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Original Article

Introduction of complementary foods with respect to French guidelines: description and associated socio-economic factors in a nationwide birth cohort (Epifane survey)

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Abstract

We described the introduction of complementary food (ICF) during the first year of life and identify associations observed with maternal and infant characteristics. We studied 3368 children included in the Epifane cohort, France, 2012. Maternal and infant characteristics and age at introduction of 28 complementary foods were collected at birth and at 1, 4, 8 and 12 months. Kaplan–Meier plots were used to represent probabilities of ICF. A score was used as tertiles in multinomial logistic regression to identify maternal and infant factors associated with ICF agreement with French recommendations. Median age of ICF was 152 days. While 12.6% of infants received complementary food before the age of 4 months, 95% of them were introduced after 7 months. Recommendations were generally followed, except for eggs and added fats, introduced in only 23.2% and 53.1% of 1-year-old infants, respectively. Factors significantly associated with the first ICF score tertile (low agreement with recommendations) vs. third tertile were as follows: maternal age 18–24 years (OR = 2.24 [1.49–3.35]) or 25–29 years (OR = 1.57 [1.21–2.04]), education less than or equal to high school graduation (OR = 1.94[1.51–2.48]), birthplace in France (OR = 2.13 [1.41–3.21]), three or more children (OR = 1.70 [1.15–2.51]), no follow-up antenatal classes (OR = 1.58 [1.22–2.04]), unemployment before and after pregnancy (OR = 1.64 [1.04–2.59]), unemployment before pregnancy and return to work within 12 months (OR = 2.06 [1.05–4.02]), no breastfeeding (OR = 2.08 [1.55–2.79]) or lasting <28 days (OR = 1.68 [1.22–2.31]) or 1–4 months (OR = 1.45 [1.08–1.96]). Recommendations concerning complementary food were generally followed. However, guidelines should be clarified and adapted to families who have difficulties in adopting them.

Keywords: complementary food, birth cohort, social inequalities, national sample, infant feeding recommendations, socio-economic factors.

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Introduction

Appropriate feeding is essential during the first years of life to ensure optimal growth (Agostoni *et al.* 2008). The infant's nutritional needs in macronutrients and micronutrients, along with digestive, renal and psychomotor maturation, must be taken into account to ascertain the optimal age for complementary feeding and the sequence of introduction of complementary foods (ICF) (Agostoni *et al.* 2008). ICF before 4 months may be associated with greater risk of diarrhoea (Wright *et al.* 2004). Moreover, introduction of four or more types of food before the age of 4 months has been shown to be associated with increased risk of repeated episodes of eczema at the ages of 2 and 10 years (Fergusson *et al.* 1990). In addition, a US study performed in the early 2000s on infants who had never been breastfed, or who had been weaned before the age of 4 months, showed an association between introduction of solids before the age of 4 months and increased risk of obesity at 3 years of age (Huh *et al.* 2011). Nevertheless, late introduction, after 7 months, also appears to be deleterious, especially regarding cereal grain-based products (Poole *et al.* 2006) and gluten-containing foods (Szajewska *et al.* 2012). Exclusive breastfeeding is recommended until 6 months (Agostoni *et al.* 2008; World Health Organization 2003); after this age, it is not sufficient to provide adequate amounts of macronutrients and micronutrients (Agostoni *et al.* 2008).

To promote breastfeeding, the World Health Organization recommends an exclusive breastfeeding until 6 months then to begin ICF while breastfeeding until 2 years old (World Health Organization 2003). The European Society for Pediatric Gastroenterology, Hepatology and Nutrition recommends an ideal age window, between 17 and 26 weeks, for complementary feeding, defined as 'all solid and liquid foods other than breastmilk or infant formula or follow-up formula' (Agostoni *et al.* 2008). Despite this, after 4 months, 37% of formula-fed infants and 17% of breastfed infants in European countries were introduced to complementary food (Schiess *et al.* 2010). In Canada, in 2003, 86% of infants ate complementary food daily at 4 months (Dubois & Girard 2003). In the United States, 21% of mothers introduced solid foods before 4 months (Fein *et al.* 2008). To clarify such behaviours, a number of studies have focused on risk factors in early ICF. These predictors are low maternal age, low education level or low socio-economic status, smoking and short breastfeeding duration (Kronborg *et al.* 2014; Rebhan *et al.* 2009; Tarrant *et al.* 2010; Tromp *et al.* 2013). Few studies have investigated infant feeding patterns and associated maternal and infant characteristics (Betoko *et al.* 2013; Grummer-Strawn *et al.* 2008; Wen *et al.* 2014). In France, international recommendations have been adapted by the National Nutrition and Health Program (PNNS) into practical applications for parents ('MangerBouger'; Programme National Nutrition Santé 2015). French guidelines recommend introduction of foods complementary to breast milk or formula preferably at 6 months of age, but never before 4 months. A table included in all child health booklets indicates the recommended ages for introduction of a set of complementary foods.

Up until now, studies describing, in a national sample, infant feeding practices and their agreement with national recommendations are scarce, especially in France. In addition, we hypothesized that mothers whose infant feeding practices differed most from recommendations were those in the most unfavourable socio-economic position. Based on data from the Epifane survey, our aims were to describe ages for ICF during the first year of life and to identify maternal and infant factors associated with practices according to their agreement with the recommendations.

Subjects and methods

Sampling

Epifane is a national prospective cohort study and comprises 3368 mother–infant dyads using a random sample. Based on attrition observed during a pilot study performed in 2010, the sample size to be included was set initially at 3500 mother–infant dyads ('dyads') and enabled participation of approximately 3000 subjects at 12 months. The sampling design was also split into two steps. In the first step, 136 maternity wards were randomly selected throughout mainland France proportionally to the number of deliveries. This sampling was stratified on private/public status,

Key messages

- Recommendations to parents and health professionals concerning the optimal moment for introducing each complementary food during the first year of life must be clarified. They should also emphasize the importance of introducing good quality added fats.
- Concordance of complementary feeding behaviour with recommendations differs according to socio-economic factors.
- The role of health care professionals in contact with parents is essential for providing advice concerning complementary feeding while taking into account the child and family uniqueness.

equipment level of the maternity hospital (three levels) and on five geographic areas (Ile-de-France, Northeast, Northwest, Southeast and Southwest). Using a day chosen for each maternity ward between January and April 2012, midwives selected dyads for inclusion 1 or 2 days after delivery, after ascertaining eligibility criteria and participation agreement. Recruitment was exhaustive up until inclusion of 25 dyads. Eligibility criteria for mothers were age over 18, not institutionalized, able to speak, read or write French or to get help from someone who could. The newborn had to be born at 33 amenorrhoea weeks or more, without severe pathology requiring hospitalization. Dyads were followed up from birth until the child's first birthday. The Epifane survey received the approval of the Advisory Committee for Data Processing in Health Research (CCTIRS, registration no. 11.335) and that of the French Data Protection Authority (CNIL, authorization no. 911 299).

Maternal socio-economic characteristics and birth conditions

Information on socio-economic characteristics was collected using a questionnaire self-completed by the mothers at the maternity ward. Maternal body mass index before pregnancy was calculated using self-reported weight and height. Information on birth conditions was noted in an additional questionnaire by the midwife from the health record.

Dietary data

In addition to infant feeding mode collected in the maternity ward, mothers were interviewed at 1, 4, 8 and 12 months after delivery by interviewers trained by the Perinatal surveillance and nutritional epidemiology unit (USPEN) research team. They used computer-assisted telephone interviews (CATI) enabling direct controls. Specifically designed for the Epifane survey, questionnaires had been tested previously in a pilot study. Data collected were related to infant anthropometric data, average daily number of feeds or baby bottles and the child's age, in days, at the time of breastfeeding cessation and at the time of ICF for 28 foods. At 1, 4, 8 and 12 months, the interviewer asked whether each complementary food was simply tasted or regularly introduced. The mother herself estimated the date when the food was regularly consumed. The age at the beginning was collected in months and days. In order to detect inconsistencies in the collected ages of introduction, answers from consecutive interviews were compared and confirmed by the mother. The 28 complementary foods were then grouped into 12 PNNS food groups (Table 1). When at least one food was regularly consumed, we considered this to constitute introduction of one PNNS food group.

Computation of the variable ICF score

To identify infant and maternal characteristics associated with age of ICF inconsistent with PNNS recommendations, we created an 'a priori' score based on these recommendations (Table 1). One point was subtracted when complementary food was introduced before or at 115 days. A point was subtracted if food was introduced prior to the age of the PNNS recommendation. One point was added when a food group was introduced between its recommended age and 1 year (Table 1). If it was not introduced before 1 year, one point was subtracted. PNNS guidelines also give recommendations concerning milk intake during the period of ICF. Either breast milk or formula, but not cow's milk or other milk not meant for infant feeding, remains the infant's basic food source during this first year. One point was therefore subtracted when both breastfeeding and formula feeding were stopped before the age of 1 year. If a mother introduced all group foods before their recommended ages and stopped breast milk or formula milk before 1 year, she lost 19 points. On the contrary, if a mother introduced all groups of foods recommended during the first year of life at the recommended ages, 8 points were attributed. To avoid a negative final score, an initial score of 19 was attributed; thus, the minimum score was 0, and the maximum score was 27.

Statistics

Weights were first calculated so as to take into account inclusion probabilities. In order to provide statistical estimates representative of the source population, marginal calibration was then performed on maternal age, matrimonial status, level of education and type of pregnancy according to the percentage observed in

Table 1. Introduction of complementary food score according to PNNS guidelines

Group of foods in PNNS	Foods in Epifane questionnaires	Recommended age of introduction for each group	Scoring criteria according to age of introduction	Score*
Dairy	Infant dairy products	Could be introduced between 4 and 6 months;	<115 days	−1
			[115–365 days]	+1
	Regular dairy products	must be introduced before 12 months	Not introduced at 365 days	−1
Fruits	Cooked fruits	Could be introduced between 4 and 6 months;	<115 days	−1
			[115–365 days]	+1
	Raw fruits	must be introduced before 12 months	Not introduced at 365 days	−1
Vegetables	Cooked/Raw vegetables	Could be introduced between 4 and 6 months;	<115 days	−1
			[115–365 days]	+1
	Meal including meat and vegetables	must be introduced before 12 months	Not introduced at 365 days	−1
	Meal including fish and vegetables			
Potatoes	Potatoes	Could be introduced between 4 and 6 months;	<115 days	−1
	Meal including meat and vegetables	must be introduced before 12 months	[115–365 days]	+1
			Not introduced at 365 days	−1
	Meal including fish and vegetables			
Fish/meat	Meat/Fish	Could be introduced between 4 and 6 months;	<115 days	−1
	Meal including meat and vegetables	must be introduced before 12 months	[115–365 days]	+1
	Meal including fish and vegetables		Not introduced at 365 days	−1
Infants cereals	Infant cereals without/With gluten	Could be introduced between 4 and 6 months	<115 days	−1
	Infants cereals with formula milk	but introduction is not necessary		
Cereal products	Bread	Could be introduced after 6 months;	<115 days	−1
	Infant biscuits		<176 days	−1
	Pasta rice, semolina	must be introduced before 12 months	[176–365 days]	+1
			Not introduced at 365 days	−1
Eggs	Egg yolk	Could be introduced after 6 months;	<115 days	−1
	Egg white	must be introduced before 12 months	<176 days	−1
			[176–365 days]	+1
			Not introduced at 365 days	−1
Added fats	Butter	Could be introduced after 6 months;	<115 days	−1
			<176 days	−1
	Added fats in seasoning	must be introduced before 12 months	[176–365 days]	+1
			Not introduced at 365 days	−1
Sugar products	Breakfast cereals	Introduction not necessary during the first year and not recommended before 6 months	<115 days	−1
	Regular biscuits		<176 days	−1
Cow's milk	Whole, semi-skimmed, skimmed milk and chocolate milk	Introduction not recommended during the first year of life	<115 days	−1
			<365 days	−1
Legumes	Legumes	Introduction not recommended during the first year of life	<115 days	−1
			<365 days	−1
Infant milk	Breast/Formula milk	Infant milk recommended during the first year	Stop infant milk before 365 days	−1

*Initial score = 19, minimal score = 0, maximum score = 27.

the French National Perinatal Survey (ENP) 2010 (Blondel & Kermarrec 2011). We used results from the ENP because they are considered representative of all births and were validated against vital statistics (Blondel *et al*. 2012). For each of these four calibration variables, weighting factors were estimated iteratively, making their distribution comparable with that of the ENP population. To take into account random complex sampling, we declared the stratification variable and final weights for all analyses using the 'svyset' command. To take into account the Epifane study design, we analysed ICF age as a censored variable. This enabled us to include in analyses dyads with missing data on ICF, but with a non-nil follow-up. Censored data corresponded to subjects lost to follow-up (for which available ICF ages were used until they were lost to follow up) and to children who had not begun ICF at 1 year. Kaplan–Meier plots were used to represent ICF probabilities during follow-up. The percent of infants introduced to complementary foods according to the different infant age intervals was determined by Kaplan–Meier survival functions.

Multivariate analyses were performed in the population that had an ICF score and available data for covariates. To identify selection biases, we compared characteristics of this population with those of subjects without such variables available using adjusted Wald tests. Because the distribution of our score was not normal, splitting of our score into tertiles enabled reliable partitioning of dyads. In addition, characteristics of dyads were compared between tertiles of the ICF score using adjusted Wald tests. Maternal and child characteristics associated with ICF score tertiles in univariate analysis with a P-value <0.20 were selected in the initial multivariate multinomial logistic regression model. Covariates were then selected using a back stepwise procedure. Analyses were performed using STATA (version 12.1). A P-value <0.05 was considered statistically significant. Odds ratios (ORs) were estimated with a 95% confidence interval.

Results

Study population

We have included in our study 3368 dyads. For 293 mother and infant dyads, an ICF score could not be established, as they were lost to follow-up before the first month. In addition, 343 dyads were excluded for multivariate analysis because data concerning covariates were missing. Indeed, 2732 dyads were included in multivariate analyses. The follow-up rate was high; 2806 of the 3368 dyads included were still followed up at 12 months (83%). In all, 2963 person-years were followed up, when taking into account the durations of follow-up of each dyad.

Maternal and child characteristics in the Epifane population and comparisons between included and excluded dyads in multivariate analyses are shown in Table S1. In the Epifane study, 64% of mothers were aged to 25–34 years, and 44% were primiparous. A majority was not married and had an educational level superior to the high school graduation. Foreign-born mothers were 18%. Approximately 70% of mothers were employed before their pregnancy. Less than one-third of mothers were employed before their pregnancy and started back before 4 months after birth. Less than 20% of mothers had a caesarean delivery, and 90% of children weighed between 2500 and 4000 g. More than 70% of children were breastfed at maternity ward. A familial history of asthma or eczema was reported for 30% of children.

Compared with the 2732 mothers included in multivariate analyses, the 636 excluded mothers were more often 18–24 years old, with a level of education equal to or inferior to a high school graduation and foreign-born. They more often smoked during pregnancy, less often attended antenatal classes and were more likely to be unemployed than included mothers. There was no statistical difference in characteristics of their infants, except for a history of parental asthma or eczema and duration of breastfeeding. Indeed, the included infants were more often breastfed and had more often a familial history of asthma and eczema than excluded infants (Table S1).

Description of age at ICF

Introduction of complementary food probabilities during the first year are presented in Fig. 1. The median ICF age was 152 days. Only 13% of mothers introduced complementary food before 4 months, and 67% began complementary feeding before 6 months. Probabilities of ICF varied according to breastfeeding duration (Fig. S2). For instance, median age was equal to 152 days for infants breastfed less than 28 days and those breastfed between 1 and 4 months. Infants breastfed longer than 4 months were introduced to complementary foods 1 month later than infants who had never been breastfed (167 vs. 136 days).

Among foods that could be introduced between 4 and 6 months (Fig. 2), infant cereals and then fruits

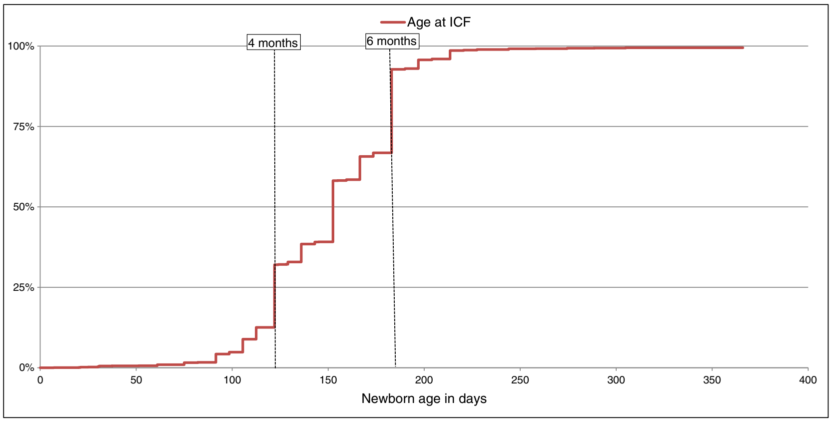

Fig. 1. Probability of introduction of complementary foods (ICF) during the first year of life ($n = 3368$).

and vegetables were first introduced, while 90% of mothers introduced meat and fish after 6 months. At the age of 1 year, more than 95% of infants regularly consumed vegetables, fruits, meat and fish, and 92%, cereal products. Only 53% of infants were introduced to added fats and 23% to eggs at 12 months (Fig. 3). Cow's milk was introduced by 26% of mothers during the first year, but not as substitution for formula or breastfeeding; only 31 mothers had replaced formula or breastfeeding by cow's milk at 12 months.

Factors associated with ICF

The first tertile (ICF score between 10 and 22; $n = 857$) was characterized by more frequent introduction of foods prior to the recommended age than in the second and third tertiles. Mothers in the second tertile (ICF score between 23 and 24; $n = 971$) less frequently introduced eggs (12% vs. 46%) and added fats (41% vs. 93%) during the first year of life than those in the third tertile (ICF score between 25 and 27; $n = 904$).

Compared with 30–34-year-old mothers, those aged 18–24 and 25–29 years had a higher risk of being in the first tertile than in the third tertile (Table 2). This was also the case for mothers with an educational level less than or equal to high school graduation who were born in France and those who did not follow antenatal classes (Table 2). The risk of being in the first tertile was also higher for mothers not employed before pregnancy, whether they worked after birth or not, compared with mothers who were employed prior to pregnancy and went back to work 4–6 months after

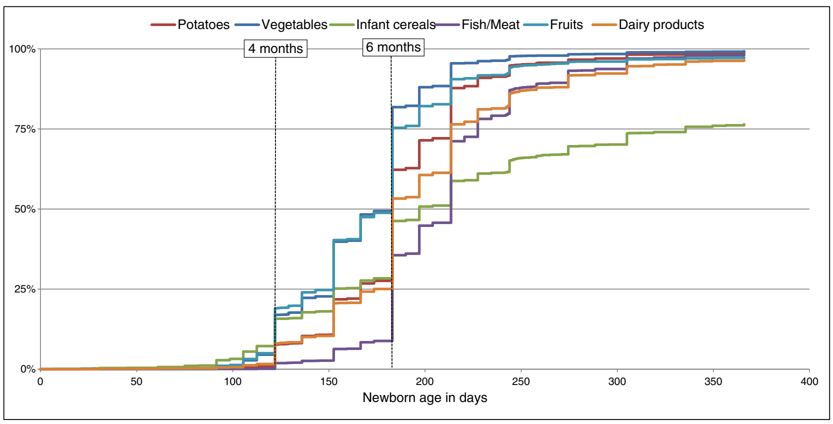

Fig. 2. Probability of introduction of foods that could be introduced at 4–6 months ($n = 3368$).

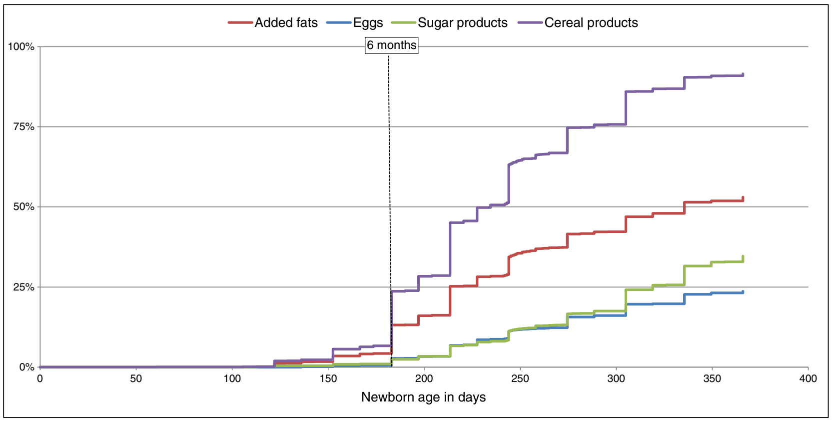

Fig. 3. Probability of introduction of foods that should be introduced after 6 months ($n = 3368$).

birth. Compared with primiparous women, mothers with three or more children also had a higher risk of being in the first tertile, like mothers who breastfed less than 4 months compared with those who breastfed longer. After adjustment, the education level, a history of parental asthma or eczema and breastfeeding duration were significantly associated with risk of inclusion in the second tertile rather than in the third tertile (Table 2).

Sensitivity analyses

When the second and third tertiles were merged, results remained similar to those aforementioned results (data not shown), except for smoking during pregnancy and parity. Unlike findings in the multinomial regression model, mothers who smoked had higher risk of inclusion in the first tertile than in the merged second and third tertiles (OR = 1.38 [1.09–1.75]). Compared with primiparous women, mothers of three or more children did not run a significant risk of being included in the first tertile (OR = 1.37 [0.99:1.90]) in the binary logistic model. We also ran interaction tests between breastfeeding duration and dyad characteristics, but no significant interactions were found ($P < 0.10$).

Discussion

Results from the Epifane survey indicated that, in 2012, in France, national infant feeding guidelines were generally followed by most mothers during the first year of life. The median age for introducing complementary food was 5 months. However, although eggs and added fats are recommended during the first year of life, only one-fourth of the children had eaten eggs, while half of the children had eaten added fats at 12 months. The ICF score highlighted variations in infant feeding practices and their concordance with PNNS recommendations, associated with a set of socio-economic characteristics.

The mean ICF age in the EDEN study, performed between 2003 and 2006 in two French cities, Nancy and Poitiers, was 4.5 months (Betoko *et al.* 2013). In our survey, the mean age was 151 days (5 months). A comparison test between the Epifane mean and the EDEN mean, considered as theoretical, showed that they were statistically different ($P < 0.0001$). But comparison between these two studies was limited because of differences in sampling. EDEN was limited to two towns. However, the two studies were performed at different time periods in France, and national recommendations were being changed during those years. A 15-day increase in the mean age of ICF over 4–5 months appears important in terms of public health.

As reported in other European countries (Schiess *et al.* 2010), 95% of children were introduced to complementary feeding at the age of 7 months. In contrast, the proportion of mothers who introduced complementary food before 4 months was lower in our study than the rate of 26% observed in the EDEN study (Betoko

Table 2. Factors associated with the introduction of complementary foods according to recommendations (ICF score tertiles and multinomial logistic regression model) (n = 2732)

	ICF score: tertile 1 vs. tertile 3		ICF score: tertile 2 vs. tertile 3	
	Univariate model	Final model	Univariate model	Final model
Maternal and infant characteristics	Crude OR (95% CI)	OR (95% CI)	Crude OR (95% CI)	OR (95% CI)
Maternal age (years) vs. 30–34				
18–24	3.83 (2.68, 5.47)	2.24 (1.49, 3.35)	1.45 (0.99, 2.10)	1.13 (0.74, 1.73)
25–29	1.65 (1.29, 2.10)	1.57 (1.21, 2.04)	1.13 (0.90, 1.42)	1.12 (0.88, 1.43)
≥35	1.26 (0.94, 1.68)	1.20 (0.88, 1.65)	1.19 (0.91, 1.55)	1.16 (0.89, 1.52)
Marital status				
Not married vs. married	1.70 (1.39, 2.09)	1.22 (0.97, 1.52)	1.23 (1.01, 1.49)	1.15 (0.93, 1.41)
Education level				
≤High school graduation vs. high school + 1 year	3.37 (2.72, 4.16)	1.94 (1.51, 2.48)	1.76 (1.43, 2.16)	1.64 (1.30, 2.08)
Maternal birth place				
France vs. abroad	2.29 (1.59, 3.29)	2.13 (1.41, 3.21)	1.27 (0.94, 1.71)	1.11 (0.80, 1.54)
BMI vs. [18.5–24.9]				
<18.5	1.04 (0.71, 1.52)		0.84 (0.58, 1.23)	
25–29.9	1.46 (1.12, 1.90)		1.17 (0.90, 1.52)	
≥30	1.62 (1.14, 2.30)		1.15 (0.81, 1.65)	
Smoking during pregnancy				
Smoker vs. non-smoker	2.49 (1.90, 3.26)	1.32 (0.98, 1.77)	1.24 (0.93, 1.65)	0.94 (0.70, 1.27)
Antenatal classes				
Not followed vs. followed	2.22 (1.81, 2.74)	1.58 (1.22, 2.04)	1.42 (1.16, 1.74)	1.20 (0.94, 1.52)
Employment status before and after pregnancy vs. employment before and started back at 4–6 months				
Unemployed before and after	2.85 (1.92, 4.25)	1.64 (1.04, 2.59)	1.23 (0.85, 1.78)	0.96 (0.64, 1.44)
Unemployed before and went back to work by 12 months	3.18 (1.63, 6.21)	2.06 (1.05, 4.02)	1.09 (0.54, 2.23)	0.97 (0.47, 1.97)
Employed before and started back by 4 months	1.47 (1.02, 2.12)	1.28 (0.87, 1.90)	1.11 (0.81, 1.53)	1.04 (0.74, 1.47)
Employed before and started back at 6 and 12 months	1.21 (0.81, 1.82)	1.25 (0.81, 1.92)	1.12 (0.79, 1.59)	1.15 (0.80, 1.64)
Employed before and had not gone back by 12 months	1.70 (1.13, 2.54)	1.25 (0.79, 1.96)	0.93 (0.64, 1.35)	0.78 (0.53, 1.16)
Multiparity vs. primiparous				
Two children	1.11 (0.89, 1.39)	1.17 (0.89, 1.54)	1.21 (0.98, 1.50)	1.22 (0.95, 1.56)
Three children or more	1.63 (1.23, 2.16)	1.70 (1.15, 2.51)	1.44 (1.09, 1.90)	1.41 (0.99, 2.01)
Asthma or eczema familial history				
One or more history vs. no history	1.10 (0.89, 1.35)	1.10 (0.88, 1.37)	1.21 (0.99, 1.48)	1.24 (1.01, 1.52)
Apgar score at 5 vs. 10 min				
8–9	0.98 (0.59, 1.61)		1.30 (0.82, 2.06)	
7	1.87 (0.56, 6.18)		0.24 (0.03, 1.95)	
Breastfeeding duration vs. >4 months				
0 day	3.29 (2.50, 4.33)	2.08 (1.55, 2.79)	1.96 (1.51, 2.54)	1.70 (1.28, 2.25)
<28 days	2.34 (1.74, 3.13)	1.68 (1.22, 2.31)	1.27 (0.96, 1.69)	1.16 (0.86, 1.58)
Between 1 and 4 months	1.66 (1.25, 2.22)	1.45 (1.08, 1.96)	1.48 (1.14, 1.92)	1.44 (1.09, 1.89)

ICF, introduction of complementary foods; OR, odds ratio; CI, confidence interval, BMI, body mass index.

et al. 2013). Our estimate prior to 4 months was also lower than rates observed in other countries such as the UK (95% in 1999–2000) (Wright *et al.* 2004), Quebec (86% in 1998) (Dubois & Girard 2003), Australia (46% in 2002–2003) (Scott *et al.* 2009) and the United States (40% in 2005–2007) (Clayton *et al.* 2013). However, in a German study conducted in 2005, 16% of mothers began complementary feeding before 4 months (Rebhan *et al.* 2009). A low rate (7%) was also observed in Denmark in 2008 (Kronborg *et al.* 2014). These differences may be explained by varying definitions of complementary feeding between studies.

Because our study was the most recent, the low rate we found might also reflect rising awareness by parents of early complementary feeding risks.

Complementary foods were introduced progressively in Epifane, in accordance with recommendations. One review underlined how gradual ICF, with repetition of various tastes, can improve infant acceptance (Harris 2008). However, recommendations concerning eggs and added fats were not followed. Despite changes in recommendations regarding allergy prevention during the first year of life (Turck *et al.* 2015), a low proportion of children was introduced to eggs in Epifane. In the United States, nearly 60% of infants consumed eggs at 1 year in 2005–2007 (Grummer-Strawn *et al.* 2008). Parents may have been confused by guideline changes (Koplin & Allen 2013). Moreover, added fats contribute to lipid intake, indispensable to central nervous system development and infant growth (Briend *et al.* 2014). It would be interesting to determine how eggs and added fats are perceived by parents. Indeed, parents may feel that their own children's needs are inconsistent with national guidelines. Reasons for not following up recommendations should be investigated, as was done previously (Clayton *et al.* 2013; Wright *et al.* 2004).

We found that low maternal age and low educational level were associated with a lower ICF score. In previous studies, these characteristics were associated with complementary feeding before 4 months (Rebhan *et al.* 2009; Schiess *et al.* 2010; Scott *et al.* 2009). In accordance with other studies (Dubois & Girard 2003; Kronborg *et al.* 2014; Scott *et al.* 2009), but not all (Tromp *et al.* 2013), marital status was not associated with infant feeding practices in our study. After adjustment, mothers born in foreign countries had higher ICF scores than mothers born in France. In a study performed in Germany, women born in foreign countries introduced complementary food earlier than mothers born in Germany (Rebhan *et al.* 2009), in contrast with a study performed in Australia (Scott *et al.* 2009). Comparison with other studies is limited, because infant feeding practices depend on those of the country of birth and differ between native countries.

In the multivariate binary logistic regression model, smoking during pregnancy was associated with higher risk of inclusion in the first tertile than in the merged second and third tertiles. In the multinomial logistic regression model, this association was not significant, possibly because of lack of statistical power. Smoking status was shown to be a risk factor for earlier ICF (Rebhan *et al.* 2009; Schiess *et al.* 2010; Scott *et al.* 2009), but not in all studies (Tarrant *et al.* 2010). This difference could be explained by differences between studies in the definition of the variable 'smoking during pregnancy'. Smoking might also be inversely associated with compliance with health recommendations. Like smoking and follow-up of antenatal classes, breastfeeding may also be considered a marker of overall compliance with health recommendations. Indeed, in accordance with previous research (Wijndaele *et al.* 2009), we found that breastfeeding duration of over 4 months was associated with higher ICF scores.

Time lapse for returning to work following birth was not associated with the ICF score, in agreement with results of the EDEN study (Betoko *et al.* 2013). However, we used a composite variable in our analyses that took into account employment status both before and after birth. We did not find other studies in the literature that used this composite variable; thus, comparisons are limited. We nevertheless conclude that employment before pregnancy is the factor associated with agreement with recommendations, rather than going back to work during the first year.

Parity has not been associated with earlier ICF (Grummer-Strawn *et al.* 2008; Scott *et al.* 2009), but multiparity has been associated with the pattern 'use of adult foods' (Betoko *et al.* 2013). In our study, mothers of three or more children had lower ICF scores than primiparous women. The former may early give to their babies same foods as older siblings, and the presence of the latter might continue to influence last-born feeding during the first years of life (Lioret *et al.* 2015).

Our study had some limitations. Mothers in our sample were more often married, with a higher education level and were more often employed before pregnancy than mothers in the National Perinatal Survey. However, marginal calibration performed on percentages observed in the French National Perinatal Survey improved statistical national representativeness. Survival analyses performed to describe ICF age enabled taking into account missing data and losses to follow up. Nevertheless, missing data might not be missing at random, leading to underestimation of the prevalence of children with an early ICF age. The recall period of 4 months may have led to a potential recall bias. However, by using answers provided at each previous interview, interviewers helped mothers to remember such information, and in general, mothers are attentive to their child's feeding. Our study had several strengths, including its setting up of the birth cohort. The questionnaires were specifically designed for the Epifane survey, and their comprehension was tested during the pilot study performed in 2010 (De Launay *et al.* 2011). This enabled determining the best data collection method (interviews vs. self-completed, depending on the topic) and defining the formulation leading to the best understanding. In addition, training of the interviewers and use of CATI and CAWI questionnaires helped to limit variability between interviewers. Repeated use of data collection, phone interviews, internet and paper questionnaires enabled a high follow-up rate (83%) at the age of 12 months. Although we cannot exclude a potential residual confounding bias, we included in our study a large set of variables in terms of maternal and infant characteristics for adjustment.

The a priori ICF score enabled summarizing multidimensional information from a longitudinal point of view. However, based on PNNS guidelines, it presents some limitations.

Guidelines recommend a minimum age at which each complementary food can be introduced, while stressing the importance of gradual ICF. However, they do not give a maximum age after which ICF should not be given during the first year of life. Therefore, too late an age for ICF was not taken into account in the score. Nonetheless, in our study, 99% of infants were introduced to complementary food at 244 days (7 months of age). Our score is based on French recommendations, but it may be used in other countries by adapting it to national guidelines. We used equal weights for each food group when calculating ICF scores because, to our knowledge, there is no scientific or clinical evidence warranting attributing more points to introduction of one food rather than another. To validate the ICF score, 'a posteriori' models such as principal component analysis could be used in the Epifane study. Thus, associations between ICF scores and childhood growth and morbidity could be estimated.

Conclusions

Complementary feeding recommendations were generally followed in France in 2012. However, our study highlights the low rate of introduction of eggs and added fats during the first year of life. A goal is to clarify guidelines designed for parents and health care providers. Indeed, health care providers are important when guiding parents about complementary feeding recommendations. The effectiveness of advice and guidelines among population subgroups should also be evaluated by adapting messages. Finally, the Epifane study should be reperformed so as to ascertain changes in infant feeding practices.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

JBB analysed data and wrote the initial manuscript. KC and BS designed research, supervised statistical analyses and contributed to the writing. KC, BS and CDL conducted data collection. JBB had primary responsibility for final content. All authors read and approved the final manuscript.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Figure S2: Probability of introduction of complementary foods according to breastfeeding duration ($n = 3368$)
Table 1: Maternal and infant characteristics and comparison between dyads included and excluded in multivariate analyses