

ORIGINAL ARTICLE

Factors associated with the timing of introduction of complementary feeding: the Generation R Study

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BACKGROUND/OBJECTIVES: Many parents do not follow recommendations for the timing of introduction of complementary feeding. The aim of this study was to identify determinants associated with the timing of introduction of complementary feeding in a multiethnic birth cohort.

SUBJECTS/METHODS: Subjects were 3561 mothers and infants participating in a prospective cohort study. The timing of introduction of complementary feeding and maternal and infant characteristics were obtained by parent-derived questionnaires. Regression analyses were performed to identify determinants for the timing of introduction of complementary feeding (<3, 3–6 and ≥6 months).

RESULTS: In total, 62% of infants were introduced to complementary feeding before the age of 6 months. Determinants for very early (<3 months) introduction were being a single parent and infant day care attendance. Determinants for early (3–6 months) introduction were young maternal age, multiple parities, no infant family history of asthma, atopy and no infant history of allergy to cow's milk. Determinants for both very early and early introduction were low educational level and not fully breastfeeding for 4 months. Maternal educational level was only significantly associated with the timing of introduction in mothers of Western origin.

CONCLUSIONS: This study confirmed determinants for the timing of introduction of complementary feeding that have been identified by previous studies, which may be appropriate targets for education and guidance. Moreover, mothers whose infants attend day care and have a family history of asthma, atopy or allergy to cow's milk may need guidance to follow infant feeding recommendations.

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INTRODUCTION

The first year of life includes many transitions in food consumption.¹ Appropriate nutrition during infancy is essential for adequate growth, development and health.² The World Health Organization (WHO) recommends breastfeeding for the first 6 months of life with the introduction of complementary feeding thereafter.^{2–4} The primary aim of the current WHO infant feeding recommendations is the reduction of infections in developing countries.⁴ Advisory committees in developed countries, including the European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) and the American Association of Pediatrics (AAP) recommend delaying the introduction of complementary feeding, preferably until the age of 6 months and at least until 4 months of age.^{5–7} The ESPGHAN also recommends the introduction of complementary feeding no later than 26 weeks.^{5,6} Many studies have focused on determining the optimal time to introduce complementary feeding. Very early introduction of complementary feeding has been suggested to be associated with adverse health outcomes like obesity and celiac disease later in life.^{8,9} However, late introduction of complementary feeding is also not recommended as exclusive

breastfeeding will not be sufficient to meet the infant's nutritional needs after the age of 6 months, as well as for developmental reasons.⁵ Many studies focused on determining factors associated with the initiation, duration and cessation of breastfeeding.^{10–12} As both very early and late introduction of complementary feeding is not preferred and national studies indicate that many parents do not follow recommendations,⁷ identifying factors associated with the timing of introduction of complementary feeding is of importance. Several determinants associated with the timing of introduction of complementary feeding have been identified in previous studies in different countries.^{3,4,6,13} However, infant feeding practices have been found to differ between countries despite similar recommendations for the introduction of complementary feeding.⁶ Differences in feeding practices have also been reported among subgroups of populations.^{7,14} Determining the factors associated with the timing of introduction of complementary feeding in a developed country with a multicultural population could give health care workers more insight and assist in identifying potential groups or individuals who are least likely to follow optimal feeding recommendations.

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Therefore, the aim of this study is to determine maternal and infant characteristics associated with the timing of introduction of complementary feeding in infancy in a multiethnic birth cohort.

MATERIALS AND METHODS

Participants and study design

This study was embedded in the Generation R Study, a multiethnic population-based prospective birth cohort study from fetal life until young adulthood.¹⁵ The Generation R Study included 9778 pregnant women living in Rotterdam, the Netherlands, with a delivery date from April 2002 until January 2006. Informed consent for postnatal follow-up was provided by 7893 participants. At the child's age of 14 months, 5088 mothers received a questionnaire about food consumption and the timing of introduction of complementary feeding (Supplementary Figure 1). Comprehensive data collection of food consumption was implemented in the study from 2003 onwards. The study was approved by the medical ethical review board of the Erasmus Medical Center, Rotterdam, the Netherlands.

Introduction of complementary feeding

At the child's age of 14 (± 2) months, parents were asked to complete a questionnaire about food consumption and the timing of introduction of complementary feeding. The food products used in the questionnaire were selected based on food items frequently consumed among Dutch toddlers, as described in a previous survey.¹⁶ Parents were asked at which age the following products were first introduced into the infant's diet: (full- or semi-skimmed) dairy products (with the exception of breastfeeding and formula-feeding), porridge, bread, biscuits, crackers, baby cookies, pasta, (breaded) meat products, vegetarian meat substitutes, fish, shellfish, vegetables, fruit, peanuts and nuts. The timing of introduction of complementary feeding was categorized as (I) before the age of 3 months, (II) at the age of 3–6 months and (III) at the age of 6 months and after. The categories are referred to as (I) very early, (II) early and (III) timely introduction of complementary feeding. The introduction of complementary feeding at the age of 6 months and after was defined as the reference group in accordance with the WHO recommendation which was currently followed during this study. Questionnaire response rate was 72% ($n = 3643$) and information on the timing of introduction of complementary feeding was available for 3603 infants.

Maternal and infants characteristics

Several maternal and infant characteristics were assessed as potential associated factors for the timing of introduction of complementary feeding. Data on maternal age, infant birth weight and gender were available from obstetric records assessed in midwife practices and hospital registries.¹⁵ Prenatal questionnaires included information on maternal and infant ethnicity, maternal educational level, household income per month, marital status, maternal smoking and alcohol consumption during pregnancy, folic acid intake during pregnancy, multiple parities, family history of asthma or atopy and maternal body mass index at intake (questionnaire response rate: 91, 80 and 77% for early, mid and late pregnancy, respectively). Maternal educational level was defined according to the classification of Statistics Netherlands and categorized as follows: low (no education, primary school or <3 years of secondary school), mid (>3 years of secondary school, higher vocational training or bachelor's degree) and high (academic education).¹⁷ Ethnicity of the mother and infant was also categorized according to the classification of Statistics Netherlands into Western (Dutch, European, American-Western, Asian-Western, Oceanian and Indonesian) and non-Western (American non-Western, Asian non-Western, African, Turkish, Cape Verdean, Moroccan, Dutch Antillean and Surinamese).¹⁸ Net household income per month ($\leq \text{€}2200$, $> \text{€}2200$), marital status (no partner, married/living together), family history of asthma or atopy (no, yes), maternal smoking (never smoked during pregnancy, smoked during pregnancy), maternal alcohol consumption (no alcohol consumption during pregnancy, alcohol consumption during pregnancy), multiple parities (no, yes) and folic acid intake (no intake, started in first 10 weeks of pregnancy, started preconceptional) were defined into categories.

Data on breastfeeding were collected by a combination of delivery reports and postnatal questionnaires at the age of 2, 6 and 12 months (response rate: 82, 73 and 72%, respectively). Delivery reports included information on whether the infant was ever breastfed. Postnatal

questionnaires included information on breastfeeding at the age of 2, 6 and 12 months and the age of breastfeeding cessation. Consequently, breastfeeding was categorized into the following groups: never breastfed, partial breastfeeding for at least 4 months and full breastfeeding for at least 4 months. Partial breastfeeding was defined as receiving both breast milk and infant formula and/or complementary feeding. Full breastfeeding was defined as receiving breastfeeding without any other infant formula, milk or complementary feeding. In addition, at the infant's age of 6 and 12 months, parents were asked by the questionnaire whether their child had attended a doctor for allergy to cow's milk in the first year of life (no, yes). At the age of 12 months, the questionnaire also included information on day care attendance. Day care attendance in the first year of life was defined as never, <16, 16–32 and ≥ 32 h per week.

Population for analyses

Only mothers and infants who returned the questionnaire were included in the analyses ($n = 3643$). Non-response analysis revealed that mothers who filled in the questionnaire, relative to non-responders, had a higher educational level (33 vs 21%), were of Western ethnicity (78 vs 41%), were more often married or had a partner (91 vs 81%), had a lower BMI (24.4 vs 26.0 kg/m²), more often drank alcohol during pregnancy (60 vs 43%) and took adequate folic acid supplementation during pregnancy (31 vs 12%) (Supplementary Table 1). To prevent clustering, twins were excluded from the analyses ($n = 82$). Therefore, data of 3561 mother and infants were available for statistical analyses (Supplementary Figure 1).

Statistical methods

To determine the factors associated with the timing of introduction of complementary feeding, two regression models were built. The first model included the factors associated with very early (<3 months) introduction of complementary feeding relative to timely (≥ 6 months) introduction of complementary feeding. The second model reflected the factors associated with early (3–6 months) introduction of complementary feeding relative to timely (≥ 6 months) introduction of complementary feeding.

Univariate logistic regression analyses were performed for the timing of introduction of complementary feeding and various potential associated factors as independent variables. All independent variables with a P -value <0.20 in the univariate analyses were selected as candidate determinants for the multivariate analyses. Subsequently, multiple logistic regression analyses with a backward stepwise elimination procedure was performed with $P < 0.10$ as the end-point, keeping only the strongest determinants. The Hosmer–Lemeshow test was applied to test the goodness of fit of the regression model.

To diminish potential bias associated with missing data, a multiple imputation procedure was used.¹⁹ The multiple imputation procedure predicts values for missing data on the basis of the associations between missing data and other variables. Missing values of maternal and infant characteristics (~ 2.0 –45.9%) were multiple imputed ($n = 5$ imputed datasets). The results of the five imputed analyses were pooled and reported as odds ratios (OR) and 95% confidence interval (CI) in this paper. A P -value <0.05 was considered as statistically significant. Statistical analyses were conducted using Statistical Package for Statistical Science Software version 17.0 (SPSS Inc, Chicago, IL, USA).

RESULTS

Study population

Maternal and infant characteristics of the study population are presented in Table 1 and Supplementary Table 2. Out of 3561 infants, 6% was introduced to complementary feeding very early (<3 months), 56% early (3–6 months) and 38% timely (≥ 6 months).

Factors associated with the timing of introduction of complementary feeding

Descriptive information on the determinants of interest and their associations with the timing of introduction of complementary feeding are presented in Table 2 and Supplementary Table 3.

Introduction before the age of 3 months. Relative to timely introduction, very early introduction of complementary feeding

Table 1. Characteristics of the study population according to the timing of introduction of complementary feeding

N = 3561	< 3 months			3–6 months			≥ 6 months	
	Very early		P-value	Early		P-value	Timely	
	N = 217	(% = 6)		N = 2009	(% = 56)		N = 1335	(% = 38)
Maternal characteristics								
Age, mean (s.d.)	30.4	5.7	< 0.01	31.2	5	< 0.01	31.8	4.4
Ethnicity								
Western	136	5		1534	56		1088	39
Non-Western	81	10	< 0.01	475	59	< 0.01	247	31
Educational level								
Low	55	10		346	63		152	27
Mid	121	7	< 0.01	1060	57	< 0.01	676	36
High	41	4	< 0.01	603	52	< 0.01	507	44
Household income per month								
≤ €2200	79	8		557	58		332	34
> €2200	138	5	< 0.01	1452	56	0.07	1003	39
Marital status								
Married/living together	173	5		1822	56		1250	39
No partner	44	14	< 0.01	187	59	0.01	85	27
Maternal BMI, mean (s.d.)	24.6	4.5	0.30	24.6	4.3	0.04	24.2	4.1
Multiple parities								
No	125	6		1163	55		812	39
Yes	92	6	0.04	846	58	0.08	523	36
Smoking during pregnancy								
Never	151	5		1539	55		1100	40
Smoked during pregnancy	66	9	< 0.01	470	61	< 0.01	235	30
Alcohol use during pregnancy								
Never	108	8		794	56		510	36
Drank alcohol during pregnancy	109	5	0.05	1215	57	0.55	825	38
Folic acid intake								
Never	69	12		339	57		187	31
Start in first 10 weeks	62	5	0.03	651	58	0.51	412	37
Start periconceptual	86	5	< 0.01	1019	55	0.10	736	40
Infant characteristics								
Gender								
Male	116	7		978	56		653	37
Female	101	5	0.21	1031	57	0.90	682	38
Ethnicity								
Western	133	5		1520	56		1081	39
Non-Western	84	10	< 0.01	489	59	< 0.01	254	31
Birth weight z-score, mean (s.d.)	− 0.25	1.00	< 0.01	0.02	1.01	0.41	− 0.01	1.06
Breastfeeding								
Never	27	6		260	60		144	34
Non-fully for 4 months	154	7	0.60	1281	61	0.75	665	32
Fully for 4 months	36	4	0.02	468	45	< 0.01	526	51
Family history of asthma or atopy								
Yes	99	6		940	53		724	41
No	118	7	0.03	1069	59	< 0.01	611	34
Allergy to cow's milk								
Yes	10	4		108	48		108	48
No	207	6	0.11	1901	57	< 0.01	1227	37
Day care attendance								
Never	74	8		535	56		347	36
< 16 h	40	4	0.04	555	57	0.63	380	39
16–32 h	81	5	0.07	845	57	0.75	566	38
≥ 32 h	22	16	0.09	74	54	0.67	42	30

Abbreviations: BMI, body mass index; s.d., standard deviation. *P*-values were assessed by using univariate logistic regression analyses. % represents proportion by row.

Table 2. Determinants for the timing of introduction of complementary feeding

	Univariate model (<3 vs ≥6 months)	Multiple regression model (<3 vs ≥6 months)	Univariate model (3–6 vs ≥6 months)	Multiple regression model (3–6 vs ≥6 months)
<i>Maternal characteristics</i>				
Age	0.94* (0.91–0.97)	—	0.97* (0.96–0.99)	0.98* (0.96–1.00)
Ethnicity				
Non-Western vs Western	2.60* (1.86–3.64)	—	1.36* (1.14–1.62)	—
Educational level				
Mid vs low	0.50* (0.33–0.74)	0.90 (0.56–1.44)	0.69* (0.55–0.86)	0.86 (0.68–1.09)
High vs low	0.23* (0.14–0.37)	0.49* (0.28–0.89)	0.52* (0.42–0.66)	0.74* (0.57–0.96)
Household income per month				
>€2200 vs ≤€2200	0.58* (0.42–0.80)	—	0.86 (0.74–1.01)	—
Marital status				
No partner vs married/living together	3.78* (2.49–5.73)	2.22* (1.39–3.56)	1.50* (1.13–2.00)	—
Maternal BMI	1.02 (0.98–1.06)	—	1.02* (1.00–1.04)	—
Multiple parities	1.19* (1.01–1.41)	—	1.08 (0.99–1.18)	1.23* (1.05–1.43)
Smoking during pregnancy				
Smoking during pregnancy vs never	2.03* (1.32–3.11)	1.54 (0.98–2.42)	1.43* (1.19–2.71)	1.22 (1.00–1.50)
Alcohol use during pregnancy				
Drank alcohol during pregnancy vs never	0.62* (0.40–0.96)	—	0.95 (0.79–1.13)	—
Folic acid intake				
Start in first 10 weeks vs never	0.41* (0.21–0.80)	0.51 (0.25–1.02)	0.87 (0.59–1.29)	—
Start periconceptional vs never	0.32* (0.18–0.55)	0.55 (0.29–1.04)	0.77 (0.57–1.03)	—
<i>Infant characteristics</i>				
Gender				
Female vs Male	0.83 (0.61–1.12)	—	1.01 (0.88–1.16)	—
Ethnicity				
Non-Western vs Western	2.69* (1.87–3.87)	—	1.37* (1.15–1.63)	—
Birth weight (z-score)	0.80* (0.70–0.92)	—	1.03 (0.96–1.10)	—
Breastfeeding				
Non-fully for 4 months vs never	1.19 (0.63–2.25)	1.38 (0.81–2.35)	1.06 (0.77–1.45)	1.11 (0.78–1.58)
Fully for 4 months vs never	0.35* (0.16–0.78)	0.48* (0.25–0.92)	0.49* (0.33–0.71)	0.53* (0.34–0.83)
Family history of asthma or atopy				
Yes vs no	0.71* (0.52–0.96)	—	0.74* (0.64–0.85)	0.80* (0.69–0.93)
Allergy to cow's milk				
Yes vs no	0.57 (0.29–1.13)	—	0.65* (0.48–0.87)	0.63* (0.46–0.85)
Day care attendance				
<16 h vs never	0.49* (0.26–0.92)	0.63 (0.33–1.22)	0.95 (0.76–1.19)	—
16–32 h vs never	0.68 (0.45–1.02)	1.00 (0.65–1.53)	0.97 (0.79–1.18)	—
≥32 h vs never	2.43 (0.94–6.27)	2.77* (1.22–6.32)	1.12 (0.66–1.92)	—
Hosmer–Lemeshow test	—	χ^2 5.15 ($P=0.72$)	—	χ^2 11.34 ($P=0.33$)

Abbreviations: BMI, Body Mass Index; CI, confidence interval; OR, odds ratio for the introduction of complementary feeding relative to at 6 months and after per group or per unit of continuous predictor. χ^2 for the goodness of fit of the model. Values are represented as OR (95% CI). *signifies P -value < 0.05.

was inversely associated with higher maternal educational level and full breastfeeding for 4 months, and associated with a single-parent household and >32 h of day care attendance per week.

Introduction at 3–6 months. Relative to timely introduction, early introduction of complementary feeding was inversely associated with maternal age, higher maternal educational level, family history of asthma or atopy, allergy to cow's milk and full breastfeeding for 4 months and associated with multiple parities.

Ethnicity and the timing of introduction of complementary feeding

A significant interaction was found between maternal educational level and ethnicity ($P=0.01$ and $P=0.06$ for mid- and high educational levels, respectively). Only in mothers of Western origin, higher maternal educational level was inversely associated with very early (<3 months) (OR: 0.36; 95% CI: 0.21–0.61 and OR: 0.18; 95% CI: 0.10–0.33) and early (3–6 months) introduction (OR: 0.52; 95% CI: 0.38–0.71 and OR: 0.41; 95% CI: 0.30–0.56) of complementary feeding (Table 3).

DISCUSSION

Out of 3562 infants, 62% was introduced to complementary feeding before the age of 6 months. Infants with a single parent and who attended day care were more often introduced to complementary feeding very early (<3 months). Mothers who introduced complementary feeding early (3–6 months) were more often younger, had multiple parities and had an infant without a family history of asthma, atopy or a history of allergy to cow's milk. Mothers with a low educational level and those who did not fully breastfeed for 4 months were more likely to introduce complementary feeding very early and early. However, the socioeconomic gradient in complementary feeding practices was only present in mothers of Western origin.

Comparison with other studies is difficult as most studies defined early introduction of complementary feeding to be before the age of 4–6 months in accordance with the recommendations of the ESPGHAN and the APP. This study defined early introduction of complementary feeding to be before the age of 6 months according to the recommendation of the WHO which was currently followed in the Netherlands during the study period. The main determinants found in this study are confirmatory. Previous studies also found low maternal age, low maternal

Table 3. Ethnicity and the timing of introduction of complementary feeding.

	Multiple regression model (<3 vs ≥6 months)		Multiple regression model (3–6 vs ≥6 months)	
	OR (95% CI)		OR (95% CI)	
	Western ethnicity	Non-Western ethnicity	Western ethnicity	Non-Western ethnicity
<i>Maternal educational level</i>				
Mid vs low	0.36* (0.21–0.61)	1.01 (0.55–1.85)	0.52* (0.38–0.71)	0.98 (0.69–1.38)
High vs low	0.18* (0.10–0.33)	0.59 (0.21–1.64)	0.41* (0.30–0.56)	0.86 (0.51–1.45)

Abbreviations: CI, confidence interval; OR, odds ratio for the introduction of complementary feeding relative to at 6 months and after. Values are represented as OR (95% CI) *signifies P -value < 0.05. $P_{\text{interaction}}$: 0.01 and 0.06 for mid- and high educational level respectively for comparison between <3 and ≥6 months and $P_{\text{interaction}}$: 0.01 and 0.06 for mid- and high educational level respectively for comparison 3–6 and ≥6 months.

educational level, not fully breastfeeding and being a single parent to be determinants associated with early introduction of complementary feeding.^{3,4,6,13} In addition, this study found infants with a family history of asthma, atopy or a history of allergy to cow's milk to be more likely to be introduced to complementary feeding after the age of 6 months. The WHO also recommends delaying the introduction of complementary feeding after the age of 6 months for the prevention of asthma and allergic disease.²⁰ However, recent evidence lends little support for delaying the introduction of complementary feeding in order to prevent allergic disease.⁸ Mothers whose infants have an increased risk of allergic disease may be more conscious and aware of the introduction of complementary feeding and therefore less likely to introduce complementary feeding early or more likely to delay the introduction of complementary feeding for too long.

This study also found day care attendance for more than 32 h a week to be a determinant for very early (<3 months) introduction of complementary feeding independent of socioeconomic status. However, in agreement with previous studies, this study did not find day care attendance to be a determinant for early introduction (3–6 months) of complementary feeding.³ As confirmed by previous studies, this study did not find maternal ethnicity to be an independent determinant for the timing of introduction of complementary feeding.^{4,6,13} However, it has been suggested that the socioeconomic gradient in complementary feeding practices may vary by maternal ethnic background.^{7,14} In addition, this study found that educational level was only associated with the timing of complementary feeding in mothers of Western origin.

The findings of this study may have several implications. The maternal and child determinants can assist health care workers and dieticians in identifying groups or individuals who are less likely to comply with infant feeding recommendations. Most determinants were confirmed in other studies as well and may be appropriate targets for education and guidance. Additionally, mothers whose infants attend day care and have a family history of asthma, atopy or a history of allergy to cow's milk may introduce complementary feeding differently. Mothers of these children may need additional guidance to follow infant feeding recommendations.

An important strength of this study was the large sample size and the multiethnic population. In addition, this study was able to examine a large number of potential factors associated with the timing of introduction of complementary feeding. Another important strength of this study was that it identified determinants for both very early (<3 months) and early introduction (3–6 months) of complementary feeding.

A limitation of this study was that it could not specifically identify determinants for the introduction of complementary feeding using the recommendations of other advisory committees (that is, 16 weeks).^{5–7} However, this study identified determinants associated with the introduction of complementary feeding

before the age of 6 months as recommended by the WHO and preferred by most advisory committees. Another limitation of this study was the retrospective character of the self-reported questionnaire on the timing of introduction of complementary feeding. Parents were asked to complete the questionnaire at the child's age of 14 (±2) months, about 8–11 months after the introduction of complementary feeding. Therefore, maternal recall bias cannot be excluded. However, this would have only influenced our results if, for example, mothers with a low socioeconomic background were more likely to misclassify having introduced complementary feeding after the age of 6 months instead of before the age of 6 months.

CONCLUSION

This study identified important maternal and infant determinants for the timing of introduction of complementary feeding. The determinants should assist health professionals in identifying groups and individuals who are least likely to follow optimal feeding recommendations. This study confirmed determinants that have been identified by previous studies, which may be appropriate targets for education and guidance. Moreover, mothers whose infants attend day care and who have a family history of asthma, atopy or a history of allergy to cow's milk may need guidance to follow infant feeding recommendations.

CONFLICT OF INTEREST

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DISCLAIMER

The funders had no role in the design of the study, data collection and analyses, interpretation of data, preparation, review and decision to submit the manuscript.

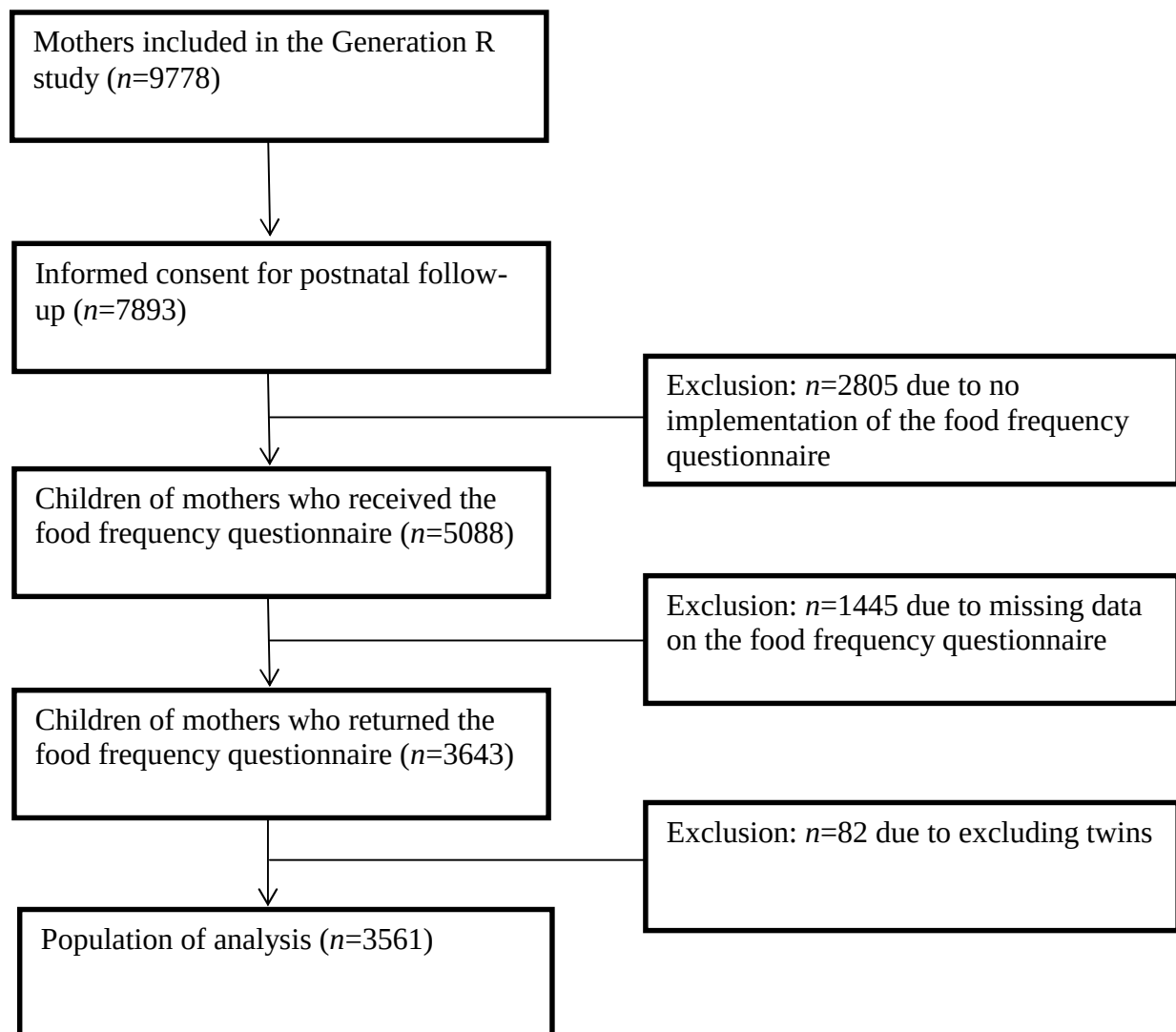
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Supplementary Information accompanies this paper on European Journal of Clinical Nutrition website (<http://www.nature.com/ejcn>)

Supplementary figure 1 Flow chart of the participants within the Generation R Study



Supplementary table 1 Non-response analysis (N=3561)

		Responders	Non-responders	P-value
Maternal characteristics				
Age	Mean (SD)	31.4 (4.6)	30.1 (6.1)	0.08
Ethnicity (%)	Western	78	41	<0.01
	Non-western	22	59	
Educational level (%)	Low	15	37	<0.01
	Mid	52	42	
	High	33	21	
Household income per month (%)	≤ 2200 euro	27	28	0.96
	> 2200 euro	73	72	
Marital status (%)	Married/living together	91	81	0.02
	No partner	9	19	
Maternal BMI	Mean (SD)	24.4 (4.24)	26.0 (3.9)	0.03
Multiple parities (%)	No	59	53	0.05
	Yes	41	47	
Smoking during pregnancy (%)	Never	79	80	0.86
	Smoked during pregnancy	21	20	

Alcohol use during pregnancy (%)	Never	40	57	0.04
	Drank alcohol during pregnancy	60	43	
Folic acid intake (%)	Never	15	36	<0.01
	Start in first 10 weeks	31	12	
	Start periconceptional	54	52	
Infant characteristics				
Gender (%)	Male	49	48	0.84
	Female	51	52	
Ethnicity (%)	Western	77	43	<0.01
	Non-western	23	57	
Birth weight (z-score) <i>Mean (SD)</i>		-0.01 (1.01)	-0.20 (1.11)	0.26
Breastfeeding (%)	Never	9	0	0.09
	Non- fully for 4 months	63	83	
	Fully for 4 months	28	17	
Family history of asthma or atopy (%)	Yes	49	56	0.46
	No	51	44	
Cow's milk allergy (%)	Yes	6	0	0.15
	No	94	100	
Day care attendance (%)	Never	23	34	0.05

< 16 hours	28	20
16-32 hours	47	33
≥ 32 hours	3	13

Supplementary table 2 Characteristics of the study population according to the timing of introduction of complementary feeding –

Original data

N=3521	< 3 months			3-6 months			≥ 6 months		Missing	
	Very early			Early			Timely			
	<i>N</i>	(%)	<i>P</i> -value	<i>N</i>	(%)	<i>P</i> -value	<i>N</i>	(%)	<i>N</i>	(%)
	202	6		1999	57		1320	37		
Maternal characteristics										
Age <i>Mean (SD)</i>	30.3	5.7	<0.01	31.2	5	<0.01	31.8	4.4	0	0
Ethnicity									86	2
Western	122	5		1502	56		1062	39		
Non-western	65	9	<0.01	454	60	<0.01	230	31		
Educational level									129	4
Low	45	9		321	64		136	27		
Mid	106	6	<0.01	1022	57	<0.01	649	37		
High	36	3	<0.01	589	53	<0.01	488	44		

Household income per month								0	0	
≤ 2200 euro	74	8		555	58		328	34		
> 2200 euro	128	5	<0.01	1444	56	0.06	992	39		
Marital status								148	4	
Married/living together	148	5		1743	56		1190	39		
No partner	38	13	<0.01	177	61	<0.01	77	26		
Maternal BMI <i>Mean (SD)</i>	24.5	4.6	0.37	24.5	4.3	0.05	24.2	4.1	291	8
Multiple parities								93	3	
No	114	5		1134	56		788	39		
Yes	81	6	0.03	815	58	0.06	496	36		
Smoking during pregnancy								643	18	
Never	117	5		1253	55		894	40		

Smoked during pregnancy	49	8	<0.01	381	62	<0.01	184	30
Alcohol use during pregnancy							620	18
Never	82	7		657	57		416	36
Drank alcohol during pregnancy	85	5	<0.01	991	57	0.41	670	38
Folic acid intake							947	27
Never	38	10		233	59		124	31
Start in first 10 weeks	45	6	<0.01	463	58	0.21	291	36
Start periconceptual	62	4	<0.01	753	55	0.01	565	41
Infant characteristics								
Gender							0	0
Male	108	6		974	56		647	38
Female	94	5	0.24	1025	57	0.87	673	38

Ethnicity									70	2
Western	120	4		1490	56		1060	40		
Non-western	71	9	<0.01	473	61	<0.01	237	30		
Birth weight z-score <i>Mean (SD)</i>	-0.24	1.01	<0.01	0.01	0.99	0.77	-0.01	1.04	278	8
Breastfeeding									363	10
Never	16	6		175	63		86	31		
Non- fully for 4 months	134	7	0.62	1219	62	0.77	624	31		
Fully for 4 months	30	3	<0.01	407	45	<0.01	467	52		
Family history of asthma or atopy									153	4
Yes	83	5		894	54		691	41		
No	104	6	0.01	1013	60	<0.01	583	34		
Cow's milk allergy									155	4
Yes	10	5		102	47		103	48		

No	179	6	0.18	1803	57	<0.01	1169	37
Day care attendance							1218	35
Never	28	5		297	57		199	38
< 16 hours	20	3	0.06	369	58	0.85	253	39
16-32 hours	47	4	0.40	614	57	0.96	414	39
≥ 32 hours	7	11	0.06	35	57	0.59	20	32

BMI: Body Mass Index; SD: standard deviation; *P*-values were assessed by using univariate logistic regression analyses.

% represent proportion by row.

Supplementary table 3 Predictors for the timing of introduction of complementary feeding - Original data

	Univariate	Multiple regression	Univariate	Multiple regression
	Model	Model	Model	Model
	< 3 vs. ≥ 6 months	< 3 vs. ≥ 6 months	3-6 vs. ≥ 6 months	3-6 vs. ≥ 6 months
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Maternal characteristics				
Age	0.93 * (0.90-0.96)	-	0.97 * (0.96-0.99)	0.97 * (0.95-1.00)
Ethnicity				
Non-western vs. Western	2.46 * (1.76-3.43)	-	1.40 * (1.17-1.67)	-
Educational level				
Mid vs. Low	0.49 * (0.33-0.73)	-	0.67 * (0.53-0.83)	-
High vs. Low	0.22 * (0.14-0.36)	-	0.51 * (0.41-0.65)	-
Household income per month				
>2200 euro vs. ≤ 2200 euro	0.57 * (0.42-0.78)	-	0.86 (0.73-1.01)	-
Marital status				
No partner vs. Married/living together	3.97 * (2.60-6.07)	-	1.57 * (1.19-2.07)	-
Maternal BMI	1.02 (0.98-1.05)	-	1.02 (1.00-1.04)	-

Multiple parities	1.20 * (1.02-1.41)	-	1.09 (1.00-1.19)	1.39 * (1.14-1.69)
Smoking during pregnancy				
Smoking during pregnancy vs. never	2.04 * (1.41-2.94)	2.03 * (1.35-3.05)	1.48 * (1.21-1.80)	1.27 * (1.01-1.60)
Alcohol use during pregnancy				
Drank alcohol during pregnancy vs. never	0.64 * (0.46-0.89)	-	0.94 (0.80-1.10)	-
Folic acid intake				
Start in first 10 weeks vs. never	0.51 * (0.31-0.82)	0.64 (0.38-1.08)	0.85 (0.65-1.10)	-
Start periconceptional vs. never	0.36 * (0.23-0.56)	0.56 * (0.34-0.94)	0.71 * (0.56-0.91)	-
Infant characteristics				
Gender				
Female vs. Male	0.84 (0.62-1.13)	-	1.01 (0.88-1.16)	-
Ethnicity				
Non-western vs. Western	2.65 * (1.91-3.66)	2.14 * (1.40-3.29)	1.42 * (1.19-1.69)	-
Birth weight (z-score)	0.81 * (0.69-0.94)	-	1.01 (0.94-1.09)	-
Breastfeeding				
Non-fully for 4 months vs. never	1.15 (0.66-2.03)	-	0.96 (0.73-1.27)	1.11 (0.79-1.55)
Fully for 4 months vs. never	0.35* (0.18-0.66)	-	0.43* (0.32-0.57)	0.51* (0.36-0.72)

Family history of asthma or atopy				
Yes vs. No	0.67 * (0.49-0.92)	0.71 (0.49-1.02)	0.75 * (0.65-0.86)	0.74 * (0.62-0.89)
Cow's milk allergy				
Yes vs. No	0.63 (0.33-1.24)	-	0.64 * (0.48-0.85)	0.61 * (0.42-0.89)
Daycare attendance				
< 16 hours vs. never	0.56 (0.31-1.03)	-	0.98 (0.77-1.24)	-
16-32 hours vs. never	0.81 (0.49-1.33)	-	0.99 (0.80-1.24)	-
≥ 32 hours vs. never	2.49 (0.97-6.42)	-	1.17 (0.66-2.09)	-
Hosmer-Lemeshow test	-	χ^2 9.76	-	χ^2 11.89

95% CI: 95% confidence interval; BMI: Body Mass Index; OR: Odds ratio for the introduction of complementary feeding relative to at 6 months and after per group or per unit of continuous predictor; χ^2 : chi-square for the goodness of fit of the model; * *P*-value <0.05.