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Sociodemographic determinants of early weaning: a Finnish birth cohort study in infants with human leucocyte antigen-conferred susceptibility to type 1 diabetes

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Abstract

Objective: To assess the most important sociodemographic determinants of age at introduction of complementary foods in infancy.
Design: A prospective birth cohort with increased risk of type 1 diabetes, recruited between 1996 and 2004. The families completed at home a follow-up form on the age at introduction of new foods and, for each clinic visit, a structured dietary questionnaire with 3 d food records.
Setting: Data from the Type 1 Diabetes Prediction and Prevention (DIPP) Project, Finland.
Subjects: A cohort of 5991 infants (77 % of those invited) belonging to the DIPP Nutrition Study.
Results: Sixty-three per cent of the infants were introduced to complementary foods, including infant formula, before the age of 4 months. The median age at introduction of infant formula was 1·5 months (range 0–18 months) and that of the first other complementary food 3·5 months (range 0·7–8 months). All sociodemographic and lifestyle factors studied were associated with the age at introduction of infant formula and/or first other complementary food. Female sex of the infant, being born in the southern region of Finland, living in a rural municipality, the presence of siblings, the mother or the father being a high-school graduate, high maternal professional education and maternal non-smoking during pregnancy predicted later introduction of complementary foods.
Conclusions: Compliance was relatively poor with the current recommendations for the age of introducing complementary foods. Small-sized young families with less well-educated parents were most prone to introduce complementary foods early.

Keywords
Infant feeding
Complementary food
Infant formula
Sociodemographic determinants

An appropriate diet is critical for the growth and development of children, especially during the first 2 years of life[1]. Timing of weaning is particularly important, given the immaturity of the gastrointestinal, renal and neurophysiological systems in early infancy and the health risks associated with early weaning[2]. Infant feeding is mostly considered in terms of three overlapping periods: (i) the period of exclusive breast-feeding, (ii) the weaning period and (iii) the period of a modified family diet[3,4]. Eating behaviours and particular dietary patterns developed during infancy remain relatively stable and may be reflected in food choices made later in life[5].

Complementary feeding (weaning) is defined as the process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants and therefore other foods and liquids are needed, along with breast milk. Since 2003, the WHO global infant feeding recommendations have stated that infants should be exclusively breast-fed for the first 6 months of life and thereafter should receive nutritionally adequate and safe

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complementary foods to meet their evolving nutritional requirements[4]. The Finnish national recommendations on infant feeding were updated in 2004 to follow the global recommendations[6]. Instead of the earlier recommendation of 4 months of age at the earliest, complementary foods are now recommended to be introduced flexibly by 6 months of age at the latest depending on the needs and growth of the child[6].

Social class differences in diet and health are seen in all ages, beginning in early life[7,8]. Food preferences are strongly influenced by social, demographic and lifestyle factors related to the family, particularly the mother[9]. Risk factors, including lack of breast-feeding, early weaning, smoking, physical inactivity, obesity and unhealthy diet, are clustered in the lower socio-economic groups[10,11]. In the industrialised countries, children of well-educated, older and non-smoking mothers come closer to meeting recommended food habits[12–15]. The impact of other family characteristics has been more controversial.

We have demonstrated previously that feeding practices on the maternity ward and length of breast-feeding are strongly influenced by sociodemographic determinants[15]. In the present study we aimed to assess the age at introduction of complementary foods within a large cohort of Finnish infants and to identify the most important sociodemographic determinants. Relatively little is known about factors associated with the timing of introducing complementary foods, particularly with regard to Finnish infants.

Participants and methods

The participants in the present study were recruited from the Type 1 Diabetes Prediction and Prevention (DIPP) cohort[16]. Written informed consent to screening for genetic susceptibility to type 1 diabetes of the newborn infant was asked of the parents. The families of children with a *hla-dQb1*-conferred genetic susceptibility to type 1 diabetes (*hla-dQb1**02/0302 heterozygous and *dQb1**0302/x-positive individuals, x standing for homozygosity or a neutral allele) were invited to a prospective follow-up study. The children were observed for diet, growth, viral infections and autoantibodies associated with type 1 diabetes at intervals of 3 to 12 months. The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Ethical Committees of the University Hospitals of Turku, Oulu and Tampere, Finland. The present series comprises the at-risk children born between 2 September 1996 and 31 August 2004 at Oulu University Hospital and between 20 October 1997 and 5 September 2004 at Tampere University Hospital. A total of 5991 participants (77 % of the children invited) in the present study comprised the children in those families who had returned at least one of the study questionnaires during the first two follow-up years (characteristics presented in Table 1). From a questionnaire completed at 3 months after delivery, the following information was obtained: parents' age, basic and vocational education and occupation and the number of siblings. Data on duration of gestation, mode of delivery, birth weight and length and maternal smoking during pregnancy were obtained from the Medical Birth Registries of the Oulu and Tampere University.

Dietary and background data collection

Structured dietary questionnaire

Data on infant feeding were obtained from questionnaires completed at the ages of 3 and 6 months. At the age of 3 months, all the food items the infant had received so far were carefully recorded in the questionnaire. Both questionnaires asked for the duration of breast-feeding and the age at introduction and brand names of all infant formulas that the child had received. Accordingly, the age at introduction of other products based on cow's milk (such as sour milk, yoghurt, ice cream) and foods and drinks containing cow's milk were recorded. Trained study nurses checked the questionnaires during the clinic visits.

Follow-up form

During the first 2 years of life the family was asked to update continuously at home the 'age at introduction of new foods' form, developed by the DIPP nutrition research group. Parents were asked to mark down on the dietary follow-up form the age when the infant started to receive various supplementary foods (including taste portions of food). The form includes the following food groups: fruits and berries; potato; carrot; spinach and beetroot; turnip and swede; cabbages; lettuce; wheat; barley; oats; rye; maize, rice, millet and buckwheat; pork; beef; chicken; other meats; sausage; fish; egg; sour milk products; foods containing cow's milk; cow's milk and ice cream; and soya products. The age of the infant when exclusive and total breast-feeding was stopped was added by a study nurse during the interview. The follow-up form was completed at home and checked at every visit, and the information was transferred to the dietary database.

3 d Food record

A 3 d food record was collected at the age of 3 and 6 months. The 3 d food record comprised two consecutive weekdays and one weekend day. Families were instructed to record all foods and drinks that the child consumed during the recording days with the amount, brand, recipe and preparation method. Portion size was estimated with household measures (e.g. spoons, cups, glasses and decilitres). Trained study nurses checked food records during the respective visits[17].

Food records were entered and processed with the software program that uses the Fineli Nutrition Database and the Fineli Dietary Database. Fineli was developed,

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and is being continuously updated, by the Finnish National Institute for Health and Welfare[18]. The DIPP Nutrition Study added industrial baby foods and infant formulas to the existing food selection of Fineli. The system is able to accommodate the creation or modification of specific recipes, and personal recipes were used whenever possible. The amount of food intake was calculated for the following food groups: roots (including potato), fruits and berries, milk products (including infant formula), cereals (wheat, barley, oat and rye), meat and fish.

Data analysis

Mann–Whitney and Kruskal–Wallis tests were used to analyse the differences in median month of the beginning of formula use and the introduction of first complementary foods according to the selected maternal and infant characteristics. Multiple logistic regression analysis was performed to examine the association between background characteristics of the participants and the introduction of complementary foods (infant formula, roots or fruits, and cereals). The selection of background characteristics included in the logistic regression model was based on evidence from the literature and the associations found in the Mann–Whitney and Kruskal–Wallis tests. The characteristics were categorised as shown in Table 1. In the logistic regression analysis, early introduction (i.e. the lowest tertile) was used as the outcome for the dependent variables. In all analyses, $P < 0{\cdot}05$ was considered statistically significant. The SPSS for Windows statistical software package version 15·0 (SPSS Inc., Chicago, IL, USA) was used for the statistical analyses.

Results

Breast-feeding, introduction of complementary foods and background characteristics of participants

Characteristics of the participating families and their infants are shown in Table 1. The median duration of exclusive and total breast-feeding of the infants was 1·4 months (range 0–8 months) and 7 months (range 0–25 months), respectively. At the age of 1 year, 18 % of the infants were still being breast-fed. The median age at introduction of infant formula was 1·5 months (range 0–18 months), while the first complementary food was introduced at a median age of 3·5 months (range 0·7–8 months). The first complementary foods introduced to the infants (apart from infant formula) were roots (potatoes and carrots), fruits and berries (Table 2). Egg was introduced at a median age of 9·5 months (range 1–41 months). Figure 1 presents the survival probability *v.* age for the introduction of infant formula and any solid food observed in the participating infants.

Later introduction of infant formula was seen among children living in southern Finland, those with two or more siblings, those whose parents were high-school graduates (compared with less than high-school graduates), those whose mothers had university studies or a degree (compared with those with lower vocational education), those whose fathers had secondary vocational education and those whose mothers did not smoke during pregnancy (Table 1). Later introduction of solid foods was seen among girls, children living in southern Finland, those with two or more siblings, those with a high-school graduated mother or father, those having a mother or a father with university studies or a degree, those with an older (≥35 years) mother and those whose mothers did not smoke during pregnancy (Table 1).

The quantities of foods eaten increased with increasing age of the infant (Table 2). Already at the age of 6 months, an average diet included foods from all of the main food groups.

Association of measured sociodemographic factors with infant diet

In the logistic regression models, several sociodemographic variables were associated with the risk of early introduction of infant formula and other complementary foods (Table 3). Number of siblings in the family and maternal professional education were inversely associated, and maternal age positively associated, with the early introduction of infant formula. With a few exceptions, female gender, living in southern Finland, living in a rural municipality, number of siblings and maternal and paternal education showed inverse associations, and maternal smoking during pregnancy a positive association, with the early introduction of first solid food (Table 3).

Discussion

In this large, prospective birth cohort study, feeding during the first 2 years of life among 5991 Finnish infants was assessed using a continuously updated follow-up form and age-specific structured dietary questionnaires with 3 d food records at 3 and 6 months of age. Only 37 % of the infants adhered to the national recommendation at the time, to be introduced to complementary foods no earlier than at the age of 4 months. Also, compliance was relatively poor with the current recommendation for exclusive breast-feeding; 1·4 *v.* 6 months. The weaning process seemed to be strongly associated with infant and maternal characteristics; with high maternal basic and vocational education, high paternal basic education, older maternal age, having a non-smoking mother, living in the southern part of Finland, living in a rural municipality, the presence of siblings and female gender of the infant predicting later introduction of complementary foods.

In total, 63 % of the infants were introduced to complementary foods earlier than at the age of 4 months. Other studies conducted in the late 1990s and early 2000s

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Table 1 Characteristics of the participating infants and their families according to timing of the introduction of complementary foods, DIPP (Type I Diabetes Prediction and Prevention) Nutrition Study, Finland

Characteristic	*n*	%	Age at introduction of infant formula (includes feeding in the delivery hospital)† (months)		Age at introduction of the first complementary food, other than infant formula† (months)	
			Median	Range	Mean	SD
Infant sex			*		**	
Boys	3181	53	1·15	0–21	3·37	0·99
Girls	2810	47	1·38	0–16	3·45	0·98
Hospital of birth			**		**	
Oulu (north Finland)	2860	48	1·00	0–21	3·33	0·98
Tampere (south Finland)	3131	52	1·50	0–16	3·48	0·99
Degree of urbanization						
Rural municipality	4570	76	1·10	0–16	3·48	1·03
Semi-urban municipality	561	9	1·15	0–16	3·34	0·97
Urban municipality	811	14	1·38	0–21	3·40	0·98
Missing information	49	1	1·00	0–16	3·44	1·01
Number of siblings in the family‡			**		**	
None	2714	45	1·10	0–18	3·29	0·94
One	1791	30	1·38	0–16	3·43	1·02
Two or more	1291	22	1·50	0–21	3·62	1·00
Missing information	195	3	1·38	0–16	3·39	0·95
Maternal basic education‡			**		**	
Less than high-school graduate	2575	43	1·00	0–16	3·23	1·00
High-school graduate	3163	53	1·73	0–21	3·56	0·95
Missing information	253	4	1·38	0–16	3·33	0·98
Maternal professional education			**		**	
None or vocational school or course	2165	36	1·00	0–16	3·18	0·99
Secondary vocational education	2521	42	1·38	0–18	3·45	0·96
University studies or a degree	1280	21·5	2·13	0–21	3·72	0·94
Missing information	25	0·5	0·78	0–3	2·34	0·93
Paternal basic education‡			**		**	
Less than high-school graduate	3440	58	1·10	0–18	3·31	0·99
High-school graduate	2181	36	1·61	0–21	3·58	0·96
Missing information	370	6	1·00	0–16	3·25	0·96
Paternal professional education			**		**	
None or vocational school or course	2812	47	1·00	0–16	3·27	0·95
Secondary vocational education	1611	27	1·80	0–18	3·50	0·95
University studies or a degree	1248	21	1·66	0–21	3·63	1·01
Missing information	320	5	1·00	0–16	3·21	0·99
Maternal age (years)‡					**	
<25	1120	19	1·10	0–16	3·16	0·92
25–29	2048	34	1·38	0–21	3·35	0·99
30–34	1753	29	1·50	0–16	3·50	0·94
≥35	1070	18	1·00	0–16	3·62	1·06
Maternal smoking during pregnancy			**		**	
Yes	575	10	0·81	0–16	2·91	0·90
No	5211	87	1·38	0–21	3·46	0·98
Missing information	205	3	1·13	0–18	3·43	0·99
Total	5991	100				

Significant differences between the classes: $*P<0·05$, $**P<0·01$.
†*P* values based on Mann–Whitney and Kruskal–Wallis tests of heterogeneity between the classes. Class of missing values is not taken into account in the analysis.
‡At the time of the child's birth.

also reported rather high rates of non-compliance with the earlier WHO recommendations, with one-third of UK[19], 34 % of Italian[20], 41 % of US[3] and 44 % of Australian[14], but interestingly only 5 % of Swiss[21] infants receiving solid foods before 4 months of age. In well baby clinics, clearer guidance to parents about the appropriate time to introduce their infants to solids seems to be of importance. The potential to achieve an enormous health gain through improved diet in early infancy is unquestionable. Early weaning could affect child growth and neurocognitive development, and increase the risk for obesity, CVD, type 1 diabetes and allergic diseases[2,4]. The immune defence mechanisms of the infant gut mature with age and the putative dietary regulation of autoimmunity may well depend on age[22]. Age at introduction of foods is also related to later food consumption. Early introduction to solid foods could be a risk factor for earlier cessation of breast-feeding and increased consumption of fatty and sugary foods at 1 year of age[3].

In the present study, the number of siblings and maternal professional education were more strongly associated with positive child feeding practices than other

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Table 2 Daily food consumption (g/d) of the participating infants at 3 and 6 months of age, DIPP (Type I Diabetes Prediction and Prevention) Nutrition Study, Finland

	Age at introduction (months)		Food intake at 3 months (g/d)					Food intake at 6 months (g/d)				
			All children (n 1918)		Consumers			All children (n 1529)		Consumers		
	Median	Range	Mean	SD	Mean	SD	n % of all	Mean	SD	Mean	SD	n % of all
Potato	3·5	0·2–19	2·8	9·1	13	16	22	43	33	44	16	96
Roots	3·5	0·2–12	1·0	4·9	12	13	8·4	11	16	20	17	53
Fruits and berries	4	0–12	3·2	11·8	19	25	17	51	35	53	35	97
Infant formula	1·5	0–21	241	345	508	341	47	278	298	426	270	65
Milk products	10·5	0·2–25	7·7	39·1	118	102	6·5	90	118	142	121	63
Cereals (oats, barley, wheat, rye)	5	0·2–23	0·1	0·8	5·9	5·7	1·1	7·9	9·7	15	12	79
Meat	5	1–24	0·0	0·1	1·3	0·7	0·2	14	13	17	12	79
Fish	7	1–25	0·0	0·0	0·0	0·0	0	0·8	2·7	5·9	5·1	13

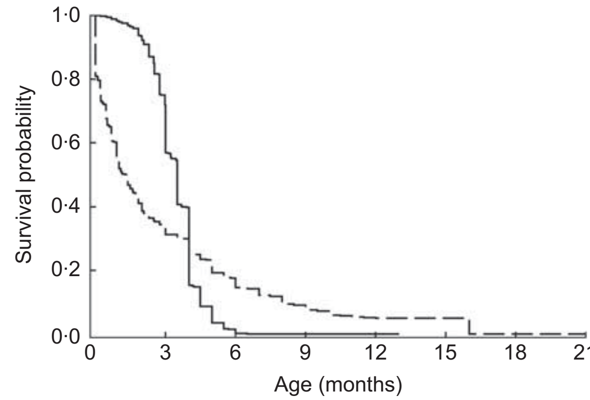

Fig. 1 Survival probability *v.* age for the introduction of infant formula (— — —) and any solid food (——) observed in the participating infants, Type 1 Diabetes Prediction and Prevention (DIPP) Nutrition Study, Finland

background characteristics. A higher number of siblings and increasing length of maternal professional education increased the odds for later introduction of infant formula and other complementary foods. Interestingly, maternal professional education was a stronger determinant of early infant feeding than maternal basic education. Contradictory to that, paternal basic education was a stronger determinant of early infant feeding than professional education. Mother's professional education may be associated with an inclination to consume healthy foods, while the education of the father is probably a more important determinant of available economic resources, especially in families with young children[23]. However, paternal professional education did associate with the duration of breast-feeding in our earlier study in the same cohort of children[15]. Partners can have a significant impact in supporting breast-feeding if they are positive about breast-feeding and have skills to support it[24]. The required skills might improve alongside increasing education. In earlier studies, higher maternal education has been consistently associated with healthier diet in childhood[3,12–15,20,21,25]. Studies regarding paternal education seem to be scarce. The finding on the positive association between the presence of siblings and later introduction of complementary foods brings an additional piece of evidence to clarify earlier inconclusive findings[13,21]. However, education seems to be the key determinant of feeding in infancy. It is a challenge in Finland, as well as in most Western countries, to develop new and creative information channels and to sharpen the information to specific target groups in order to improve the diet of families having less-educated parents.

Boys were introduced to the first complementary foods earlier than girls. Previous findings have been somewhat conflicting[13–15]. We showed earlier that in 1-, 3- and 6-year-old children average variance ratios of macro- and micronutrient intake were greater in girls than in boys[26].

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Table 3 Adjusted odds ratios and 95 % confidence intervals for early introduction of first complementary foods† in participating infants, DIPP (Type I Diabetes Prediction and Prevention) Nutrition Study, Finland

	Infant formula (<1·5 months)		Potato (<3·2 months)		Carrot (<3·5 months)		Fruits and berries (<3·5 months)	
Characteristic	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Infant sex								
Boys	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
Girls	1·06	0·94, 1·19	0·73**	0·65, 0·82	0·73**	0·64, 0·84	0·90	0·79, 1·02
Hospital of birth								
Northern Finland	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
Southern Finland	0·71**	0·63, 0·80	0·66**	0·58, 0·75	0·56**	0·49, 0·64	0·61**	0·53, 0·70
Degree of urbanization‡								
Urban municipality	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
Semi-urban municipality	1·07	0·87, 1·32	1·01	0·82, 1·25	0·99	0·79, 1·24	1·05	0·84, 1·31
Rural municipality	1·05	0·88, 1·26	0·78**	0·65, 0·94	0·78*	0·64, 0·94	0·89	0·74, 1·08
Number of siblings in the family‡								
None	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
One	0·85*	0·74, 0·98	0·90	0·79, 1·04	1·02	0·88, 1·19	0·95	0·82, 1·11
Two or more	0·79**	0·67, 0·93	0·61**	0·51, 0·73	0·68**	0·56, 0·82	0·68**	0·57, 0·82
Maternal basic education‡								
Less than high-school graduate	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
High-school graduate	0·93	0·80, 1·08	0·88	0·76, 1·02	0·77**	0·65, 0·90	0·76**	0·65, 0·89
Maternal professional education‡								
None or vocational school or course	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
Secondary vocational education	0·83*	0·71, 0·97	0·66**	0·57, 0·77	0·64**	0·55, 0·76	0·67**	0·57, 0·78
University studies or a degree	0·78*	0·63, 0·97	0·47**	0·37, 0·59	0·38**	0·29, 0·49	0·47**	0·37, 0·60
Paternal basic education‡								
Less than high-school graduate	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
High-school graduate	1·03	0·87, 1·23	0·81*	0·67, 0·96	0·77**	0·64, 0·94	0·77**	0·63, 0·92
Paternal professional education‡								
None or vocational school or course	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
Secondary vocational education	0·93	0·79, 1·10	0·95	0·80, 1·11	0·88	0·74, 1·05	0·96	0·81, 1·15
University studies or a degree	1·00	0·80, 1·25	0·90	0·71, 1·14	0·92	0·71, 1·19	1·05	0·81, 1·35
Maternal age (years)								
<25	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
25–29	1·30**	1·08, 1·55	1·01	0·85, 1·21	0·99	0·83, 1·20	0·92	0·77, 1·11
30–34	1·35**	1·11, 1·64	0·93	0·77, 1·13	0·98	0·80, 1·19	0·88	0·72, 1·07
≥35	1·73**	1·39, 2·15	0·91	0·73, 1·13	0·82	0·65, 1·04	0·83	0·66, 1·05
Maternal smoking during pregnancy‡								
No	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
Yes	1·18	0·96, 1·45	1·99**	1·62, 2·44	1·97**	1·60, 2·43	1·87**	1·53, 2·30

Ref., referent category.
Significant OR and 95 % CI: *$P<0·05$, **$P<0·01$.
†The models included all covariates presented in the table. Early introduction (i.e. the lowest tertile) was used as the outcome for the dependent variables.
‡Missing information: degree of urbanization, *n* 49 (0·8 %); number of siblings, *n* 195 (3·3 %); maternal basic education, *n* 253 (4·2 %); maternal professional education, *n* 25 (0·4 %); paternal basic education, *n* 370 (6·2 %); paternal professional education, *n* 320 (5·3 %); maternal smoking during pregnancy, *n* 205 (3·4 %).

The finding implies sex differences in timing of introducing foods and adjusting to the family diet. Whether boys' earlier introduction to complementary foods reflects hidden expectations for males to show rapid 'masculine' growth already during infancy is unknown. It has been indicated that the infant's weight itself is an important predictive factor for the age of introducing complementary foods. Among the infants belonging to the Promotion of Breastfeeding Intervention Trial, smaller size (especially weight-for-age) was strongly associated with increased risks of subsequent weaning and of discontinuing exclusive breast-feeding, especially between 2 and 6 months of age[27]. The authors speculated that in developed countries, smaller infant size is likely to undermine the mother's confidence in her ability to provide sufficient nutrition for her infant, thus leading to supplementation and weaning.

Consistent with earlier studies, maternal age[3,13–15,20,21] and maternal smoking during pregnancy[12–15,20,21,28] were associated with infant feeding. Increasing maternal age increased the risk of early formula feeding but not the risk of early introduction of solids, whereas maternal smoking during pregnancy increased the risk of receiving first solid foods early. Mothers living in the southern part of Finland and in rural municipalities were less likely to introduce the first solid foods very early. Regional differences in child feeding have also been reported in earlier studies[3,12,13,15,19,20]. As the results are mainly country specific they are difficult to compare.

In a recent review on determinants of early introduction of complementary foods, strong evidence was found for six determinants: young maternal age, low maternal education, low socio-economic status, absence or short duration of breast-feeding, maternal smoking and lack of information or advice from health-care providers[13]. The authors suggested improving the advice given by health-care providers as the most tractable area for intervention in the short term. Age at introduction of food items could also be strongly determined by factors other than socio-demographic ones; fish and egg are considered by Finnish parents as hyperallergenic food items and, therefore, they are rarely introduced earlier than recommended (median *v.* recommendation: fish 7 *v.* 6 months, egg 9·5 *v.* 5 months)[6].

Infant diet has changed during the last decades in Finland as well as in many other countries. There have been marked changes in the composition of infant formulas, in the consumption of ready-made commercial infant foods, and in the recommendations and advice o n what constitutes a weaning diet. In 2008, the ESPGHAN (European Society for Paediatric Gastroenterology, Hepatology and Nutrition) Nutrition Committee recommended that solid foods should not be introduced before 17 weeks and not later than 26 weeks[29]. The current WHO global infant feeding recommendations collide with that in stating that infants should be exclusively breast-fed for the first 6 months of life and that complementary foods, including solid foods, should be introduced thereafter[4]. In the current Finnish national recommendations, solid foods are recommended to be introduced flexibly by the latest at 6 months of age depending on the needs and growth of the child[6]. At the time of the present study, complementary foods were recommended to be introduced after 4 months of age[30]. Mixed recommendations and an ongoing debate add to any existing confusion on the optimal time for infant weaning.

Simple, valid and reliable tools to measure infant feeding are lacking[31]. The problem of measurement arises primarily because infant feeding practices encompass a series of age-specific, interrelated behaviours that are difficult to summarise into one or even a few variables. The longitudinal design of the DIPP study allowed us to examine infant feeding practices frequently during the first years of life. A follow-up form developed for studying the age at introduction of complementary foods among the infants in the present study seemed to function well. The method gives qualitative information on the first food exposures and provides a feasible tool to be used in epidemiological studies. The follow-up form does not require high literal skills or burden parents to the same extent as other dietary recording methods. The age at introduction of foods as an exposure is easier to measure and is not as easily biased as is encountered for example with quantitative measurements of foods. It would also be easier to remember to record small portions given as a taste if the form is kept on the refrigerator door as was advised with the follow-up form. However, the form gives only information on the age at introduction of new foods, not about the amounts consumed. For that purpose, diet records or recalls are needed. In Finland, the time windows for exposure to most food groups are narrow, and it could make the analyses less sensitive for detecting relationships between the time at first exposure and endpoint variables.

Some limitations of the current study should be considered when interpreting the findings. Although the present cohort carries increased human leucocyte antigen-conferred susceptibility to type 1 diabetes, the participants are expected to be representative of the general population of Finnish children. Almost 20 % of the Finnish population carries increased human leucocyte antigen-conferred predisposition to type 1 diabetes, while only 3–4 % of those actually progress to clinical disease[32]. In terms of sociodemographic characteristics, the study sample was biased towards higher parental education and a smaller number of siblings. This may have had some bearing on our results. Regions of Oulu and Tampere do not completely represent all Finnish regions.

Conclusions

The diets of Finns reflect socio-economic differences already in pregnancy and the same is true throughout

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infancy, and they share similar determinants. Initiatives to improve infant feeding practices should focus on assisting small-sized young families with less well-educated parents. Regional inequalities in infant feeding should be narrowed through tailored programmes. In the public health sector, promoting the benefits of exclusive breast-feeding should be accompanied by promotion of the avoidance of early introduction of complementary foods.

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References

1. Brown KH (2007) Breast feeding and complementary feeding of children up to 2 years of age. *Nestlé Nutr Workshop Seri Pediatr Progr* **60**, 1–10.
2. Wu TC & Chen PH (2009) Health consequences of nutrition in childhood and early infancy. *Pediatr Neonatol* **50**, 135–142.
3. Grummer-Strawn LM, Scanlon KS & Fein SB (2008) Infant feeding and feeding transitions during the first year of life. *Pediatrics* **122**, Suppl. 2, S36–S42.
4. World Health Organization (2003) *Global Strategy for Infant and Young Child Feeding*. Geneva: WHO.
5. Nicklaus S (2009) Development of food variety in children. *Appetite* **52**, 253–255.
6. Hasunen K, Kalavainen M, Keinonen H *et al.* (2004) *Lapsi, perhe ja ruoka. Imeväis- ja leikki-ikäisten lasten, odottavien ja imettävien äitien ravitsemussuositus* (*The Child, Family and Food. Nutrition Recommendations for Infants and Young Children as Well as Pregnant and Breastfeeding Mothers*). *Publications of the Ministry of Social Affairs and Health 2004:11*. Helsinki: Ministry of Social Affairs and Health (in Finnish with an English summary).
7. Gissler M, Rahkonen O, Järvelin MR *et al.* (1998) Social class differences in health until the age of seven years among the Finnish 1987 birth cohort. *Soc Sci Med* **46**, 1543–1552.
8. Hupkens CLH, Knibbe RA & Drop MJ (2000) Social class differences in food consumption: the explanatory value of permissiveness and health and cost considerations. *Eur J Public Health* **10**, 108–113.
9. Birch LL (1998) Development of food acceptance patterns in the first years of life. *Proc Nutr Soc* **57**, 617–624.
10. James PTJ, Nelson M, Ralph A *et al.* (1997) Socioeconomic determinants of health: the contribution of nutrition to inequalities in health. *BMJ* **314**, 1545–1549.
11. Gudnadottir M, Gunnarsson BS & Thorsdottir I (2006) Effects of sociodemographic factors on adherence to breast feeding and other important infant dietary recommendations. *Acta Paediatr* **92**, 419–524.
12. Hendricks K, Briefel R, Novak T *et al.* (2006) Maternal and child characteristics associated with infant and toddler feeding practices. *J Am Diet Assoc* **106**, Suppl. 1, S135–S148.
13. Wijndaele K, Lakshman R, Landsbaugh JR *et al.* (2009) Determinants of early weaning and use of unmodified cow's milk in infants: a systematic review. *J Am Diet Assoc* **109**, 2017–2028.
14. Scott JA, Binns CW, Graham KI *et al.* (2009) Predictors of the early introduction of solid foods in infants: results of a cohort study. *BMC Pediatr* **9**, 60.
15. Erkkola M, Salmenhaara M, Kronberg-Kippilä C *et al.* (2010) Determinants of breast-feeding in a Finnish birth cohort. *Public Health Nutr* **13**, 504–513.
16. Kupila A, Muona P, Simell T *et al.* (2001) Feasibility of genetic and immunological prediction of type I diabetes in a population-based birth cohort. *Diabetologia* **44**, 290–297.
17. Kyttälä P, Erkkola M, Kronberg-Kippilä C *et al.* (2010) Food consumption and nutrient intake in Finnish 1- to 6-year-old children. *Public Health Nutr* **13**, Suppl. 6A, 947S–956S.
18. National Public Health Institute (2005) *Fineli – Finnish Food Composition Database*. http://www.fineli.fi/ (accessed January 2011).
19. Griffiths LJ, Tate AR & Dezateux C (2007) Do early infant feeding practices vary by maternal ethnic group? *Public Health Nutr* **10**, 957–964.
20. Giovannini M, Riva E, Banderali G *et al.* (2004) Feeding practices of infants through the first year of life in Italy. *Acta Paediatr* **93**, 492–497.
21. Dratva J, Merten S & Ackermann-Liebrich U (2006) The timing of complementary feeding of infants in Switzerland: compliance with the Swiss and the WHO guidelines. *Acta Paediatr* **95**, 818–825.
22. Virtanen SM, Kenward MG, Erkkola M *et al.* (2006) Age at introduction of new foods and advanced β-cell autoimmunity in young children with HLA-conferred susceptibility to type 1 diabetes. *Diabetologia* **49**, 1512–1521.
23. Uusitalo L, Uusitalo U, Ovaskainen M-L *et al.* (2008) Sociodemographic and lifestyle characteristics are associated with antioxidant intake and the consumption of their dietary sources during pregnancy. *Public Health Nutr* **11**, 1379–1388.
24. Clifford J & McIntyre E (2008) Who supports breastfeeding? *Breastfeed Rev* **16**, 9–19.
25. Fein SB, Labiner-Wolfe J, Scanlon KS *et al.* (2008) Selected complementary feeding practices and their association with maternal education. *Pediatrics* **122**, Suppl. 2, S91–S97.
26. Erkkola M, Kyttälä P, Takkinen H-M *et al.* (2011) Nutrient intake variability and number of days needed to assess intake in preschool children. *Br J Nutr* **106**, 130–140.

https://doi.org/10.1017/S1368980012002595 Published online by Cambridge University Press

27. Kramer MS, Moodie EE, Dahhou M *et al.* (2011) Breastfeeding and infant size: evidence of reverse causality. *Am J Epidemiol* **173**, 978–983.
28. Weiser TM, Lin M, Garikapaty V *et al.* (2009) Association of maternal smoking status with breastfeeding practices: Missouri, 2005. *Pediatrics* **124**, 1603–1610.
29. Agostoni C, Decsi T, Fewtrell M *et al.* (2008) Complementary feeding: a commentary by the ESPGHAN Committee on Nutrition. *J Pediatr Gastroenterol Nutr* **46**, 99–110.
30. Hasunen K, Kalavainen M, Keinonen H *et al.* (1997) *Lyytikäinen A, Nurttila A, Peltola T. Lapsi, perhe ja ruoka. Imeväis- ja leikki-ikäisten lasten, odottavien ja imettävien äitien ravitsemussuositus* (*The Child, Family and Food. Nutrition Recommendations for Infants and Young Children as Well as Pregnant and Breastfeeding Mothers*). *Publications of the Ministry of Social Affairs and Health 1997:7.* Helsinki: Ministry of Social Affairs and Health (in Finnish with an English summary).
31. Ruel MT, Brown KH & Caulfield LE (2003) Moving forward with complementary feeding: indicators and research priorities. International Food Policy Research Institute Discussion Paper no. 146. *Food Nutr Bull* **24**, 289–290.
32. Ilonen J & Hermann R (2010) Novel gene associations in type 1 diabetes. *Curr Diab Rep* **10**, 338–344.

https://doi.org/10.1017/S1368980012002595 Published online by Cambridge University Press