Infant feeding patterns over the first year of life: influence of family characteristics

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Abstract

Background/Objectives: Early eating patterns and behaviors can determine later eating habits and food preferences and they have been related to the development of childhood overweight and obesity. We aimed to identify patterns of feeding in the first year of life and to examine their associations with family characteristics.

Subjects/Methods: Our analysis included 1004 infants from the EDEN mother-child cohort. Feeding practices were assessed through maternal self-report at birth, 4, 8 and 12 months. Principal component analysis was applied to derive patterns from breastfeeding duration, age at complementary food (CF) introduction and type of food used at 1y. Associations between patterns and family characteristics were analyzed by linear regressions.

Results: The main source of variability in infant feeding was characterized by a pattern labeled 'Late CF introduction and use of ready-prepared baby foods'. Older, more educated, primiparous women with high monthly income ranked high on this pattern. The second pattern, labeled 'Longer breastfeeding, late CF introduction and use of home-made foods' was the closest to infant feeding guidelines. Mothers ranking high on this pattern were older and more educated. The third pattern, labeled 'Use of adults' foods' suggests a less age-specific diet for the infants. Mothers ranking high on this pattern were often younger and multiparous. Recruitment center was related to all patterns.

Conclusion: Not only maternal education level and age but also parity and region are important contributors to the variability in patterns. Further studies are needed to describe associations between these patterns and infant growth and later food preferences.

Keywords: Feeding patterns – Breastfeeding – Complementary feeding – Home-made foods – Ready-prepared foods – Infants – Parents – Sociodemographic factors.

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Introduction

Obesity is a worldwide epidemic and numerous studies have focused on the identification of its early determinants. The early postnatal period appears to be a critical window of development. Observational studies showed that rapid infant weight gain increases the risk of overweight and obesity later in childhood[1-3]. Moreover, childhood obesity seems to track into adulthood[4] increasing the risk of chronic diseases[5]. Early eating patterns and behaviors can determine later eating habits and food preferences[6-7] and they have been related to the development of childhood overweight and obesity[8]. It's therefore important to identify feeding patterns that emerge in the early infancy and related factors.

Most of the pediatric societies recommend exclusive breastfeeding until 6 months of age[9-12]. Further, there is a general consensus on the fact that complementary feeding should not be introduced to infant diet before 4 months or delayed after 6 months. Results from various studies of infant feeding practices have shown high level of non-compliance with these recommendations. Across studies, lower maternal age and education level appeared consistently related to shorter breastfeeding duration and early complementary food (CF) introduction[13-15].

There has been a general cultural shift in eating practices over the last decades. Because more women are working longer hours outside home, there is a decrease in time spent in meal preparations and an increased use of ready-prepared foods[16-17]. Much remains to be learned about how these emerging eating habits affect maternal feeding practices.

A few studies showed that dietary patterns emerge in early infancy[18-19] and track into childhood[20-21]. None of those studies have undertaken a global approach of food intake over the first year of life by taking into account type and duration of milk feeding, age at CF introduction and type of food used by the mother. Yet, breastfeeding and complementary feeding practices are interrelated[22-23] and there are arguments to suggest that both influence later health[24-25]. Our aims were to identify feeding patterns over the first year of life, and to examine their associations with parental and infants characteristics.

Material and Methods

Study population

Subjects were participants of the EDEN mother-child prospective cohort (study of pre- and early postnatal determinants of child health and development). Between 2003 and 2006, the study recruited 2,002 pregnant women aged 18-45 years attending their prenatal visit before 24 weeks gestation at Nancy and Poitiers University Hospitals. Exclusion criteria were multiple pregnancies, diabetes history, illiteracy, moving outside the region planned in the next three years. The study received approval from relevant ethics committee. Files have been declared to the 'National Committee for Processed Data and Freedom' (CNIL). Written consents were obtained from each participant.

Infant feeding assessment

Our infant feeding assessment concentrated on qualitative aspects controlled by the parents and did not include amounts of food ingested, which depend for a great part on the infant. Infant feeding mode at discharge was extracted from medical records. In the 4, 8 and 12-month self questionnaires, mothers reported (1)type of milk feeding and when necessary date of breastfeeding cessation, (2)age at CF introduction. Among infants whose questionnaires were returned, reported data at the different ages were combined to estimate any and full breastfeeding duration and age at CF introduction. In EDEN study, ages of CF introduction were not collected beyond 8 months for cereals, fruit, vegetables, potatoes, fruit juice, dairy products, dairy desserts, cheeses, biscuits, or 12 months for the other foods. For infants who were not introduced to a specific food by 8 or 12 months, respectively the values 9 or 13 were attributed in order to analyze the variable quantitatively. For infants with available information on diet in at least one questionnaire, missing data for some of the key variables were imputed as follows: when mothers reported that the considered food was not introduced in the first 4 months and information was missing in the following questionnaires, the median age of introduction among all infants who have been introduced to that food between 4 and 12 months was attributed (n=27, 0.03%). The same rule was applied for those who were not introduced to foods at 8 months with missing information on at least one CF group at 12 months (n=233, 23.2%).

An additional questionnaire on type of food used for the baby at 12 months was added to the 12-month questionnaire during data collection. It collected information on type (ready-prepared baby foods, home-made foods, ready-prepared adults' foods) and frequency of use (never, occasionally, regularly, always) of various food and juice groups (dairy products, soups, vegetables and fruit purees, fruit juices, biscuits, cereals, meat and fish). Subjects with >2 missing values on the listed items were excluded (n=183, 15.4%); otherwise modal value of the considered variable was imputed (n=57; 4.8%).

Other data

Between 24-28 weeks gestation, household income, maternal education and pre-pregnancy weight were obtained by interviewing the mother; maternal height was measured in a clinical examination. Paternal anthropometric measurements were collected at some point between mother's inclusion and delivery. Details on measurement protocol have been published elsewhere[26]. When measurements were unavailable from the father, reported weight by the father (11.3%) was used, and reported height by the father (11.6%) or by the mother (6.3%) was used. Parental BMI(kg/m^2) were categorized as : underweight (BMI<18.5), normal weight (18.5-<25), overweight (25-<30) and obese (BMI ≥30). Because of small number of underweight fathers in EDEN cohort (n=19; 1.0%), underweight fathers were grouped in the normal BMI categories.

From obstetrical and pediatric records, parity, infant gender, birthweight and gestational age were collected. In the 4, 8 and 12-month questionnaires, mothers were asked information about employment status and main type of childcare. Types of childcare were (1)childcare center, (2)licensed family childcare home, (3)family member, neighbor and (4)child's own home by a nanny or a regular infant sitter or parents themselves. Infants were categorized according to age of first attendance to types (1) and (2).

Missing data were handled as follows: when percentage of missing values was <5%, we imputed the modal class value (maternal education and BMI, household income, parity), otherwise subjects were grouped into a separate category (paternal BMI, childcare attendance).

Sample

Of the 2,002 recruited women, 96 were excluded because they left the study before or at delivery for personal reasons, 4 because intra-uterine death, 3 because they delivered outside the study hospitals. Birthweight was available for 1,899 newborns. The 4, 8 and 12 month-questionnaires of 1,445 infants were returned. Because the additional questionnaire on type of food used at 12 months was added to the 12-month questionnaire during data collection, 496 of the recruited families did not receive it. Among the 1,445 families who returned the 4, 8 and 12-month questionnaires 1,187 also returned the additional questionnaire and 183 had more than 2 missing data on type of food used. The final sample consisted of 1,004 infants. Compared with the 1,004 included, the 895 excluded mothers were younger (29.0 vs. 29.9 years old, $p<0.001$), less educated (44.6% vs. 59.2% university degree, $p<0.001$) and often multiparous (58.3% vs. 52.9%, $p=0.03$). Infants that were not included had lower birthweight and gestational age than that of included infants (3,252g vs. 3,302g, $p=0.04$; 39.1 vs. 39.4, $p<0.001$). There was no statistical difference on gender ($p=0.18$).

Patterns derivation

All the variables described in the infant feeding assessment section were considered for principal component analysis (PCA). PCA is a statistical technique that aggregates variables on the basis of the degree to which they are correlated to one another, producing components that are uncorrelated linear combinations of the initial variables and that maximize the explained variance[27-28]. To determine the number of components to retain, we used the Kaiser criterion (eigenvalues>1) in conjunction to scree test (plot of total variance associated with each component) and interpretability of components. The first 3 components were kept from this analysis. We considered that variables with coefficients>|0.3| contribute significantly to the components. Finally, for each participant, a score was calculated as a sum of the products of the values of each of the standardized variables included in the PCA with the corresponding coefficients of the correlation matrix.

Statistical analysis

Infants' scores on the feeding patterns were used as continuous dependent variables. Unadjusted relations between patterns scores and recruitment centre, parental (maternal

education, age at delivery, BMI and employment status, parity, paternal BMI, income) and infant characteristics (gender, birthweight, gestational age, childcare attendance) were performed by Student t-test or ANOVA for categorical variables, and Spearman correlations for quantitative variables (data not shown). Quartiles of the scores were calculated for presentation purpose. Associations between the pattern scores and family characteristics were examined using multiple regression models. Analyses were executed with SAS software (version 9.2; SAS Institute). A p-value<0.05 was considered statistically significant.

Results

Family characteristics are presented in Table1. The mean birthweight was 3,302 g and 4.1% of the infants were born preterm. The mean duration of full breastfeeding since hospital discharge and age at CF introduction were 2 and 4.5 months respectively. Nearly 26% infants were introduced to solid foods before 4 months.

The first pattern (pattern-1) was characterized by high positive coefficients for introduction of all foods and use of ready-prepared vegetables, fruit purees and baby main meals but by high negative coefficients for use of home-made and ready-prepared adults' foods (Table 2). It was labeled '*Late CF introduction and use of baby foods*'. The second pattern (pattern-2) was termed '*Longer breastfeeding, late CF introduction and use of home-made foods*' since it showed high positive coefficients for breastfeeding duration, age of introduction of meat, fish, vegetables, fruit, potatoes, cereals, dairy products, biscuits and fruit juices and for use of home-made soups, vegetables, fruit purees and fresh meat and fish but high negative coefficients for use of baby foods. The third pattern (pattern-3) was named '*Use of adults' foods*' as it was characterized by high coefficients on use of ready-prepared dairy products, soups, fruit purees, fruit juices and biscuits contrasting with lower coefficients on baby dairy products and on home-made fruit and vegetable purees, fish and meat. The patterns explained 14.7, 12.7, and 6.0% of the variation in the original data respectively. PCA properties allow maximization of variance along each pattern, contrasting individuals whose characteristics differ most[29]. Thus, for each pattern, scores define the position of each individual along a gradient. To facilitate interpretation of the pattern coefficients, distribution of the original variables within the first and fourth quartiles of the patterns scores have been presented in table 2. The higher the coefficient of a variable on a pattern, the greater is the variability in its distribution across quartiles of the patterns scores.

High scores on pattern-1 were significantly related to high family income, maternal age and education, low parity, tended to be more common in females (Table 3). Mothers of infants with high scores on pattern-2 were more likely to be older, to have high education level, and less likely to be obese. High scores on pattern-3 were significantly associated with low maternal age, being multiparous. None of the patterns was significantly related to paternal BMI and infant's gestational age.

We ran the same multivariate models, excluding premature infants (n=27, 0.03%), then excluding subjects having missing values on parental characteristics (n=88, 5.5%). Results remained similar to those presented above (data not shown). Further analyses were performed excluding infants with missing value on CF introduction between 4-12 months (n=27, 0.03%), between 8-12 months (n=233, 23.2%) and type of food use at 12 months (n=57; 4.8%). Results were similar to those presented except for centre that was no longer significantly related to pattern-2 (0.10[-0.07, 0.26]) and pattern-3 (-0.16[-0.32, 0.01]).

Discussion

In our study, the main source of variability in infant feeding was characterized by pattern-1 labeled '*Late CF introduction and use of ready-prepared baby foods'*. Older, more educated, primiparous women with high monthly income ranked high on this pattern. Pattern-2, labeled '*Longer breastfeeding, late CF introduction and use of home-made* was the closest to infant feeding guidelines. Mothers with high scores on this pattern were older and more educated. Pattern-3, labeled *Use of adults' foods* suggests a less age-specific diet for the infants. Mothers ranking high on this pattern were often younger and multiparous.

Recent studies in infants have applied PCA on various food items (from food frequency questionnaires (FFQ)) to derive dietary patterns with a transversal approach[18-19]. Our study is original in its longitudinal aspect: we used breastfeeding duration, age at CF introduction and type of food used at 12 months. This approach enabled us to appreciate the prospective aspect of infant feeding in the first year of life. Although some differences in variables included, our second pattern was similar to the '*infant guidelines*' pattern of the Southampton Women Study[18] and to the '*Breastfeeding*' pattern of ALSPAC study[19], both extracted at 6 months and characterized by longer breastfeeding, high frequency of consumption of home-made foods but low frequency of use of baby foods.

In our study, mothers of infants ranking high on pattern-1 and pattern-3, more often recruited in Nancy, were more likely to use ready-prepared foods but in pattern-1, types of food were adapted to infants whereas in pattern-3, types of food were less specific to infants. In patterns 1 and 2, age of introduction of eggs contributed little to the characterization of early or late introducers of CF, showing that the recommendation of late introduction of eggs (see table 2 footnote) is well met by the mothers in our cohort. Higher scores on pattern-1 seem to be explained by awareness of specific nutritional needs for infant, lack time or culinary skills to implement it and income allowing the use of ready-prepared infant foods. Higher scores on pattern-3 were mainly related to low maternal age and increased parity. Young mothers of our study seem to cook less and the presence of older children in the household decreases the likelihood for a specific diet for the infant. Unlike others, mothers ranking high on pattern-2, more often recruited in Poitiers, breastfed longer, introduced CF later and were more likely to cook meals. These mothers may be more aware of infant feeding guidelines and may have more time to spend for meals preparation. These findings are consistent with previous results that showed a negative relation between age, education and household size and ready-prepared foods use in general population[30-32], which may be explained by lack of time or ability and/or willingness to 'cook from scratch'[16]. Local culture as well as food availability and prices play a major role in determining where, how and what foods are eaten[33]. Type of jobs and time spent in transportation, which are likely to differ between the regions of Poitiers and Nancy may also explain the differences in feeding patterns. Nancy region is more urbanized than Poitiers region (population density of their regions in 2009: 100 people/km sq.[34] vs. 68 people/km sq.[35]). We have to acknowledge that nowadays, ready-prepared foods are widely used and 'home-made' meals sometimes include the help of various ready-prepared products[36]. We were not able to evaluate this aspect in our study.

Longer breastfeeding duration has been positively associated with later CF introduction[22-23], higher maternal age and education level[13,37-38], parity[37,39]. Early CF introduction has been related to lower maternal age and education[13,38,40], higher birthweight[22,41] and infant gender[38,40,42]. Our findings are consistent with those results. When considering the whole feeding in the first year of life, infants' characteristics were not related to the patterns except for a tendency for earlier CF introduction in boys as already published[38,40,42]. Early return to employment in the postpartum period has been negatively associated with breastfeeding duration[43-44]; relations with CF introduction have less been examined. Evidences showed that

infants cared in non-parental care compared with parental care were shorter breastfed[45-46] and early introduced to CF[45]. In our study, maternal employment and childcare attendance were not strongly associated with parental feeding practices suggesting that they are not major factors explaining the variability in infant feeding.

In accordance with other studies[18-19], we found a significant association between the feeding patterns and maternal BMI. Previous analyses suggested that women who are overweight/obese before pregnancy are more likely to discontinue breastfeeding earlier than do normal-weight women[47-50]. In our results, mothers with high scores on pattern-2 were less likely to be obese in contrast to mothers with high scores on pattern-3 who were more likely to be obese. Paternal BMI, marker of a familial obesogenic environment besides maternal BMI, was not related to the patterns.

Our study had some limitations. The EDEN population is not representative of the general population. Compared to the national perinatal survey carried out on 14,482 women who delivered in France in 2003[51], women included in EDEN study were slightly older, more educated and more often employed. We were however able to show differences in infant feeding practices according to maternal age, education, household income, and region even if our sample was more homogenous than the general French population according to these criteria. We did not found association regarding employment status although our sample did not lack variability on this criterion (29% of the mothers never worked between 0-12 months). Therefore, we believe that the relationships observed are of interest for the general population of infants born in France from middle class parents.

Our questionnaire on infant feeding has not been validated as most questionnaires used to assess food habits in infancy (ref JAND). Nevertheless, some questions were repetead in in the 4, 8 and 12-mo questionnaires, which allow to correct for inconsistency in maternal report. As we did not use a FFQ in our study, we were not able to go into details on qualitative aspects of diet at different ages to reproduce published results. However, interesting patterns emerged from our analyses and we believe that our approach provides complementary information to existing publications on feeding practices in the first year of life. Data on breastfeeding duration and age at CF introduction were missing at some ages between 0-12 months. However we were able to retrieve information by combining data from three questionnaires. Imputations that were performed in infants with incomplete data probably lead

to a loss of information in terms of variability of maternal practices but represent a fairly good approximation of early or late CF introduction/breastfeeding discontinuation according to the current guidelines.

In summary, our study allowed the identification of well individualized feeding patterns in the first year of life, which explain a large part of the variability in our samples. It highlighted that not only maternal education level and age but also parity and region are important contributors to the variability in patterns. Our results reflect constraints regarding cooking skills, spendable time on meals preparation, cost and availability of fresh foods in different regions, factors that could be analyzed in depth in future studies.

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Contributors: The EDEN Study group, coordinated by MAC and BH, was responsible for study design and data collection. MAC and BLG were involved in all aspects from study conception to manuscript writing. AB, AF and MB participated in data management for the present analyses. AB analyzed and interpreted the data and wrote the initial draft of the manuscript. BH, RH, MJSC and all the co-authors critically reviewed all sections of the text

for important intellectual content. MAC is the guarantor of the study. All authors had full access to all of the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

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References

1. Monteiro PO, Victora CG. Rapid growth in infancy and childhood and obesity in later life--a systematic review. *Obes Rev* 2005; **6**, 143-154.

2. Botton J, Heude B, Maccario J, Ducimetiere P, Charles MA. Postnatal weight and height growth velocities at different ages between birth and 5 y and body composition in adolescent boys and girls. *Am J Clin Nutr* 2008; **87**, 1760-1768.

3. Druet C, Stettler N, Sharp S, et al. Prediction of childhood obesity by infancy weight gain: an individual-level meta-analysis. *Paediatr Perinat Epidemiol* 2012; **26**, 19-26.

4. Reilly JJ, Methven E, McDowell ZC, et al. Health consequences of obesity. *Archives of Disease in Childhood* 2003; **88**, 748-752.

5. Morrison JA, Glueck CJ, Wang P. Childhood risk factors predict cardiovascular disease, impaired fasting glucose plus type 2 diabetes mellitus, and high blood pressure 26 years later at a mean age of 38 years: the Princeton-lipid research clinics follow-up study. *Metabolism* 2012; **61**, 531-541.

6. Coulthard H, Harris G, Emmett P. Long-term consequences of early fruit and vegetable feeding practices in the United Kingdom. *Public Health Nutr* 2010; **13**, 2044-2051.

7. Beauchamp GK, Mennella JA. Flavor perception in human infants: development and functional significance. *Digestion* 2011; **83 Suppl 1**, 1-6.

8. Lanfer A, Knof K, Barba G, et al. Taste preferences in association with dietary habits and weight status in European children: results from the IDEFICS study. *Int J Obes (Lond)* 2012; **36**, 27-34.

9. Boland M. Exclusive breastfeeding should continue to six months. *Paediatr Child Health* 2005; **10**, 148.

10. Gartner LM, Morton J, Lawrence RA, et al. Breastfeeding and the use of human milk. *Pediatrics* 2005; **115**, 496-506.

11. Turck D. Allaitement maternel : les bénéfices pour la santé de l'enfant et de sa mère. *Archives de Pédiatrie* 2005; **12, Supplement 3**, S145-S165.

12. Agostoni C DT, Fewtrell M, Goulet O, Kolacek S, Koletzko B, Fleischer Michaelsen K, Moreno L, Puntis J, Jacques Rigo, Shamir R, Szajewska H, Turck D, and van Goudoever J.

Complementary feeding : a commentary by the ESPGHAN Comitte on Nutrition. *Journal of Pediatric Gastroenterology and Nutrition* 2008; **46**, 99-110.

13. Dubois L, Girard M. Social inequalities in infant feeding during the first year of life. The Longitudinal Study of Child Development in Quebec (LSCDQ 1998-2002). *Public Health Nutr* 2003; **6**, 773-783.

14. Wijndaele K, Lakshman R, Landsbaugh JR, Ong KK, Ogilvie D. Determinants of Early Weaning and Use of Unmodified Cow's Milk in Infants: A Systematic Review. *Journal of the American Dietetic Association* 2009; **109**, 2017-2028.

15. Schiess S GV, Scaglioni S, Luque V, Martin F, Stolarczyk A, Vecchi F, Koletzko B; European Childhood Obesity Project. Introduction of complementary feeding in 5 European countries. *J Pediatr Gastroenterol Nutr.* 2010; **50**, 92-98.

16. Lang T, Caraher M. Is there a culinary skills transition? Data and debate from the UK about changes in cooking culture. *J HEIA* 2001; **8**, 2-14.

17. Jabs J, Devine CM. Time scarcity and food choices: an overview. *Appetite* 2006; **47**, 196-204.

18. Robinson S, Marriott L, Poole J, et al. Dietary patterns in infancy: the importance of maternal and family influences on feeding practice. *Br J Nutr* 2007; **98**, 1029-1037.

19. Smithers LG, Brazionis L, Golley RK, et al. Associations between dietary patterns at 6 and 15 months of age and sociodemographic factors. *Eur J Clin Nutr* 2012.

20. North K, Emmett P. Multivariate analysis of diet among three-year-old children and associations with socio-demographic characteristics. The Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) Study Team. *Eur J Clin Nutr* 2000; **54**, 73-80.

21. Northstone K, Emmett P. Multivariate analysis of diet in children at four and seven years of age and associations with socio-demographic characteristics. *Eur J Clin Nutr* 2005; **59**, 751-760.

22. Wright CM, Parkinson KN, Drewett RF. Why are babies weaned early? Data from a prospective population based cohort study. *Arch Dis Child* 2004; **89**, 813-816.

23. Scott JA BC, Graham KI, Oddy WH. Predictors of the early introduction of solid foods in infants: results of a cohort study. *BMC Pediatr* 2009; **9**, 60.

24. Van Rossum CMT, Büchner FL, Hoekstra J. Quantification of health effects of breastfeeding : Review of the literature and model simulation. RIVM report 350040001/2005. Available at http://www.rivm.nl/bibliotheek/rapporten/350040001.pdf. Accessed July 6, 2012. 2006.

25. Ziegler AG, Schmid S, Huber D, Hummel M, Bonifacio E. Early infant feeding and risk of developing type 1 diabetes-associated autoantibodies. *JAMA* 2003; **290**, 1721-1728.

26. Regnault N, Botton J, Forhan A, et al. Determinants of early ponderal and statural growth in full-term infants in the EDEN mother-child cohort study. *Am J Clin Nutr* 2010; **92**, 594-602.

27. Joliffe I, Morgan B. Principal component analysis and exploratory factor analysis. *Statistical Methods in Medical Research* 1992; **1**, 69-95.

28. Michels KB, Schulze MB. Can dietary patterns help us detect diet-disease associations? *Nutr Res Rev* 2005; **18**, 241-248.

29. Joliffe IT, Morgan BJ. Principal component analysis and exploratory factor analysis. *Stat Methods Med Res* 1992; **1**, 69-95.

30. Brunner TA, van der Horst K, Siegrist M. Convenience food products. Drivers for consumption. *Appetite* 2010; **55**, 498-506.

31. Buckley M, Cowan C, McCarthy M. The convenience food market in Great Britain: Convenience food lifestyle (CFL) segments. *Appetite* 2007; **49**, 600-617.

32. Olsen NV, Menichelli E, Sørheim O, Næs T. Likelihood of buying healthy convenience food: An at-home testing procedure for ready-to-heat meals. *Food Quality and Preference* 2012; **24**, 171-178.

33. Mela DJ. Food choice and intake: the human factor. *Proc Nutr Soc* 1999; **58**, 513-521.

34. French National Institute of Statistics and Economic Studies (Insee). The Lorraine region : Population structure and evolution (Document in French). http://www.recensement.insee.fr/exportPDF.action?codeZone=41-REG&idTheme=3. Accessed Septembre 25th, 2012.

35. French National Institute of Statistics and Economic Studies (Insee). The Poitou-Charentes region : Population structure and evolution (Document in French). http://www.recensement.insee.fr/exportPDF.action?codeZone=54-REG&idTheme=3. Accessed Septembre 25th, 2012.

36. Carrigan M, Szmigin I, Leek S. Managing routine food choices in UK families: the role of convenience consumption. *Appetite* 2006; **47**, 372-383.

37. Thulier D, Mercer J. Variables associated with breastfeeding duration. *J Obstet Gynecol Neonatal Nurs* 2009; **38**, 259-268.

38. Kristiansen AL, Lande B, Overby NC, Andersen LF. Factors associated with exclusive breast-feeding and breast-feeding in Norway. *Public Health Nutr* 2010; 1-10.

39. Bolling K, Grant C, Hamlyn B, Thornton A. Infant Feeding Survey 2005. *The Information Centre Part of the Government Statistical Service, London* 2007; **Available at http://www.ic.nhs.uk/statistics-and-data-collections/health-and-lifestyles-related-surveys/infant-feeding-survey/infant-feeding-survey-2005. Accessed on November 16, 2010.**

40. Erkkola M, Salmenhaara M, Nwaru BI, et al. Sociodemographic determinants of early weaning: a Finnish birth cohort study in infants with human leucocyte antigen-conferred susceptibility to type 1 diabetes. *Public Health Nutr* 2012; 1-9.

41. Schack-Nielsen L, Sørensen TI, Mortensen EL, Michaelsen KF. Late introduction of complementary feeding, rather than duration of breastfeeding, may protect against adult overweight. *The American Journal of Clinical Nutrition* 2010; **91**, 619-627.

42. Alder EM, Williams FLR, Anderson AS, Forsyth S, Florey C, van der Velde P. What influences the timing of the introduction of solid food to infants? *British Journal of Nutrition* 2004; **92**, 527-531.

43. Gielen AC, Faden RR, O'Campo P, Brown CH, Paige DM. Maternal employment during the early postpartum period: effects on initiation and continuation of breast-feeding. *Pediatrics* 1991; **87**, 298-305.

44. Visness CM, Kennedy KI. Maternal employment and breast-feeding: findings from the 1988 National Maternal and Infant Health Survey. *Am J Public Health* 1997; **87**, 945-950.

45. Kim J, Peterson KE. Association of infant child care with infant feeding practices and weight gain among US infants. *Arch Pediatr Adolesc Med* 2008; **162**, 627-633.

46. Benjamin SE, Rifas-Shiman SL, Taveras EM, et al. Early child care and adiposity at ages 1 and 3 years. *Pediatrics* 2009; **124**, 555-562.

47. Hilson JA, Rasmussen KM, Kjolhede CL. Maternal obesity and breast-feeding success in a rural population of white women. *Am J Clin Nutr* 1997; **66**, 1371-1378.

48. Baker JL, Michaelsen KF, Sorensen TI, Rasmussen KM. High prepregnant body mass index is associated with early termination of full and any breastfeeding in Danish women. *Am J Clin Nutr* 2007; **86**, 404-411.

49. Amir LH, Donath S. A systematic review of maternal obesity and breastfeeding intention, initiation and duration. *BMC Pregnancy Childbirth* 2007; **7**, 9.

50. Mok E, Multon C, Piguel L, et al. Decreased full breastfeeding, altered practices, perceptions, and infant weight change of prepregnant obese women: a need for extra support. *Pediatrics* 2008; **121**, e1319-1324.

51. Blondel B, Supernant K, Du Mazaubrun C, Breart G. Trends in perinatal health in metropolitan France between 1995 and 2003: results from the National Perinatal Surveys. *J Gynecol Obstet Biol Reprod (Paris)* 2006; **35**, 373-387.

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Table 1: Characteristics of parents and offspring (n=1,004).

Variable	Total	Mean ± SD or % yes
Parental characteristics		
Education (% university degree)	984	60.4 %
Monthly family income < 3,000 €	999	69.0 %
Primiparous	1,002	47.0 %
The mother never worked in 0-12 months	1,004	29.1 %
Maternal age at child's birth (yrs)	1,004	29.9 ± 4.7
Maternal pre-pregnancy BMI < 25 kg/m²	987	75.1 %
Paternal BMI < 25 kg/m²	931	47.9 %
Child characteristics		
Female sex	1,004	48.9 %
Gestational age (weeks of amenorrhea)	1,004	39.2 ±1.7
Birthweight (kg)	1,004	3.3 ± 0.5
Never attended to childcare in the first year of life	753	11.2
Other variables		
Recruitment center (% Poitiers)	1,004	43.6 %

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Table 2: Description of infant feeding variables within quartiles (Q) of pattern scores and PCA coefficients, n=1004.

	Pattern 1			Pattern 2			Pattern 3		
	Q1	**Q4**	**Coefficients**	**Q1**	**Q4**	**Coefficients**	**Q1**	**Q4**	**Coefficients**
*Breastfeeding duration in the first year (months)**									
Any breastfeeding duration	2.58	4.55	0.20	1.58	6.13	**0.48**	2.99	3.76	0.08
Full breastfeeding duration	1.50	2.67	0.17	0.75	4.02	**0.47**	1.55	2.40	0.11
*Ages of food introduction in the first year (months)**									
Meat	6.20	7.47	**0.33**	6.09	7.90	0.51	6.47	7.31	0.20
Fish	6.95	9.01	**0.39**	6.82	9.37	**0.47**	7.66	8.41	0.11
Vegetables	4.34	5.92	**0.40**	4.20	6.04	**0.50**	4.81	5.66	0.21
Fruit	4.46	6.08	**0.36**	4.37	6.17	**0.43**	4.86	5.92	0.23
Potatoes	5.25	7.00	**0.41**	5.45	6.86	**0.34**	5.62	6.75	0.26
Cereals	5.70	8.06	**0.35**	5.79	8.12	**0.38**	6.73	6.94	0.02
Dairy products	5.42	7.33	**0.47**	5.60	7.40	**0.47**	6.01	6.79	0.16
Cheeses	7.99	8.90	**0.41**	8.48	8.79	0.12	8.45	8.69	0.07
Dairy desserts	6.94	8.68	**0.49**	7.41	8.30	0.26	8.06	7.74	-0.12
Biscuits	7.00	8.39	**0.35**	6.89	8.63	**0.42**	7.49	8.10	0.12
Eggs	11.5	12.4	0.29	11.8	12.1	0.09	11.8	12.0	0.01
Egg yolks	9.83	11.6	**0.39**	10.9	10.8	-0.02	10.2	11.1	0.18
Fruit juices	6.38	8.44	**0.40**	6.65	8.42	**0.35**	7.12	7.89	0.14
Cow's milk	10.0	12.7	**0.49**	11.6	12.0	0.07	12.1	11.2	-0.18
*Use of Ready-prepared baby foods at 12 mo***									
Dairy products	39.4	73.9	0.25	79.5	39.0	**-0.34**	84.9	31.5	**-0.42**
Soups	21.3	44.3	0.23	62.3	6.8	**-0.52**	28.3	27.0	0.01
Vegetables puree	24.9	81.8	**0.53**	83.1	17.9	**-0.56**	34.3	60.9	0.20
Fruit puree	42.6	93.3	**0.47**	84.7	45.8	**-0.38**	75.7	54.8	-0.23
Fruit juices	10.4	7.9	-0.09	22.5	2.4	**-0.34**	18.7	6.1	-0.18

Biscuits	24.9	36.8	0.15	41.8	20.7	-0.18	42.2	18.9	-0.26
Cereals	53.0	37.1	-0.12	58.6	33.1	-0.27	58.6	42.3	-0.13
Main meals (including meat, fish and vegetables)	33.3	84.6	**0.46**	91.2	17.5	**-0.65**	37.9	67.3	0.25
*Use of ready-prepared adults' foods at 12 mo***									
Dairy products	72.3	26.7	**-0.41**	36.9	56.2	0.11	25.5	79.8	**0.48**
Soups	18.5	6.7	**-0.37**	9.2	6.8	-0.06	1.6	21.0	**0.40**
Vegetables puree	34.1	17.0	**-0.48**	10.4	17.5	0.09	7.6	25.8	0.25
Fruit puree	44.2	5.1	**-0.49**	16.5	20.7	0.00	4.8	45.6	**0.50**
Fruit juices	17.7	0.0	**-0.44**	7.6	7.6	-0.09	2.0	12.9	**0.31**
Biscuits	51.4	4.7	**-0.48**	27.3	20.3	-0.11	8.0	46.0	**0.41**
Cereals	12.9	1.2	**-0.32**	5.2	2.8	-0.04	2.4	10.1	0.19
Processed meat and fish	31.7	3.2	**-0.45**	10.8	15.9	0.06	9.6	18.6	0.11
*Use of home-made foods at 12 mo***									
Dairy products	18.1	1.2	**-0.45**	4.0	13.9	0.08	11.2	4.0	-0.04
Soups	60.6	11.5	**-0.44**	10.0	68.5	**0.46**	61.8	24.2	**-0.32**
Vegetables puree	68.7	22.1	**-0.43**	12.5	89.6	**0.62**	74.9	33.1	**-0.39**
Fruit puree	25.3	10.3	-0.24	4.8	52.2	**0.52**	33.5	10.1	-0.28
Fruit juices	8.0	0.8	-0.22	0.4	6.4	0.15	6.8	2.8	-0.15
Biscuits	12.6	17.4	**-0.40**	1.6	8.0	0.14	6.0	6.5	0.02
Fresh meat and fish	69.5	13.4	**-0.48**	8.4	76.5	**0.52**	70.9	27.8	**-0.39**

* Values in Q1 and Q4 are means. ** Values in Q1 and Q4 are proportion of subjects using the considered type of food regularly or always.
Patterns coefficients ≥ |0.3| are shown in bold. Pattern 1: *'Late complementary food introduction and use of baby foods'*, Pattern 2: *'Longer breastfeeding, late complementary food introduction and use of home-made foods'*, Pattern 3*: 'Use of adult's foods'*. French recommendations on introduction of various CF groups are available in the infant's personal health record and are the following: fruit, vegetables, potatoes, cereals, meat and fish should be introduced to the infant between 5 and 7 month; dairy products and cheeses between 6 and 7 months; eggs from 7 months.

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Table 3: Multivariate associations between infant feeding patterns and family characteristics in EDEN cohort study, n=1004.

		Feeding patterns					
	n	*Late CF* introduction and use of baby foods*		*Longer breastfeeding, late CF* introduction and use of home-made foods*		*Use of adults' foods*	
		β	95% CI**	β	95% CI	β	95% CI
Recruitment center							
Nancy	566	Referent		Referent		Referent	
Poitiers	438	**-0.25**	**-0.38, -0.13**	**0.16**	**0.03, 0.29**	**-0.20**	**-0.33,-0.07**
Parental characteristics							
Mother's age at child's birth(y)	1004	**0.02**	**0.00, 0.03**	**0.03**	**0.01, 0.04**	**-0.03**	**-0.04,-0.01**
Maternal Education							
No diploma	240	**-0.32**	**-0.51, -0.14**	**-0.61**	**-0.80, -0.41**	0.11	-0.08, 0.30
High school diploma	170	**-0.22**	**-0.41, -0.03**	**-0.36**	**-0.56, -0.17**	-0.03	-0.23, 0.17
2-year university degree	225	-0.11	-0.26, 0.05	**-0.28**	**-0.45, -0.12**	-0.07	-0.24, 0.09
≥ 3-year university degree	369	Referent		Referent		Referent	
Monthly family income (euros)							
<1501	113	**-0.50**	**-0.76, -0.25**	-0.03	-0.29, 0.23	0.19	-0.08, 0.45
1501-2300	300	**-0.22**	**-0.40, -0.04**	-0.09	-0.27, 0.09	0.06	-0.12, 0.25
2301-3000	281	-0.11	-0.27, 0.05	-0.04	-0.20, 0.13	0.15	-0.02, 0.32
>3000	310	Referent		Referent		Referent	
Maternal employment status in the first year							
Worked from 0-4m	397	Referent		Referent		Referent	
Worked from 4-8m	243	0.06	-0.13, 0.26	0.07	-0.13, 0.26	0.03	-0.17, 0.22
Worked from 8-12m	72	-0.07	-0.37, 0.23	0.04	-0.27, 0.34	0.24	-0.07, 0.55
Never in the 1st year	292	-0.15	-0.44, 0.13	-0.00	-0.29, 0.29	0.28	-0.02, 0.58
Parity							
1	473	Referent		Referent		Referent	
2	359	**-0.15**	**-0.29, -0.02**	-0.01	-0.15, 0.13	**0.30**	**0.15, 0.44**
≥ 3	172	**-0.22**	**-0.43, -0.02**	-0.14	-0.34, 0.07	**0.47**	**0.26, 0.68**

Maternal BMI							
Thin	84	0.12	-0.10, 0.34	0.03	-0.19, 0.26	-0.03	-0.28, 0.22
Normal	674	Referent		Referent		Referent	
Overweight	169	**-0.19**	**-0.35, -0.03**	-0.13	-0.29, 0.04	0.06	-0.07, 0.20
Obese	77	0.00	-0.23, 0.23	**-0.24**	**-0.47, -0.00**	0.17	-0.07, 0.41
Paternal BMI							
Missing	73	-0.06	-0.30, 0.18	-0.15	-0.40, 0.09	-0.03	-0.28, 0.22
Normal	481	Referent		Referent		Referent	
Overweight	370	-0.08	-0.21, 0.05	0.04	-0.09, 0.17	0.06	-0.07, 0.20
Obese	80	0.03	-0.20, 0.26	0.08	-0.16, 0.32	0.17	-0.07, 0.41
Infant characteristics							
Birthweight (kg)	1004	0.00	-0.15, 0.15	0.11	-0.04, 0.26	0.04	-0.12, 0.19
Gestational age (weeks of amenorrhea)	1004	-0.01	-0.05, 0.04	0.02	-0.03, 0.07	0.01	-0.03, 0.06
Gender							
Male	513	**-0.12**	**-0.24, -0.00**	-0.02	-0.14, 0.10	-0.04	-0.16, 0.09
Female	491	Referent		Referent		Referent	
Infant's age at first attendance to childcare							
Missing	251	0.08	-0.21, 0.38	0.29	-0.01, 0.59	-0.21	-0.52, 0.09
0-4m	364	Referent		Referent		Referent	
4-8m	208	0.11	-0.09, 0.31	0.12	-0.09, 0.32	-0.09	-0.30, 0.12
8-12m	69	0.06	-0.25, 0.37	0.25	-0.06, 0.57	-0.22	-0.54, 0.10
Never in the 1st year	112	-0.00	-0.23, 0.22	0.11	-0.12, 0.34	-0.01	-0.25, 0.22

* CF : complementary food, ** CI : Confidence interval