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Food consumption and nutrient intake in Finnish 1–6-year-old children

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Abstract

Objective: To study food consumption and nutrient intake in Finnish children aged 1–6 years and to assess the effect of age and sex on food consumption and nutrient intake.

Design: Cross-sectional samples of children participating in the Type 1 Diabetes Prediction and Prevention (DIPP) birth cohort study in Finland.

Subjects: The study population comprised healthy children recruited in the nutrition study within the DIPP study in 1998–2003. Three-day food records (2535 in total) from 1-, 2-, 3-, 4- and 6-year-old children were kept between the years 2003 and 2005.

Results: The energy-adjusted consumption of fruits and berries, cereal products, infant formulas and meat dishes was higher and the consumption of vegetables, salads, breads, dairy products, fat spreads, drinks, sweets and sugar was lower among 1-year-old children than older age groups (P for all $<0{\cdot}05$). The mean daily energy intake increased with age and was higher among boys than girls in all age groups, except among the 2-year-olds (P for all $<0{\cdot}05$). The diet of the 2–6-year-old children contained too much saturated fat and sucrose, and too little PUFA compared with the current Nordic Nutrition Recommendations. The intakes of most vitamins and minerals met the recommendations. However, the intakes of vitamin D, E and iron fell below the recommended levels. The nutrient density of the diet decreased after the age of 1 year at the time that the children adapted to the regular family diet.

Conclusions: In order to improve the diet of young children, it is essential to evaluate the diet of the whole family.

Keywords
Children
Food
Food consumption
Nutrient intake

Eating habits that can lead to diet-related health problems begin to develop in early childhood[1,2]. Persistent eating behaviours and particular dietary patterns, which are strongly influenced by social, demographic and lifestyle factors related to the family, can be seen by the age of 2–3 years[3–7]. Information on the diet and nutrition of young children is essential when planning and implementing national health programmes.

Studies on young children's food consumption are available from the Czech Republic[8], England[9–11] and Sweden[12], and that of infants and toddlers from twelve countries around Europe[13]. The comparison between studies is hampered by differences in the research methods used, and differences in reported food groupings. Nonetheless, food consumption trends can be compared. The comparison of nutrient intake in children and adolescents in twenty-three European countries showed large variations between the countries[14]. The overall mean energy intake increased with the child's age and was higher for boys than for girls. Intakes of nutrients were associated with energy intake. During the past two decades the intake of total fat (and especially that of saturated fat), sucrose, sodium and cholesterol among European children under the age of 7 years has exceeded the recommendations. The intakes of MUFA and/or PUFA, dietary fibre, vitamin D, iron, zinc and selenium have been low[9,12,15–17].

To date, the dietary habits and nutrition of young children have not been incorporated into the Finnish national health monitoring system. There are only a few

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studies currently available on the food consumption and nutrient intake of Finnish children[18–23]. Compared with the current recommendations[24], the children's diet has been reported to contain too much fat and sucrose and too little dietary fibre[21–23]. The intake of vitamin D and iron has been reported to be inadequate. However, some of the earlier studies have not considered nutrient intakes from supplements[19,20,22,23].

The aim of the present study was to obtain current information on the nutrition of 1–6-year-old Finnish children and to assess their food consumption and nutrient intakes according to sex and age.

Subjects and methods

Subjects

Subjects in the present study took part in the Type 1 Diabetes Prediction and Prevention Project (DIPP) which is a large, population-based cohort study in Finland[25]. Parents of newborn infants from three university hospital areas (Oulu, Tampere and Turku) were asked whether their child could be screened for genetic susceptibility to type 1 diabetes using cord blood samples. The families with infants carrying increased genetic susceptibility (*HLA-DQB1*02/0302 heterozygous and DQB1*0302/x*-positive subjects; x stands for homozygosity or neutral allele) were invited to take part in the DIPP study and were followed for diet, growth, viral infections and diabetes-associated antibodies at 3–12-month intervals. The study was approved by the ethics committee of the participating hospitals, and all participating families gave their written and informed consent for the study.

The DIPP Nutrition Study is part of the larger cohort and was implemented in the University Hospital of Oulu in Northern Finland and Tampere in the South[26]. Background questionnaires and structured dietary questionnaires with 3 d food records were collected at the ages of 3, 6 and 12 months, and annually thereafter. The present series comprises selected at-risk children born between 1998 and 2003. In all, 567 food record data were used for 1-year-olds, 230 for 2-year-olds, 471 for 3-year-olds, 554 for 4-year-olds and 713 for 6-year-old children. The children aged 1, 3 and 6 years comprise birth cohorts from the years 2003, 2001 and 1998–1999, respectively, whereas children aged 2 and 4 years were randomly selected from the birth years 2001–2002 and 1999–2000, respectively. Of the children in the DIPP Nutrition Study in those selected years 71 %, 59 %, 57 %, 53 % and 43 % provided 1-, 2-, 3-, 4- and 6-year food records, respectively. All food records were kept between the years 2003 and 2005.

Dietary methods

Parents kept food records on three consecutive days close to the child's birthday. Food records comprised two week days and one weekend day and were composed of two parts: one was completed at home and, when needed, the other in day care by the day-care personnel. Families and day-care personnel were instructed to record all the foods and drinks that children had consumed during the recording days with the amount, brand, recipe and preparation method used. Portion size was estimated either with household measures (e.g. spoons, cups, glasses and decilitres) or using a picture booklet of food portions[27]. Vitamin and mineral supplements were recorded by their brand names and the amounts used were entered as tablets, drops, spoonfuls or millilitres. When the families visited their local study centre, trained nurses checked the food records. When needed, missing information was requested and added. The study nurses and physicians received continuous education on how to complete and check food records.

Food records were entered and processed with a software program that uses the Fineli Nutrition Database (FND) and the Fineli Dietary Database. Fineli was developed, and is being continuously updated, by the Finnish National Institute for Health and Welfare[28]. The dietary database includes 3129 food items and dishes. The DIPP Nutrition Study added mass-produced baby foods and infant formulas to an existing food selection of the FND. Additional supplements were entered into the FND in order to improve the selection of supplements used by children. The Fineli database contains standard recipes that are based on those in current Finnish cookery books. Whenever possible, recipes were modified by nutritionists according to the actual recipes based on the children's food records. The reported food consumption was based on food records, and was converted into average daily food consumption and nutrient intake. The present study used twelve major and ten minor food groups for the 1-year-olds and eleven major and twenty-nine minor food groups for the 2–6-year-old children.

Statistical methods

Food consumption is expressed as grams per day. The proportion of consumers includes the children who consumed any food belonging to the food group in question at least once during the 3 d recording period. Intakes of energy and nutrients are reported separately in different subgroups for age. The results include the intakes from both foods and supplements. In 1-year-olds, breast-fed children (n 112) were not included in the nutrient intake calculations because it was not possible to estimate their energy and nutrient intake from breast milk. Comparisons of energy-adjusted food consumption and nutrient intake between boys and girls, and those of absolute food consumption between non-breast-fed and breast-fed 1-year-old children were performed with the independent samples t test. Some of the food-use variables did not meet the assumptions of normal distribution even after log-transformation. Those comparisons were done using the non-parametric Kruskal–Wallis test. Analyses were carried out using the statistical packages for

the social sciences statistical software package version 15·0 (SPSS Inc., Chicago, IL, USA).

Differences in energy-adjusted food consumption and nutrient intake between age groups were tested with the PROC MIXED-procedure of the SAS program for windows statistical software package version 8·2 (SAS Institute Inc., Cary, NC, USA), which made it possible to take into account the fact that some age groups included the same children (among 2- and 3-year-olds, the same 110 children were included in both groups and among 4- and 6-year-olds the same seventy children). Multiple comparisons were performed with Bonferroni correction. All variables were log-transformed before the analyses. The non-parametric Kruskal–Wallis test was used as a general test and Mann–Whitney *U* test as a pair test when an assumption of normal distribution was not met. The level of significance used was $P < 0{\cdot}05$.

Results

Food consumption

The consumption of major and minor food groups is presented in Tables 1 and 2. The consumption of porridge was high especially among the 1-year-olds. Mixed wheat bread was the most commonly used bread among all the children. Low-fat milk was the most popular milk product and among the fat spreads, margarines containing over 55% of fat were preferred. Meat dishes were consumed more often and in larger amounts than fish dishes. The foods containing high amounts of added sugar, such as sweetened fruit drinks, flavoured yoghurt, chocolate, sweets, dairy desserts and pastry, were already commonly consumed among the 1-year-old children. Most (60%) of the children aged 2–6 years consumed all of the sucrose sources at least once during the three recording days. Overall food consumption increased with age and was higher among boys than girls.

Food consumption among non-breast-fed and breast-fed 1-year-old children

At the age of 1 year, 22% of the girls and 18% of the boys were breast-fed. The breast-fed children consumed less infant formula ($P < 0{\cdot}001$), dairy products ($P < 0{\cdot}001$) and meat dishes ($P = 0{\cdot}022$), but more vegetables ($P = 0{\cdot}02$) than the non-breast-fed children (Table 1). Approximately, a quarter of the food eaten daily by the non-breast-fed 1-year-old children was mass-produced baby food.

Differences between boys and girls (data not shown)

There were only a few differences in food consumption between girls and boys. The energy-adjusted consumption of bread was higher among the non-breast-fed girls than the boys ($P = 0{\cdot}018$). There were no significant differences in the consumption of major food groups between boys and girls at the ages of 2–4-year-old. The energy-adjusted consumption of fruits and berries ($P = 0{\cdot}002$) and fats ($P = 0{\cdot}031$) was higher among the 6-year-old girls than boys.

Differences between age groups

The energy-adjusted mean consumption of selected food groups by age groups are presented in Fig. 1. When adjusting for energy, the non-breast-fed 1-year-olds

Table 1 Daily food consumption (g/d) and proportion of consumers (%) in 1-year-old Finnish non-breast-fed and breas-fed infants

	Non-breast-feds (*n* 455)			Breast-feds (*n* 112)		
	Mean g/d	SD	Consumers %	Mean g/d	SD	Consumers %
Infant formula	224	246	60	55	125	30
Fruits and berries	118	75	97	123	76	97
Mass-produced fruit and berry baby foods	72	66	83	73	58	92
Vegetables, fresh and cooked	21	37	64	33	52	71
Mass-produced vegetable baby foods	9	30	14	11	28	20
Potatoes	56	70	68	50	67	59
Cereal products including porridge	347	157	100	327	154	100
Mass-produced baby porridge	128	170	52	82	132	41
Bread	10	14	74	10	11	82
Dairy products	303	260	90	123	118	85
Skimmed milk	63	151	30	23	63	28
Low-fat milk (fat ≤2%)	158	212	57	39	88	35
Whole milk (fat > 2%)	9	75	2	0·02	0·3	1
Yoghurt and other sour milk products	61	67	68	48	66	61
Mass-produced baby yoghurts	4	17	10	7	19	15
Fat spreads, oils	3	6	56	3	6	52
Meat dishes	179	105	100	154	103	98
Mass-produced meat baby foods	123	106	81	109	102	78
Fish dishes	21	35	42	25	36	47
Mass-produced fish baby foods	12	26	21	17	32	28
Drinks: juices, soft drink	94	122	80	75	95	79
Sweets and sugar	1	2	20	0·4	1	20

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Table 2 Daily food consumption (g/d) and proportion of consumers (%) in 2–6-year-old Finnish children (boys and girls combined)

	2-year-olds (*n* 230)			3-year-olds (*n* 471)			4-year-olds (*n* 554)			6-year-olds (*n* 713)		
	Mean g/d	SD	Consumers %	Mean g/d	SD	Consumers %	Mean g/d	SD	Consumers %	Mean g/d	SD	Consumers %
Fruits and berries*	99	83	92	110	86	95	101	82	91	108	85	94
Vegetables*	37	44	81	47	50	91	50	49	89	54	50	92
Fresh	23	30	75	29	35	83	32	34	84	37	37	89
Cooked*	14	29	43	18	34	54	17	32	52	17	31	51
Potatoes	47	42	87	64	54	89	68	55	90	76	56	90
Bread	29	24	94	39	25	98	46	27	99	60	33	99
Rye bread	9	15	65	12	15	75	13	14	77	18	18	80
Mixed wheat bread	14	17	69	20	20	81	22	23	76	31	28	84
White bread	6	11	45	7	11	47	12	16	57	11	17	49
Cereal products*	237	176	100	204	129	100	197	117	100	195	111	99
Savoury pasties	6	12	32	9	17	34	10	19	34	16	26	42
Rice	8	22	22	8	18	21	9	19	24	10	22	22
Pasta	13	26	35	17	29	36	17	30	36	20	37	33
Porridge*	184	177	83	137	127	80	117	113	77	95	97	72
Breakfast cereals	4	6	45	5	8	49	6	9	55	7	10	53
Pizzas	4	12	14	4	12	15	7	21	18	12	30	22
Pastries	13	20	57	18	23	63	22	27	68	26	31	69
Dairy products*	455	228	98	470	223	99	516	211	99	573	222	100
Skimmed milk	106	179	44	136	184	55	144	182	56	194	217	62
Low-fat milk (fat $\leq$ 2 %)	232	233	76	197	199	76	231	208	79	233	225	76
Whole milk (fat $>$ 2 %)	6	37	5	7	40	9	12	68	10	11	60	8
Sour milk products	25	53	30	30	64	29	28	57	27	25	61	25
Yoghurt*	57	69	61	55	67	58	51	65	55	53	68	56
Cheese	9	12	67	10	12	75	10	11	72	11	13	68
Dairy desserts	21	28	60	34	40	74	40	43	77	46	46	80
Fat spreads, oils	10	9	90	15	18	97	20	21	98	21	20	99
Butter	2	4	33	2	4	39	3	6	42	3	6	42
Margarine $\geq$55 %	3	5	47	4	6	62	5	7	67	6	7	70
Margarine $<$55 %	1	3	25	2	5	37	2	4	31	3	6	35
Meat dishes*	163	86	100	151	86	99	153	84	100	173	91	100
Fish dishes*	17	34	40	18	31	46	20	33	49	22	39	48
Drinks	265	197	95	302	206	98	343	208	99	356	212	99
Sweetened fruit drinks	103	130	74	116	120	79	135	132	86	114	123	76
Soft drinks	17	39	27	25	50	34	35	64	40	55	85	48
Fruit juice	46	99	46	56	92	49	49	90	43	59	101	46
Sweets and sugar	7	9	77	12	14	90	16	17	92	20	20	92
Sugar, added	1	3	29	1	2	43	2	3	46	2	4	48
Sweet	4	7	55	7	10	72	9	14	73	11	17	71
Chocolate	2	4	37	4	8	45	6	8	58	6	10	54

*Mass-produced baby foods are included in the food group.

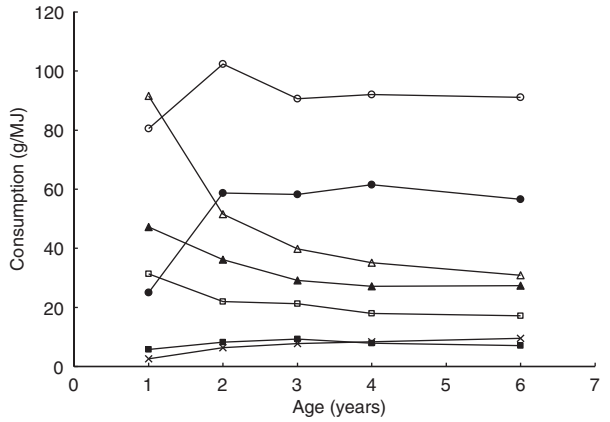

Fig. 1 The energy-adjusted (g/MJ) consumption of selected food groups by age group. Breast-fed children are not included in the group of 1-year-olds (—○—, dairy products; —●—, drinks; —△—, cereal products; —▲—, meat dishes; —□—, fruits and berries; —■—, vegetables; —×—, bread)

consumed more fruits and berries than the older children ($P < 0{\cdot}0001$). The energy-adjusted consumption of bread, sweets and sugar increased and that of cereal products decreased with increasing age (P for all $<0{\cdot}0001$, data not shown for sweets and sugar). The non-breast-fed 1-year-olds consumed fewer vegetables, dairy products and drinks than older age groups (P for all $<0{\cdot}0001$). The energy-adjusted consumption of fats increased until the age of 4 years ($P < 0{\cdot}0001$, data not shown). The energy-adjusted consumption of meat dishes was higher among the 1- and 2-year-olds than among the older children ($P < 0{\cdot}0001$).

Nutrient intake

The mean daily intakes of energy and nutrients are presented in Tables 3 and 4 and in Figs. 2 and 3. The intakes of vitamins and minerals are expressed only as absolute values (Table 4). The use of dietary supplements did not markedly contribute to the total intake of vitamins and minerals except for vitamin D intake (Table 5). The use of vitamin D supplements was most frequent (86 %) among the 1-year-olds and least common (21 %) among the 6-year-olds.

Differences between girls and boys (data not shown)

The mean intake of energy was higher for 1-year-old ($P < 0{\cdot}001$), 3-year-old ($P = 0{\cdot}002$), 4-year-old ($P < 0{\cdot}001$) and 6-year-old ($P < 0{\cdot}001$) boys than girls. The percentage contribution of protein ($P = 0{\cdot}036$) to the total energy intake was higher among the 6-year-old boys and that of sucrose ($P = 0{\cdot}014$) was higher among the 6-year-old girls, and the respective percentage for protein was higher in non-breast-fed 1-year-old girls than boys ($P = 0{\cdot}018$). Nutrient densities of the diet for vitamin D ($P = 0{\cdot}002$) and calcium ($P = 0{\cdot}038$) were higher for the non-breast-fed 1-year-old girls than boys.

Table 3 Daily intakes of energy and macronutrients by age groups

	1-year-olds* (n 455)		NNR[24] 12–23 months	2-year-olds (n 230)		3-year-olds (n 471)		4-year-olds (n 554)		6-year-olds (n 713)		NNR[24] 2–6 years
	Mean	SD	%E	Mean	SD	Mean	SD	Mean	SD	Mean	SD	%E
Energy (MJ)	3·80	0·64		4·57	0·93	5·21	0·99	5·65	1·05	6·35	1·17	
Protein (g)	34	10		43	11	47	12	51	12	57	13	
Protein (%E)	15·3	3·5	10–15	16·3	3·1	15·5	2·8	15·3	2·3	15·4	2·5	10–20
Fat (g)	30	8		37	12	43	13	48	13	54	15	
Fat (%E)	29	6	30–35	30	6	31	6	31	5	31	5	25–35
SFA (g)	12·0	4·2		16·4	5·9	18·7	6·1	21·1	6·8	23·6	7·3	
SFA (%E)	11·6	3·3		13·2	3·6	13·2	3·1	13·7	3·2	13·7	3·0	<10†
MUFA (g)	10·5	3·5		12·7	4·3	14·8	4·8	16·3	4·9	18·5	5·3	
MUFA (%E)	10·5	2·7		10·2	2·2	10·5	2·3	10·6	2·1	10·7	1·9	10–15
PUFA (g)	5·2	2·1		4·8	2·0	5·7	2·3	6·2	2·3	7·2	2·5	
PUFA (%E)	5·1	1·9		3·8	1·3	4·1	1·3	4·0	1·2	4·2	1·1	5–10
Carbohydrate (g)	123	22		142	31	163	34	176	34	196	39	
Carbohydrate (%E)	55	5	50–55	53	6	53	6	53	5	53	5	50–60
Sucrose (g)	12	9		33	16	41	18	45	17	50	20	
Sucrose (%E)	5·5	3·6	<10‡	12·2	5·5	13·3	5·0	13·7	4·6	13·4	4·5	<10‡
Dietary fibre (g)	8·6	3·2		8·3	3·3	9·3	3·0	9·5	3·1	10·9	3·6	
Dietary fibre (g/MJ)	2·3	0·8		1·8	0·6	1·8	0·6	1·7	0·5	1·7	0·5	

NNR, Nordic Nutrition Recommendations; %E, proportion of daily energy.
*Breast-fed children are not included.
†Less than 10 %E from SFA plus *trans* fatty acids.
‡Less than 10 %E from refined sugars.

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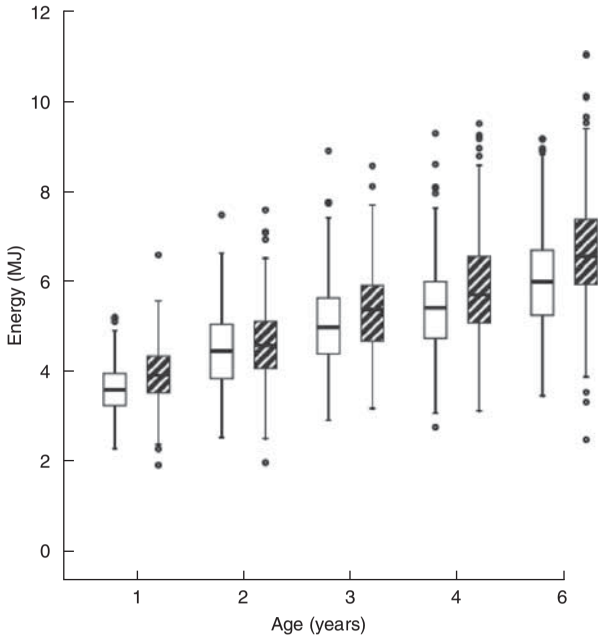

Fig. 2 Mean energy intake by age group for girls (□) and boys (▨). Breast-fed children are not included in the group of 1-year-olds

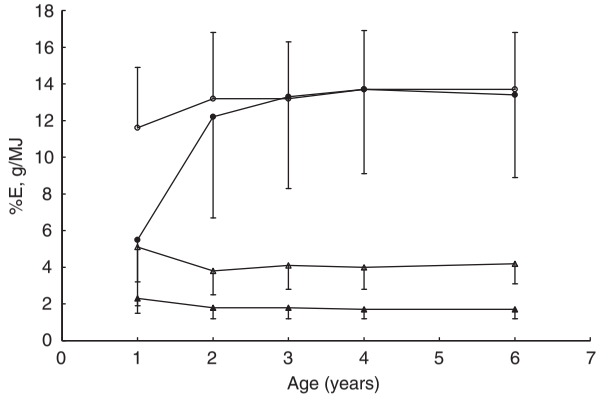

Fig. 3 Mean (SD) daily intake of sucrose, SFA and PUFA as percentage of total energy (%E) and nutrient density of dietary fibre (g/MJ) by age group (—○—, SFA; —●—, Sucrose; —△—, PUFA; —▲—, fibre)

Differences between age groups

Energy intake increased with increasing age ($P < 0{\cdot}0001$, Fig. 2). The 1-year-olds had lower %E from total fat, SFA and sucrose, and higher %E from carbohydrate and PUFA than other age groups (P for all $<0{\cdot}001$, Fig. 3). The 2-year-olds had lower %E from protein than other age groups ($P = 0{\cdot}0004$). The nutrient density of the diet for dietary fibre, vitamin C, vitamin E, thiamine, riboflavin and folate was higher among the 1-year-olds than among the older age groups (P for all $<0{\cdot}001$, data shown only for dietary fibre). The nutrient density of the diet for vitamin D and magnesium decreased with age (P for all $<0{\cdot}0001$, data not shown). The diet of the 1-year-olds had higher nutrient density for potassium, iron and zinc

Table 4 Daily intakes of nutrients (both food and supplement) by age groups

	1-year-olds* (*n* 455)			2-year-olds (*n* 230)		3-year-olds (*n* 471)		4-year-olds (*n* 554)			6-year-olds (*n* 713)		
	Mean	SD	NNR[24] 12–23 months	Mean	SD	Mean	SD	Mean	SD	NNR[24]+ 2–5 years	Mean	SD	NNR[24] 6–9 years
Vitamin A (μg RE)	315	268	300	383	391	541	619	575	633	350	634	661	400
Vitamin C (mg)	78	33	25	54	32	64	41	60	41	30	67	43	40
Vitamin D (μg)	12·2	4·6	10·0	8·8	4·4	7·0	4·4	6·0	3·8	7·5	5·9	3·4	7·5
Vitamin E (mg α-TE)	4·0	1·6	4·0	3·8	1·7	4·9	2·4	5·2	2·6	5·0	5·8	2·4	6·0
Thiamin (mg)	0·71	0·19	0·50	0·75	0·25	0·90	0·46	0·98	0·56	0·60	1·07	0·61	0·90
Riboflavin (mg)	1·32	0·39	0·60	1·42	0·47	1·60	0·63	1·77	0·69	0·70	1·93	0·76	1·10
Niacin (mg NE)	12·4	3·0	7·0	15·0	4·2	17·5	5·8	19·0	6·0	9·0	20·9	6·4	12·0
Pyridoxine (mg)	1·02	0·29	0·50	1·17	0·40	1·41	0·63	1·49	0·63	0·70	1·56	0·61	1·00
Folate (μg)	111	30	60	108	35	129	46	134	51	80	155	57	130
Vitamin B_{12} (μg)	2·7	1·2	0·6	3·5	1·7	4·0	2·2	4·4	2·4	0·8	4·9	2·6	1·3
Potassium (g)	1·8	0·5	1·4	2·1	0·5	2·3	0·6	2·4	0·6	1·8	2·6	0·6	2·0
Calcium (mg)	698	282	600	857	298	903	291	959	286	600	1048	299	700
Magnesium (mg)	163	40	85	182	50	198	46	206	48	120	231	61	200
Sodium (g)	0·74	0·42		1·52	0·48	1·77	0·47	1·94	0·51		2·16	0·55	
Iron (mg)	6·4	2·5	8·0	5·9	2·2	7·0	4·3	7·5	3·3	8·0	8·1	3·1	9·0
Selenium (μg)	23·9	7·6	20·0	30·4	8·5	34·3	10·4	37·4	11·2	25·0	41·8	12·5	30·0
Zinc (mg)	6·1	1·5	5·0	6·4	1·7	7·1	2·1	7·6	2·4	6·0	8·7	3·0	7·0

NNR, Nordic Nutrition Recommendations; RE, retinol equivalent; α-TE, alphatocopherol equivalent; NE, niacin equivalent.
*Breast-fed children are not included.

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Table 5 Proportion of supplement users and mean daily intake of nutrients from supplements by age groups

	1-year-olds*			2-year-olds			3-year-olds			4-year-olds			6-year-olds		
	Users	Intake of users		Users	Intake of users		Users	Intake of users		Users	Intake of users		Users	Intake of users	
	%	Mean	SD	%	Mean	SD	%	Mean	SD	%	Mean	SD	%	Mean	SD
Vitamin C (mg)	2	40	0	4	38	24	15	42	23	18	38	30	16	39	37
Vitamin D (μg)	86	6·8	2·4	70	6·9	2·8	47	6·4	2·9	31	5·9	3·2	21	5·5	3·3
Vitamin E (mg α-TE)	0·2	3·4	0	4	4·7	3·0	14	4·9	2·6	18	4·0	2·4	17	3·8	2·7
Thiamin (mg)	0·2	0·7	0	3	0·7	0·4	14	0·8	0·6	18	0·8	0·8	15	0·9	1·0
Riboflavin (mg)	0·2	0·8	0	3	0·8	0·5	14	0·9	0·7	18	0·9	0·9	15	1·0	1·0
Niacin (mg NE)	0·2	9·0	0	3	9·0	5·9	14	10·3	5·0	18	9·1	5·3	15	9·2	6·2
Pyridoxine (mg)	0·2	1·0	0	3	1·1	0·7	14	1·3	0·6	18	1·1	0·6	15	1·1	0·7
Folate (μg)	0·2	20	0	3	64	42	14	56	35	16	47	36	15	51	39
Vitamin B_{12} (μg)	0·2	1·0	0	0·9	2·2	1·1	4	1·0	0·5	8	1·0	0·6	6	1·2	1·0
Calcium (mg)	2	227	159	6	355	204	7	366	194	5	286	167	3	225	170
Iron (mg)	0·7	9·2	11·2	0·9	7·5	3·5	4	12·1	15·8	7	7·7	2·6	4	6·3	2·7
Selenium (μg)	0·2	25	0	0·4	30	0	4	24	8	8	22	10	6	23	15
Zinc (mg)	0·2	5·2	0	0·9	5·5	2·1	4	5·7	3·4	8	5·0	3·2	6	6·8	6·2

RE, retinol equivalent; α-TE, alphatocopherol equivalent; NE, niacin equivalent.
*Breast-fed children are not included.

(P for all $<0{\cdot}0001$, data not shown), and lower nutrient density for sodium ($P<0{\cdot}0001$, data not shown) and selenium ($P=0{\cdot}0003$, data not shown) than the older age groups. The 2-year-olds had higher nutrient density of the diet for calcium ($P<0{\cdot}0001$, data not shown).

Discussion

Based on the present study, the diet of Finnish children aged 1–6 years is adequate and meets the dietary recommendations[24] for most nutrients. However, some qualitative aspects of the diet warrant attention. Overall, the quality of the children's diet decreased after the age of 1 year, when children started to partake in family meals. The consumption of fresh vegetables, fruits and berries, vegetable oil-based fats and fish was inadequate, whereas the consumption of foods containing sucrose and salt was high. The mean daily intake of energy increased with age and was higher for boys than for girls in most age groups. Overall, the children's diet contained too much saturated, and too little polyunsaturated fat. The intake of vitamins and minerals met with the recommendations apart from vitamin D, vitamin E and iron, for which the intakes were lower than recommended levels.

At the age of 1 year, the children were still given large amounts of mass-produced baby foods. The nutrient density of the diet was highest among the 1-year-olds and decreased as the children got older. An evaluation of the whole family's diet is to be recommended when the child starts to eat the same food as the rest of the family. In Finland, a convenient way to evaluate the dietary habits of the family would be through the Mother and Child Welfare Clinics. Low, and even decreasing intakes of some key nutrients during the period of dietary transition were also reported in a previous study of 12–18-month-old US children[29].

The quality of fat in the diet of Finnish children has improved during the past three decades. The total intake of energy, and proportion of total fat from the total energy intake (especially the proportion of SFA) has decreased steadily[19,23,30]. The improved quality of fat in the diet is mostly due to the increased use of margarine as a replacement for butter, and also due to increased consumption of low-fat milk. However, the quality of fat consumed by the 2–6-year-old children in the present study was still not in accordance with the recommendations[24]. The %E from SFA was high, whereas that from PUFA was low. In general, fat intake varies a great deal across European countries[14]. Children from the Mediterranean countries have a high total fat intake (>40 %E), and in particular a high intake of MUFA and PUFA[14,16]. In contrast, children from other regions of Europe get less than 35 %E from fat but the intake of SFA is high and that of MUFA and/or PUFA low[12,15,19,20].

Low-fat milk (fat ≤2 %) was the most commonly used milk in the present study. In earlier studies full-fat (whole) milk was the most common milk consumed by the English children[9], whereas in the Czech Republic, Sweden and Finland fat-free or low-fat milk has been more popular[8,12,22]. Because liquid dairy products are consumed in large quantities by children, even low-fat milk may contribute substantially to the intake of SFA. In the present study, other contributors to the intake of SFA were meat dishes, cereal products (mainly porridge, savoury pasties and pastries) and fat spreads (data not shown). The appropriate age for the introduction of cow's milk with a reduced fat content into the children's diet, has been a controversial issue[31]. In Finland, it is recommended that cow's milk is introduced gradually from the age of 10 months, beginning with the introduction of sour milk products, such as yoghurt and curdled milk[32]. The growth data from the large Finnish STRIP trial supports the safety of a low-saturated fat, low-cholesterol diet administered to infants under the age of 7 months and continuing into the first years of life[2].

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According to the current Nordic Nutrition Recommendations[24], the intake of added sucrose should not exceed 10 %E. In the present study, the term sucrose refers to any added sucrose eaten separately at the table or used as an ingredient in processed or prepared foods, and accordingly, to naturally occurring sucrose (in fruits and berries). We have earlier shown that added sucrose is the major contributor of sucrose, providing 85 % of the total sucrose in the child's diet[33]. In the present study, the intake of total sucrose as a proportion of energy exceeded the recommended levels among 2–6-year-old children, even if sucrose intake from fruits and berries (15 %) was deducted from the total intake. Between-country comparisons in terms of the actual intake of sucrose are difficult to make and partly inaccurate due to discrepancies in the calculation or mode of expression. According to earlier studies in Sweden and in Finland, sucrose intake has been reported to be abundant, compared with the recommendations[12,19,21]. In the present study, consumption of foods containing high amounts of added sugar such as sweetened fruit drinks, flavoured yoghurt, chocolate, sweets, dairy desserts and pastries was already common among the 1-year-old children.

The intake of vitamin D was below the recommendations among 3–6-year-old children even when the intake from vitamin supplements was included in the total intake. Children over the age of 1 year were not given regular vitamin D supplementation. In Finland, liquid dairy products and fat spreads have been fortified with vitamin D since 2003. It is recommended that all children below the age of 3 years should use vitamin D supplements throughout the year, and from the age of 3 years onwards during winter season only, if they do not regularly consume liquid dairy products[34]. According to previous studies, which have reported vitamin D intake from food only, the mean daily vitamin D intake has been far lower than the recommended levels among children of all ages[9,12,14–17,19]. The use of vitamin D supplements is essential for children in all ages. It is particularly important during the winter season when vitamin D cannot be synthesised in the skin by sunlight.

The intake of vitamin E and iron also fell below the recommended levels, whereas the mean intake of other vitamins and minerals exceeded the recommended levels[24]. The low intake of vitamin E can be explained by a low consumption of fat spreads and oils, which are the main food sources of vitamin E. There are no reports of low vitamin E intake from earlier studies among children in Finland[19], Sweden[12] or the United Kingdom[9]. In the present study, the mean intake of iron was low for most children . The intake of iron among Finnish children was higher in 1980s and 1990s when wheat flour was fortified with iron[19,22,23]. Children's iron intake has been reported to be low in other European studies as well[9,12,15–17].

Some limitations of the present study should be considered when interpreting the findings. It is generally accepted that 3 d food records give an accurate estimate of usual intake for the most frequently used foods such as porridge, milk and bread spreads. However, for some less frequently used foods, more recording days would be required. The same applies to nutrients. We did not exclude potential under-reporters from the analysis. Diet during childhood tends to be highly variable from day to day, and the identification of reliable under-reporters is difficult. Ideally, we would have included anthropometric data, so that we would have had some data against which to check the reliability of food reporting. However, data on the children's weight and height were not available at the time of the present study. In the well conducted Norwegian validation study among 2-year-olds, the food items under-reported were typically sucrose-rich foods such as cake, soft drinks and sweets, whereas the over-reported foods were healthier foods like bread, fruit and potatoes[35].

The children, in the present study, took part in the DIPP study. Although the present cohort carries increased HLA-conferred susceptibility to type 1 diabetes, the infants are expected to be representative of the general population of Finnish infants. Almost 20 % of the Finnish population have increased HLA-conferred predisposition to type 1 diabetes, whereas only 3–4 % of those actually progress to clinical disease[36]. The parents got information about the implications of increased genetic susceptibility to type 1 diabetes at the time of the birth of the child. There are some indications that information about increased susceptibility influences, at least to some extent, the living habits within the family[37]. After knowing about their child's increased risk for type 1 diabetes, 34 % of US parents made some changes in the child's diet with the intention of decreasing the disease risk, although risk factors for type 1 diabetes are not well established.

In conclusion, the consumption of fresh vegetables, fruit and berries, vegetable-oil-based fats and fish was low among the 1–6-year-old Finnish children, whereas the consumption of foods containing sucrose and salt was high. The children's diet contained too much saturated fat and too little polyunsaturated fat. The intake of vitamins and minerals accorded with the recommendations apart from vitamins D, E and iron for which the intake levels fell below the recommendations. Finally, when need of improvement in the diet of young children, it is necessary to assess the diet of the whole family.

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