studies used different tools and approaches, they used similar, well standardised methodologies for the collection of the variables required and between them provided over 10,000 breastfeeding infants. This makes this analysis well powered to detect relatively small effect sizes which would nonetheless have important public health implications.

The three cohorts did differ in their sampling methodologies. ALSPAC and SWS were each restricted to one geographical area of the UK, with a high proportion of eligible mothers recruited ([Boyd et al., 2013](#_ENREF_3)) ([Inskip et al., 2006](#_ENREF_12)). In contrast IFS was sampled from throughout the UK, including regions with much lower rates of breastfeeding. Furthermore they oversampled the most deprived mothers in order to achieve reasonable numbers of responses from all social strata ([McAndrew et al., 2012](#_ENREF_17)). However, only around 1/6 of the original sample had sufficient data to be included in this analysis and in their report they stated that they found a lower response rate in areas of higher deprivation and among younger mothers, so the sample was not fully representative of the UK ([McAndrew et al., 2012](#_ENREF_17)). Despite this, the three cohorts had remarkable similar initial breastfeeding rates. IFS had a largest fall off in breastfeeding between birth and our age of inclusion. This was probably because in this analysis the eligible age for inclusion for IFS participants was, by necessity, at 10 weeks, rather than the 8-week cut off used in the other cohorts, as this is a period when breastfeeding rates are falling rapidly in the UK.

The three cohorts represented very different solid feeding eras. In the earliest (ALSPAC), two thirds of children started solids before the age of four months, at time when official advice was to start from 4 months. Since 2003 mothers have been advised to wait till 6 months and never to start before four months and by the time of the last cohort, less than a quarter did so. Generally, the strongest effects were seen in the earliest cohort which was both the largest and had the highest proportion starting solids very early. The strongest association in all cohorts was seen with SF started before 4 months, but even starting between 4 and 5 months was associated with an increased risk of breastfeeding cessation before six months in ALSPAC and IFS, while in both ALSPAC and SWS, SF starting between 4 and 5 months was also associated with an overall shorter breastfeeding duration. This dose response relationship suggest a potentially causal association and the minimal attenuation resulting from adjustment for socio demographic factors makes residual confounding by incompletely measured SE factors unlikely .

A putative mechanism for this is the displacement of milk production by solid food, leading to secondary lactation failure. Infant suckling is one of the most important stimuli to milk production and in its absence, or reduced frequency, milk production is expected to decline. An early observational study found that suckling and breast milk consumption were reduced when solid foods were offered ([Drewett et al., 1987](#_ENREF_5)) and a randomized controlled trial ([Bajaj et al., 2005](#_ENREF_1)) showed an inverse relationship between the energy density of semi-solid foods and energy intake from breast milk. More recently a trial which compared commencement of solids at four versus six months in exclusively breastfed infants and measured breast milk intake using stable isotopes found that those starting solids earlier consumed 10% less than those still exclusively breastfeeding ([Wells et al., 2012](#_ENREF_26)). These demonstrate that infants self-regulate their energy consumption, resulting in breast milk displacement by semi-solid foods. What is not clear is whether this displacement would be sufficient to lead to secondary lactation failure in some instances. A large Swedish cohort study observed reduced breastfeeding frequency after commencement of solids, but no association between time of solid food introduction and duration of breastfeeding ([Hornell et al., 2001](#_ENREF_10)). However only a small proportion of Hornell’s participants introduced solids without also introducing formula milk, so the study would have been underpowered to detect an effect.

Hornell’s study found that most breastfeeding mothers introduced some formula and that this was associated with a much steeper decline in breastfeeding frequency and reduced breastfeeding duration ([Hornell et al., 2001](#_ENREF_10)). Thus an alternative explanation is that starting solids is associated with also starting formula milk and that it was actually the introduction of formula milk at the same time as starting solids that led to earlier cessation. We were not able to test this hypothesis as the cohorts did not have consistent measures of formula intake over time. Even if this is the true underlying mechanism, it would still suggest that deferring the recommended age of first SF would also defer introduction of formula milk. It is also possible that mothers were introducing solids because they were facing challenges with breastfeeding and felt that they did not have enough breastmilk. Only controlled trials can truly test whether the relationship between the age of first solids and breastfeeding duration is causal, and such trials are very rare. However, a recent trial which randomised parents to either conventional complementary feeding or a ‘baby-led approach, where solids were introduced significantly later, did find breastfeeding duration was four weeks longer in the baby-led group ([Taylor et al., 2017](#_ENREF_24)).

These three surveys illustrate the effect of different recommendations for solid food introduction on actual practice. ALSPAC was conducted well before and SWS mainly before 2003, when the recommendation for starting SF was still specified as “from 4-6 months”, and in these surveys a majority of breastfeeding mothers actually started SF before four months. IFS in contrast, conducted 7 years after the change in recommendation to delay SF until six months, showed a much later average age of first solids. In IFS report the authors were able to compare age of SF in a series of their surveys before and after the change in recommendation in 2003 and showed a marked increase in age of first solids immediately after that date ([McAndrew et al., 2012](#_ENREF_17)). While much else may have changed in the intervening years, this rapid change demonstrated the effect of the consistent public health message that was adopted in the UK after 2003([McAndrew et al., 2012](#_ENREF_17)). However, while nearly half of mothers in IFS delayed until beyond 5 months, very few did so beyond 6 months. If all mothers most commonly introduce solids in the month prior to the then recommended age, any relaxation in the recommended age is likely to result in much early SF. This is important not only in terms of breastfeeding duration, but also because early solid food introduction has also been independently associated with other health risks ([Wright et al., 2004](#_ENREF_27)).

In conclusion, evidence from three large surveys consistently demonstrates that early introduction of solid feeding predicts a shorter breastfeeding duration and suggests that deferring SF is important to sustain breastfeeding. This confirms the importance for public health of maintaining consistent messages to parents that solid feeding should be delayed until 6 months and the importance of continued breastfeeding after solids have started ([SACN, 2018](#_ENREF_21)).

References

Bajaj M., Dubey A.P., Nagpal J., Singh P.K. & Sachdev H.P. (2005) Short-term effect of oil supplementation of complementary food on total ad libitum consumption in 6- to 10-month-old breastfed Indian infants. *J Pediatr Gastroenterol Nutr* **41,** 61-65.

Becker G.E. & Remmington T. (2014) Early additional food and fluids for healthy breastfed full‐term infants. *Cochrane database of systematic reviews*.

Boyd A., Golding J., Macleod J., Lawlor D.A., Fraser A., Henderson J., et al. (2013) Cohort Profile: the 'children of the 90s'--the index offspring of the Avon Longitudinal Study of Parents and Children. *Int J Epidemiol* **42,** 111-127.

Cohen S.S., Alexander D.D., Krebs N.F., Young B.E., Cabana M.D., Erdmann P., et al. (2018) Factors Associated with Breastfeeding Initiation and Continuation: A Meta-Analysis. *J Pediatr* **203,** 190-196 e121.

Drewett R.F., Phil D., Payman B.C. & Whiteley S. (1987) Effect of Complementary Feeds on Sucking and Milk Intake in Breastfed Babies: An Experimental Study. *Journal of Reproductive and Infant Psychology* **5,** 133-143.

EFSA (2019) Public consultation on the draft scientific opinion on the appropriate age for the introduction of complementary feeding into an infant’s diet. EFSA Panel on Nutrition.

Fewtrell M., Wilson D.C., Booth I. & Lucas A. (2010) Six months of exclusive breast feeding: how good is the evidence? *BMJ* **342,** c5955.

Fraser A., Macdonald-Wallis C., Tilling K., Boyd A., Golding J., Davey Smith G., et al. (2013) Cohort Profile: the Avon Longitudinal Study of Parents and Children: ALSPAC mothers cohort. *Int J Epidemiol* **42,** 97-110.

Health. D.o. (2003) Infant Feeding Recommendation.

Hornell A., Hofvander Y. & Kylberg E. (2001) Solids and formula: association with pattern and duration of breastfeeding. *Pediatrics* **107,** E38.

Horta B.L., Victora, Cesar G. (2013) Short-term effects of breastfeeding: a systematic review on the benefits of breastfeeding on diarrhoea and pneumonia mortality.

Inskip H.M., Godfrey K.M., Robinson S.M., Law C.M., Barker D.J., Cooper C., et al. (2006) Cohort profile: The Southampton Women's Survey. *Int J Epidemiol* **35,** 42-48.

Kramer M.S., Aboud F., Mironova E., Vanilovich I., Platt R.W., Matush L., et al. (2008) Breastfeeding and child cognitive development: new evidence from a large randomized trial. *Arch Gen Psychiatry* **65,** 578-584.

Kramer M.S. & Kakuma R. (2002) Optimal duration of exclusive breastfeeding. *Cochrane.Database.Syst.Rev.***,** CD003517.

Maijaliisa Erkkola M.S., Carina Kronberg-Kippila, Suvi Ahonen,, Tuula Arkkola L.U., Pirjo Pietinen, Riitta Veijola, Mikael Knip and & Suvi M Virtanen (2009) Determinants of breast-feeding in a Finnish birth cohort. *Public Health Nutr* **13,** 9.

Mangrio E., Persson K. & Bramhagen A.C. (2018) Sociodemographic, physical, mental and social factors in the cessation of breastfeeding before 6 months: a systematic review. *Scand J Caring Sci* **32,** 451-465.

McAndrew F., Thompson J., Fellows L., Large A., Speed M. & Renfrew M. (2012) Infant Feeding 2010.

Noble S. & Emmett P. (2006) Differences in weaning practice, food and nutrient intake between breast- and formula-fed 4-month-old infants in England. *Journal of human nutrition and dietetics : the official journal of the British Dietetic Association* **19,** 303-313.

Oakley L.L., Henderson J., Redshaw M. & Quigley M.A. (2014) The role of support and other factors in early breastfeeding cessation: an analysis of data from a maternity survey in England. *BMC Pregnancy Childbirth* **14,** 88.

Ruowei Li S.B.F., Jian Chen, MSca, Laurence M. Grummer-Strawn (2008) Why Mothers Stop Breastfeeding: Mothers’ Self-reported Reasons for Stopping During the First Year. *Pediatrics* **122,** 7.

SACN (2018) *Feeding in the first year* Public Health England London.

Simard I., O'Brien H.T., Beaudoin A., Turcotte D., Damant D., Ferland S., et al. (2005) Factors influencing the initiation and duration of breastfeeding among low-income women followed by the Canada prenatal nutrition program in 4 regions of quebec. *J Hum Lact* **21,** 327-337.

Szajewska H., Horvath A., Koletzko B. & Kalisz M. (2006) Effects of brief exposure to water, breast-milk substitutes, or other liquids on the success and duration of breastfeeding: a systematic review. *Acta Paediatr* **95,** 145-152.

Taylor R.W., Williams S.M., Fangupo L.J., Wheeler B.J., Taylor B.J., Daniels L., et al. (2017) Effect of a Baby-Led Approach to Complementary Feeding on Infant Growth and Overweight: A Randomized Clinical Trial. *JAMA Pediatr* **171,** 838-846.

Victora C.G., Bahl R., Barros A.J., Franca G.V., Horton S., Krasevec J., et al. (2016) Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. *Lancet* **387,** 475-490.

Wells J.C., Jonsdottir O.H., Hibberd P.L., Fewtrell M.S., Thorsdottir I., Eaton S., et al. (2012) Randomized controlled trial of 4 compared with 6 mo of exclusive breastfeeding in Iceland: differences in breast-milk intake by stable-isotope probe. *Am J Clin Nutr* **96,** 73-79.

Wright C.M., Parkinson K.N. & Drewett R.F. (2004) Why are babies weaned early? Data from a prospective population based cohort study. *Arch.Dis.Child* **89,** 813-816.

Table 1: Main characteristics of the three studies

|  |  |  |  |
| --- | --- | --- | --- |
|  | **ALSPAC** | **SWS** | **IFS-2010** |
| Years of birth of infants  | 1991-1992 | 1998-2008 | 2010-2011 |
| Location | South West of England | Southampton | Across UK |
| Number of participants | 13,988 | 3158 | 10768 (2nd stage) |
| Number of participants with breastfeeding information | 10256 | 2873 | 7875 |
| Number % who ever breastfed  | 7669 (75%) | 2347 (82%) | 5676 (72%) |
| Number (%) of cohort still breastfeeding at age 8 weeks (10 weeks for IFS- 2010) | 6079 (59%) | 1500 (52%) | 2828 (36%) |
| Recruitment | In pregnancy | Prior to pregnancy | After birth |
| Age of first solid feeding  | N=6031 | N=1467 | N=2749 |
| < 4months4 months≥5months  | 4092 (68%)1641 (27%)298 (5%) | 289 (20%)807 (55%)371 (25%) | 577 (21%)875 (32%)1297 (47%) |
| Breast feeding duration2-3 completed months\*4-5 completed months6 or more months | N=60791525 (25%)960 (16%)3594 (59%) | N=1500351 (23%)370 (25%)779 (52%) | N=2828775 (27%)464 (16%)1589 (56%) |

\* In IFS bands are 10 weeks to 4 months, >4 to 5 months and >5 months

Table 2: Number (%) of participants who had been breastfeeding at age 8-10 weeks who were still breastfeeding at or beyond 6 months\*, by age of first solids feeding, maternal age, education and social class.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Predictor | **ALSPAC**Number (%) | **P4** | **SWS**Number (%) | **P4** | **IFS**Number (%) | **P4** |
| Overall | 3594 (59.1) |  | 779 (51.9) |  | 1589 (56.2)5 |  |
| Solid food introduced< 4months4 months≥5months  | 2218 (54.2)1120 (68.3)230 (77.2) | *<*0.001 | 130 (45.0)419 (51.9)202 (54.4) | 0.019 | 297 (51.5)491 (56.1)755 (58.2) | 0.008 |
| Mother’s age24y or less25 to 34y35y or more | 313 (43.4)2707 (59.7)574 (69.5) | *<*0.001 | 24 (32.0)619 (52.3)136 (56.2) | 0.003 | 130 (53.3)1036 (56.5)420 (56.5) | 0.630 |
| Mother’s highest educational qualificationsNone / CSE1Vocational training1O level1A level2HND3University degree | 297 (48.4)191 (47.3)1001 (51.4)1093 (37.4)-953 (76.2) | 0.0001 | 40 (38.5)-137 (40.8)223 (49.6)68 (53.5)308 (64.2) | <0.001 | - |  |
| Social Class – MaternalProfessionalManagement/technicalSkilled non-manualSkilled manualPartly skilledUnskilled | 363 (78.1)1280 (63.8)1038 (52.4)159 (56.0)206 (55.5)32 (57.1) | <0.001 | 64 (66.7)336 (54.5)229 (46.9)51 (49.5)72 (50.0)7 (36.8) | 0.003 | - |  |
| Social Class – MaternalProfessional/ManagerialIntermediate occupationsRoutine/manual occupationsNever worked | - |  | - |  | 902 (58.6)272 (54.3)249 (51.7)44 (46.8) | 0.0011 |

1Completed by age 16  2Completed at age 18 3Equivalent to two years at university 4 Chi2 linear trend

5In ALSPAC and SWS this was the number still feeding at or beyond 6 completed months. For IFS this was the number still feeding beyond 5 months and up to 6 months, or beyond.

Table 3: Unadjusted and mutually adjusted prevalence ratio (PR) for stopping breastfeed before age 6 months at different ages of solid food introduction. IFS-2010, ALSPAC and SWS.

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictor**  | **ALSPAC** | **SWS** | **IFS-2010** |
| Crude PR (95% CI) | Adjusted PR4(95% CI) | Crude PR(95% CI) | Adjusted PR4(95% CI) | Crude PR(95% CI) | Adjusted PR4(95% CI) |
| Solid food introduction< 4 months4-5 months≥5 months | 2.18 (1.7-2.8)1.45 (1.1-1.9)1 | 1.90 (1.5-2.4)1.37 (1.1-1.8)1 | 1.19 (1.0-1.4)1.05 (0.9-1.2)1 | 1.16 (1.0-1.4)1.04 (0.9-1.2)1 | 1.16 (1.0-1.3)1.05 (0.9-1.2)1 | 1.14 (1.0-1.3)1.05 (0.9-1.2)1 |
| Mother’s age<25 years25 to 34 years>34 years | 1.91 (1.7-2.2)1.36 (1.2-1.5)1 | 1.42 (1.2-1.6)1.21 (1.1-1.4)1 | 1.51 (1.2-1.9)1.09 (0.9-1.3)1 | 1.24 (1.0-1.6)1.07 (0.9-1.2)1 | 1.06 (0.9-1.3)1.00 (0.9-1.1)1 | 0.95 (0.8-1.1)0.97 (0.9-1.1)1 |
| Mother’s qualificationCSE/vocational1O Level1A Level2Degree /HND | 2.20 (1.9-2.5)2.10 (1.9-2.3)1.58 (1.4-1.8)1 | 1.84 (1.6-2.1)1.73 (1.5-2.0)1.41 (1.2-1.6)1 | 1.58 (1.3-1.9)1.57 (1.4-1.8)1.33 (1.2-1.5)1 | 1.56 (1.3-1.9)1.52 (1.3-1.8)1.31 (1.3-1.5)1 | - | - |
| Mother’s social class3Partly skilled/unskilledManual skilledNon-manual skilledManagerial/technical/Professional | 2.01 (1.6-2.5)2.03 (1.6-2.5)2.19 (1.8-2.7)1.66 (1.4-2.0)1 | 1.17 (0.9-1.5)1.20 (0.9-1.5)1.34 (1.1-1.6)1.27 (1.0-1.5)1 | 1.54 (1.1-2.1)1.57 (1.1-2.2)1.62 (1.2-2.2)1.38 (1.0-1.8)1 | 1.13 (0.8-1.6)1.15 (0.8-1.6)1.22 (0.9-1.7)1.23 (0.9-1.7)1 | 1.24 (1.0-1.5)1.19 (1.1-1.3)1.08 (1.0-1.2)1 | 1.23 (1.0-1.5)1.18 (1.1-1.3)1.07 (1.0-1.2) |

1Completed by age 16  2Completed at age 18

3IFS-2010 classification: managerial/professional, intermediate occupational, routine/manual occupational and never worked 4all the variables shown included in the adjusted model

Table 4: Crude and adjusted Hazard Ratio (HR) and Confidence Interval for Breastfeeding cessation, in ALSPAC and SWS cohorts.

|  |  |  |
| --- | --- | --- |
| **Predictor**Solid food introduction | **ALSPAC** | **SWS** |
| HR1(95% CI) | HR2(95% CI) | HR1(95% CI) | HR2(95% CI) |
| < 4 months4-5 months≥5 months | 2.10(1.8-2.4)1.52(1.3-1.7)1 | 2.07(1.8-2.4)1.51**(**1.3-1.8)1 | 1.32(1.1-1.5)1.15(1.0-1.3)1 | 1.25(1.1-1.5)1.15(1.0-1.3)1 |
| Mother’s age<25 years25 to 34 years>34 years | 1.85 (1.7-2.1)1.38 (1.2-1.5)1 | 1.50 (1.3-1.7)1.25 (1.1-1.4)1 | 1.9 (1.5-2.6)1.2 (1.0-1.4)1 | 1.60 (1.2-2.1)1.17 (1.1-1.4)1 |
| Mother’s qualificationCSE/vocationalO levelA leveldegree | 1.46 (1.3-1.6)1.47 (1.4-1.6)1.22 (1.1-1.3)1 | 1.3 (1.2-1.5)1.3 (1.1-1.4)1.1 (1.0-1.3)1 | 1.43 (1.6-1.7)1.32 (1.1-1.5)1.25 (1.1-1.4)1 | 1.53 (1.2-1.9)1.45 (1.2-1.7)1.34 (1.2-1.5)1 |
| Mother’s social classPartly/unskilledManual skilledNon-manual skilledManager/technicalProfessional | 1.33 (1.2-1.5)1.34 (1.1-1.6)1.48 (1.3-1.6)1.19 (1.1-1.3)1 | 1.0 (0.9-1.1)1.1 (0.9-1.3)0.98 (0.8-1.2)0.97 (0.8-1.1)1 | 1.09 (0.9-1.4)1.13 (0.9-1.4)1.20 (0.9-1.6)1.15 (0.9-1.5)1 | 0.9 (0.6-1)0.9 (0.7-1.3)0.9 (0.7-1.1)1.0 (0.8-1.2)1 |

1 Unadjusted 2 mutuallyadjusted for all variables

Figure 1 – Cumulative probability of being breastfed according to the age of solid food introduction, ALSPAC (a) and SWS (b).



**Supplementary information Table S1 - Questions in each original questionnaire for building information about breastfeeding duration and solid food introduction**

|  |  |
| --- | --- |
| **IFS-2010** |  |
| Breastfeeding duration | Solid food introduction |
| **Section 2: About the milk that you give your baby** | **Section 4: About other drinks and food that you may give to your baby** |
| Q8. Has your baby EVER been given breast milk (via syringe, bottle or cup etc.) or have you put your baby to the breast, even if this was only once?Q9. How old was your baby when he/she was LAST given breast milk or you put them to your breast? Please write the age in the appropriate box Either in daysOR In whole weeks plus any additional days: | Section 4: About other drinks and food that you may give to your babyQ36. Has your baby ever had any foods such as cereal, rusks, baby rice, fruit, vegetables or any other kind of solid food?Q37. How old was your baby when he/she first had any food apart from milk? Please write a number in the box Please write in the age to the nearest whole weekQ38. At present, are you regularly giving your baby cereal, rusks, baby rice or any other solid food? |
| **SWS** |  |
| **6 MONTH INFANCY QUESTIONNAIRE** | **6 MONTH INFANCY QUESTIONNAIRE** |
| 1 MILK OR FORMULA FEEDING 1.1 Did you ever put your baby to the breast, even for a single feed?1.4 Are you still breast feeding?1.5 How old was your baby when he/she last had a breast feed?or On what date did he/she last have a breast feed? | 4 INTRODUCTION OF FOODS AND SUPPLEMENT USE4.1 How old was he/she when solids were first regularly introduced?or On what date were solids first regularly introduced? |
| **12 MONTH INFANCY** **QUESTIONNAIRE**  | **12 MONTH INFANCY** **QUESTIONNAIRE**  |
| 1 MILK OR FORMULA FEEDING * 1. Was he/she breast fed after the age of 6 months?
	2. Are you still breast feeding?

1.4 How old was your baby when he/she last had a breast feed? or On what date did he/she last have a breast feed?  | 3 INTRODUCTION OF FOODS3.1 Was he/she eating solid foods by 6 months of age? 3.2 How old was he/she when solids were first regularly introduced?or On what date were solids first regularly introduced?  |
| **24 MONTH CHILD** **QUESTIONNAIRE**  |  |
| 1. MILK OR FORMULA FEEDING
	1. Are you still breast feeding?

16.3 How old was your baby when he/she last had a breast feed? or On what date did he/she last have a breast feed?  | - |
| **3 YEAR CHILD****QUESTIONNAIRE**  |  |
| 1. FOOD FREQUENCY 1.2 \* Which types of milk has your child used regularly in drinks and added to breakfast cereals over the past 3 months? *(list up to 3 below)*  | - |
| ALSPAC |  |
|  | **Solid food introduction** |
| **MY YOUNG BABY - 4 week** |  |
| SECTION B:FEEDINGB1. How have you fed your baby since she was born? Please indicate for each of the times given.1. First 24 hours b) Rest of 1st week c) 2nd week d) 3rd week e) 4th week

B4. a) How is your baby being fed at the moment? breast 1 Bottle 2 breast and bottle 3 other 4 | - |
| **MY DAUGHTER/SON - 6 months** | **MY DAUGHTER/SON - 6 months** |
| SECTION C:FEEDINGC1. Has your baby ever had the following:Age started1. bottle of ordinary b) powdered follow-on c) soya milk d) goat's milk e) hypo-allergenic f) ordinary cow's milk C2. Did you breast feed?

Yes, I am still breast feeding Yes, I breast fed 2 How old was the baby months weeks but have now stopped when you stopped? I never breast fed | SECTION C:FEEDINGC3.a) In how many meals a day does she eat solids now? |
| **MY INFANT SON/DAUGHTER - 15 months** | **MY INFANT SON/DAUGHTER - 15 months** |
| SECTION D:FEEDINGD2. Was he/she breast fed?Yes, he/she is still being breast fed Yes, was breast fed but now stopped How old was he/she when months breastfeeding stopped? He/She was never breast fed  | D20. Babies first solid meals are usually a puree. When did your child first start having meals with lumps in? Age started (months) |

Supplementary Table 2 – Variables available on the dataset and its categorization in the Survival Analysis

|  |  |  |
| --- | --- | --- |
| **ALSPAC** |  |  |
| **Variable**  | **Label** | **Categorization** |
| **Outcomes** |
| Time\_kc403a | Time in months - ALSPAC | In months, continuous from 2mo |
| Status\_kc403a | Status | Censored (0)Event (1) |
| **Predictors** |  |  |
| kbagesolid\_teste | Solid food introduction | <4mo (0)≥4mo and <5mo (1)≥5mo (2) |
| Mother\_Age\_mz028b | Mother's age | <25y (0)25 to 34y (1)≥35y (2) |
| Mother\_Qualification\_c645a | Mother's qualification | CSE-Vocational (0)O level (1)A level (2)Degree (3) |
| Social\_Class\_755 | Mother’s social class | V unskilled- IV partly skilled (1) III skilled manual (2)III skilled no-manual (3)II management-technical (4)I Professional (5) |
| **Outcome** |
| Time\_agelbfm | Time in months - SWS | In months, continuous from 2mo |
| Status\_agelbfm | Status | Censored (0)Event (1) |
| agelbfm15mo | Time in months 1 | In months, continuous from 2mo.To be equal time as ALSPAC. All children who had BF beyond the 15mo were coded as censored.  |
| **Predictors** |  |  |
| Solid\_introduction\_agesld | Solid food introduction | <4mo (0)≥4mo and <5mo (1)≥5mo (2) |
| jwage1  | Mother's age | <25y (1)25 to 34y (2)≥35y (3) |
| awexam1 | Mother’s qualification | CSE-none (1)O level (2)A level (3)HND-Degree (4) |
| Social\_Class\_awsc | Mother’s social class | IV partly skilled-V unskilled (1)III skilled manual (2)III skilled no-manual (3)II management/technical (4)I professional (5) |

Supplementary Table 3- Variables available on the dataset and its categorization in the Poisson Regression

|  |  |  |
| --- | --- | --- |
| **ALSPAC** |  |  |
| **Variable**  | **Label** | **Categorization** |
| **Outcome** |
| kc403a1  | BF prevalence at 6mo | Yes (0)No (1) |
| Kc403x  | Breastfeeding duration  | In months  |
| BF\_3\_categories | BF 3 categories (excluded BF<2mo) | <4mo (1)≥4mo and ≤6mo (2)>6mo (3) |
| **Predictors** |  |  |
| kbagesolidx | Solid food introduction x | ≥5mo (0)≥4mo and <5mo (1)<4mo (2) |
| mz028\_x1 | Mother's age x1 | ≥35y (0)25 to 34y (1)≤24y (2) |
| c645b\_Mother\_qualification | Mother's qualification | Degree (0)A level (1)O level (2)Vocational-CSE (3) |
| c755b\_social\_class | Mother's social class | I Professional (0)II management-technical (1)III skilled no-manual (2)III skilled manual (3)IV partly skilled/unskilled (4)  |
| **SWS** |
| **Outcome** |
| agelbfm1 | BF prevalence at 6m | Yes (0)No (1) |
| agelbfm  | Age last breast fed, completed months  | In months  |
| BF\_3\_categories | BF 3 categories (excluded BF<2mo) | <4mo (1)≥4mo and ≤6mo (2)>6mo (3) |
| **Predictors** |  |  |
| agesldx | Solid food introduction x | ≥5mo (0)≥4mo and <5mo (1)<4mo (2) |
| jwagex | Mother’s age x | ≥35y (0)25 to 34y (1)≤24y (2) |
| awexam1 | Mother's qualification | Degree/HDN (0)A level (1)O level (2)CSE-none (3) |
| awsc1 | Mother's social class | I professional (0)II management/technical (1)III skilled no-manual (2)III skilled manual (3)IV partly skilled/ unskilled (4) |
|  |
| Q61 | BF prevalence 6mo | Yes (0)No (1) |
| Q6 | Q6. How old was your baby when he/she was LAST given breast milk or you put them to your breast? | 8 categories (from up to 10w to more than 9mo)The category 9 (not stated) was converted in missing |
| BF\_3\_categories | BF 3 categories (excluded BF<2mo) | <4mo (1)≥4mo and ≤6mo (2)>6mo (3) |
| Q363 | Solid Food Introduction new | ≥5mo (0)≥4mo and <5mo (1)<4mo (2) |
| mage21 | Mothers age 1 | ≥35years (0)25 to 34years (1)≤24years (2) |
| nssec31 | Mother’s social class1 | Managerial-professional (0)intermediate occupational (1) routine/manual occupation (2)never worked (3) |

1. Please note that the study website contains details of all the data that is available through a fully searchable data dictionary and variable search tool" and reference the following webpage: http://www.bristol.ac.uk/alspac/researchers/our-data/ [↑](#footnote-ref-1)