

Occurrence of parent-reported food hypersensitivities and food allergies among children aged 1–4 yr

Pyrhönen K, Näyhä S, Kaila M, Hiltunen L, Läärä E. Occurrence of parent-reported food hypersensitivities and food allergies among children aged 1–4 yr.

Pediatr Allergy Immunol 2009; 20: 328–338.

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Food allergies (FAs) and hypersensitivities (FHSs) have rarely been studied in large unselected child populations. This population-based cross-sectional survey estimated the occurrence of FHS as perceived by parents and that of FA diagnosed by a physician among children aged 1–4 yr in south-eastern Finland. Before the scheduled annual follow-up visit to the local child health clinic, the parents of children who were born between 1 April, 2001 and 31 March, 2005, and living in the Province of South Karelia (data from Finnish Population Register) were mailed a questionnaire containing items on the child's background, physician-diagnosed FAs and FHSs perceived by the parents. The questionnaires were returned during the visit. Three thousand three hundred and eight (69%) out of the 4779 questionnaires were returned. The lifetime prevalence of physician-diagnosed FAs was 9%. In an additional 21%, FHSs were perceived by the parents only. In a further 19% at least one food item had been eliminated from the diet without any perception of symptoms, this proportion having a downward trend by age. Physician-diagnosed FAs were more common in boys than in girls. Cow's milk was the most commonly reported cause of food-associated symptoms (13% of all children). One-third of the children aged 1–4 yr suffered from food-associated symptoms, and in an additional fifth at least one food item had been eliminated from their diet, implying that every other child had possibly been subjected to some form of elimination diet.

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Key words: epidemiology; child; food allergy; food hypersensitivity; The South Karelian Allergy Research Project

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Accepted 1 July 2008

Food allergy (FA) and atopic eczema are usually the first manifestations of an atopic predisposition. Some discrepancy exists in previous studies between the reported prevalences of FAs based on clinical investigations and those based on parents' perceptions. Epidemiological data from general child populations on FAs and hypersensitivities (FHSs), both diagnosed by a physician but also as perceived by the parents only, are needed for planning diagnostic protocols and treatment for these conditions in the public healthcare system and for estimating risk factors of atopic diseases.

Unlike respiratory allergies, little epidemiological research has been carried out on FAs. The reported prevalences of FAs and FHSs range from 2% to 35% depending on whether lifetime or point prevalence was used, on the methods used to assess FA, on the age range of the population studied and on the variation in food items considered (1–19). A UK study reported a cumulative incidence of 26% for parentally perceived food hypersensitivity (FHS) by 1 yr of age and that of 34% by 3 yr, while the incidences of FAs confirmed by controlled food

challenges and 'a clear convincing clinical history' were 3% and 5% respectively (15). In a Norwegian cohort, the cumulative incidence of parentally perceived adverse reactions to food was 19% by 1 yr of age and 35% by 2 yr of age, but only one-third of these symptoms were reported 6 months later (17). In Finland, the prevalence of FHSs among children aged 1, 2 and 3 yr were reported to be 19%, 22% and 27%, respectively, in 1981 (18), while the incidence of cow's milk allergy by 2 yr of age was 2% in 1994–95 (19).

According to a recent review, the reported estimates of the prevalence of FA are susceptible to bias, because of low response rates and highly selected study populations in many previous studies (16). On the other hand, an inherent methodological limitation of any population-based study on FAs is the lack of feasible gold standard diagnostic procedure; e.g. the use of double-blind placebo-controlled food challenge (20) is impossible.

The South Karelian Allergy Research Project (SKARP) was launched in order to obtain a comprehensive assessment of the burden of FAs and FHSs and their associated factors in a general child population comprising five birth cohorts (newborn plus those aged 1, 2, 3 and 4 yr, at time of the survey) living in one province of Finland. In this first report, we present estimates of the occurrence of physician-diagnosed FAs and parent-perceived FHSs among the 1- to 4-yr old, based on information provided by the parents in self-administered questionnaires and in interviews performed at child health clinics by public health nurses.

Methods

Population

The SKARP study was carried out in the province of South Karelia in south-eastern Finland, with an area of 7236 km² and 135,604 inhabitants of whom 4851 were aged 1–4 yr in 2005 (21). The province is divided into 12 local government districts: three urban (with 59,000, 30,000 and 11,000 inhabitants) and nine rural. The study population comprised 4779 children born between 1 April, 2001 and 31 March, 2005, resident in the province on 2–6 wk before their birthday, which is the expected time of the annual follow-up visit at the child health clinics. The size of the study population was thus implicitly determined by the choice of the study region and age range.

During the period 2001–06, on average eight paediatricians were working in the public

healthcare sector in the study area (one per about 2500 children and adolescents aged <16 yr). Two of them, having more profound training and expertise on allergic diseases than the rest, were mainly responsible for the medical care of these conditions. As a result of the relative scarcity of paediatricians, a greater responsibility of diagnosis and treatment of childhood allergic diseases has been mandated to general practitioners and dermatologists than is the case in other parts of the country. None of the authors was directly involved with the medical care of the children in the study population.

Data collection

Local child health clinics. The network of local child health clinics maintained by the municipal health centres in Finland, cover the entire country. Their services are available free of charge, and practically all children are examined and vaccinated in these clinics (22). Children are seen at the clinics a few weeks postnatally, several times during the first year of life and at least 16 times before the age of 7 (23, 24). This investigation was carried out in close co-operation with the local clinics and the public-health nurses, who were trained by the principal investigator to question the parents on food-related symptoms.

Population data. Every Finnish citizen gets a personal identity code (PIC) at birth, and this also applies to immigrants staying in Finland for at least 1 yr (25). The PIC, full name, gender, the PICs of siblings <18-yr old who live in the same household, the name of the mother and the home address belong to the data recorded in the Finnish Population Register Centre. The addresses and other data of a total of 4779 children aged 1–4 yr living in South Karelia were obtained from this register for the present purpose.

Questionnaire. The questionnaires were designed specifically for the present work and tested together with the research protocol in a pilot study of 200 children who were similar to the study population but lived outside the region in question.

The baseline questionnaire asked structured questions about the child's background and FAs or hypersensitivities. The organs where the symptoms might emerge, the skin, respiratory tract, mouth, eyes or gastrointestinal tract, and shock and anaphylaxis were listed before the

questions on food items in the questionnaire. The respondent was asked to tick one or more alternatives according to whether given foods in any form (fresh, raw or cooked) had been observed to cause any symptoms. The items were arranged in a structured way, grouping the foods into 20 categories (milk, milk products, egg, wheat, barley, rye, other cereals, meat, poultry, fish, nuts, leguminous plants, fruit, citrus fruit, strawberries/tomatoes/ketchup/chocolate/cocoa, root crops, spices, berries, additives, others specified).

The parents were instructed to tick one or more alternatives from among the following:

1. Never perceived symptoms caused by these food items.
2. Never tasted these food items.
3. Parents and/or nursemaid have perceived an allergy.
4. Physician has diagnosed an allergy.
5. The last symptoms occurred more than 12 months ago.
6. Symptoms have occurred during the last 12 months.

The age of the child when food-associated symptoms were first perceived was ascertained with the question 'At what age did the symptoms of food allergy first appear?' The birthdays, PICs, names, genders and number of younger, older and same-age siblings in the household (including twins and stepmother's or stepfather's children) were also ascertained.

The questionnaires were written in Finnish, and hence only children whose parents were able to understand Finnish were included, because the nurses were not expected to translate the questions into any other language (like Russian). Later on English translations of the questionnaires were produced (see the website of the SKARP, <http://kelo.oulu.fi/tutkimus/EKAT/>).

Administration of the questionnaires. Parents were mailed the baseline questionnaire 2–6 wk before the expected annual visit to the clinic (based on month of birth) and they were requested to fill in and return it during the visit, at which it was checked by the nurse who also helped in completing it if needed. If the parents failed to do so, the nurse gave them a new questionnaire together with a prepaid envelope to be returned to the clinic. Reminding questionnaires with prepaid envelopes were mailed to the non-respondents 4–5 months after sending the first questionnaire. The actual date of returning

the questionnaire was taken as the individual 'time of the survey'.

Data analysis

Definition and classification of physician-diagnosed food allergy and parentally perceived food hypersensitivity. The definitions of FA and FHS was based on the occurrence of symptoms and their perception by the parents only or a diagnosis reached by a physician. The children were categorized according to responses to the following alternatives.

1. Never perceived FA.
2. Never tasted the food.
3. Parents and/or nursemaid have perceived FHS.
4. A physician has diagnosed FA.

When items (1) and (2) were not indicated but both alternatives (3) and (4) were ticked, the child was classified as having FA diagnosed by a physician. When items (1) and (2) were not indicated but parent and/or nursemaid-perceived FHS was ticked, the child was classified as having parent-perceived FHS. When neither of the above was reported, the children were classified as having no indication of FHS or FA. Some parents reported that their children had never had any symptoms associated with a certain food item, but also that they had not even tasted that food. These children were classified as being on an elimination diet but with no indication of FHS or FA. The food items themselves were classified as being either nutritionally essential (milk, milk products, egg and cereals) or non-essential.

Statistical analysis. The lifetime prevalences of FA and FHS by time of the survey were estimated according to the answers of parents to the pertinent questions on FA symptoms with classified food items, and on whether a physician had diagnosed FA or FHS was perceived by parents only (see above). The cumulative incidences of FA were estimated by the Kaplan–Meier method for survival analysis, based on parental recollections of the age when food-associated symptoms subsequently leading to physician's diagnosis had been first observed. The R environment release 2.5.1 (26) was used in computations. Kaplan–Meier analyses were performed by function `survfit`, and prevalence ratios with approximate 95% confidence intervals (based on the Wald statistic for the logarithm of the risk ratio) were computed by function `twoby2` of the Epi package (27).

Ethics and permissions

Confidentiality and data protection were ensured by following the guidelines issued by the data protection ombudsman in the Finnish Ministry of Justice. The parents were informed about the protocol, the voluntary nature of their participation and their right to withdraw at any time. This study was not regarded as causing any harm to the subjects, but rather was considered beneficial to the source population. The protocol was approved by the Ethical Committee of the Northern Ostrobothnia Hospital District.

Results

Participation

The questionnaire was completed and returned by 69% of all parents (3308/4779), 71% of the Finnish-speaking ones and 43% (130/300) of the rest (mostly Russian speaking). The individual times of the survey as determined by the dates of filling and returning the questionnaire took place during a period 15 March, 2005–9 February, 2007. Altogether 97% of the children had been born in Finland. Families with a single child were more likely to reply, and the response rate declined with the age of the child (Table 1).

Prevalence of food-associated symptoms

The overall lifetime prevalence of physician-diagnosed FA was 9% (Table 1). It was higher in boys than in girls, and appeared lower among the 1-yr old than among older children. The prevalence was lower in children with one or more older siblings in the household than in those with no siblings or only younger ones. In an additional 21% of children the parents had perceived FHS, least commonly among the 1-yr olds, but this proportion seemed to depend less on gender and the number of siblings (Table 1).

Milk and egg were the most commonly reported essential food items causing symptoms, for 13% and 6% of participants respectively. The most commonly reported non-essential food items causing food associated symptoms were strawberry, chocolate and tomato (12% for these items pooled into one group), fruit (7%) and citrus fruit (6%) (Table 2). More rarely perceived causes were root crops (6%), spices (3%), additives (3%), meat (2%), berries (2%) and poultry (1%) (details not shown in Table 2). Symptoms associated with non-essential food items, in contrast to essential food items, were far more often observed by parents only than diagnosed

by a physician (Tables 2 and 3). Nut had caused manifest symptoms only in 0.6% of the children, but nut was also the most often eliminated item from the diet (Table 2). None of the parents reported symptoms associated with e.g. sesame seed or sunflower seed in this study.

Combination of food items associated with symptoms of allergy

The prevalence of all allergies or hypersensitivities for different food items combined with milk were overall 12.8% (425 cases), as seen in Table 2 and in the third column in Table 3, where results on different combinations of FAs (including some additional FHSs), and FHSs perceived by parents only are summarized. The most common single essential food item causing symptoms was milk, in 3.7% (122 cases) of the respondents as diagnosed by a physician and in 5.2% (173 cases) as observed by the parents only (Table 3). Milk in combination with other essential foods was responsible for FA in 2.8% (91 cases) of the subjects, as was wheat, either alone or in combination with egg or other cereals. Egg alone had caused FA in 0.9% (30 cases) of the subjects and FHS in 1.9% (63 cases) and in combination with cereals 1.1% (total of 38 cases) and 0.4% (total of 13 cases) respectively (Table 3). Symptoms associated with non-essential food items alone were reported by 12.5% (415 cases) of the respondents, almost entirely by parents alone (Table 3).

Among all physician-diagnosed FAs, 69% (213/308) were attributed to cow's milk, either alone or in combination with other foods, while 29% (204/693) of the only parentally perceived cases were due to these causes (Table 3). Wheat alone was the cause of allergy in 3% (10 cases) of all FAs, but in 25% (total of 76 cases) together with other essential foods, while only 1% (six-cases) and 3% (total of 22 cases), respectively, of the FHSs were attributed to these causes.

Elimination diets

Restrictions on non-essential food items without any indication of FA or FHS were more prevalent than on essential food items. The latter were typical among the 1-yr-old children, most commonly applying to egg (17.9% of all 1-yr olds), or milk (2.8%) (Table 2). At least one essential food item had been eliminated from the child's diet without any indication of symptoms in 4.2% (138 cases) of participants, and 14.9% (492 cases) of the children adhered elimination diet with regard to certain non-essential items (Tables 2 and 3), most commonly nuts.

Table 1. Numbers of subjects, response rate, lifetime prevalences (%) of food-associated symptoms (numbers of cases in parenthesis) and prevalence ratio (and 95% confidence intervals, CI), classified by age at the time of the survey, gender and number of siblings in the same household among participants (N = 3308)

	Response rate % (no. subjects)	Prevalence of food-associated symptoms*			
		Physician-diagnosed		Perceived by parents only	
		% (cases)	Prevalence ratio (95% CI)	% (cases)	Prevalence ratio (95% CI)
Age at survey (years)					
1	75 (853)	8 (64)	1.00	16 (134)	1.00
2	72 (852)	9 (79)	1.24 (0.90–1.69)	25 (214)	1.60 (1.32–1.94)
3	67 (784)	11 (85)	1.45 (1.06–1.97)	21 (168)	1.36 (1.11–1.67)
4	64 (819)	10 (80)	1.30 (0.95–1.78)	22 (177)	1.38 (1.12–1.69)
Gender					
Girl	69 (1624)	8 (127)	1.00	21 (339)	1.00
Boy	69 (1684)	11 (181)	1.37 (1.11–1.71)	21 (354)	1.01 (0.88–1.15)
No. siblings					
All					
None	73 (1097)	10 (113)	1.00	22 (238)	1.00
One	70 (1450)	9 (135)	0.90 (0.71–1.15)	22 (313)	1.00 (0.86–1.16)
Two or more	63 (761)	8 (60)	0.77 (0.57–1.03)	19 (142)	0.86 (0.71–1.04)
Younger					
None	69 (2706)	9 (244)	1.00	21 (568)	1.00
One or more	71 (602)	11 (64)	1.18 (0.91–1.53)	21 (125)	0.99 (0.83–1.18)
Older					
None	73 (1554)	11 (165)	1.00	22 (342)	1.00
One	69 (1156)	8 (96)	0.78 (0.62–0.99)	20 (232)	0.91 (0.79–1.06)
Two or more	62 (598)	8 (47)	0.74 (0.54–1.01)	20 (119)	0.90 (0.75–1.09)
Total	69 (3308)	9 (308)		21 (693)	

*Subjects with illogical or missing answers (n = 39, 1.1%) are included into the denominators of the prevalence proportions.

The prevalences of any kind of elimination diets, among all the participants were 72%, 20%, 11% and 8% among the 1, 2, 3 and 4-yr-old children respectively. Children with a physician-diagnosed FA were on elimination diets more commonly than those having only parent-perceived FHS (41% vs. 26%).

Cumulative incidence of food-associated symptoms by age, gender and number of siblings

The cumulative incidence curves by age for physician-diagnosed FA, estimated by the Kaplan–Meier method, increased steeply during the first year of life but nearly stabilized by the age of 1.5 yr (Fig. 1). The curves were at an equal level across the different age groups at survey, they were at a higher level for boys than for girls, and also for the first-born children than for the others. The age of the child when food-associated symptoms were first perceived was missing or illogical for 7% (n = 23) out of all reported cases of FAs. As this proportion had only negligible variation by age of the child at the time of the survey, no essential bias was induced to the relative comparisons of the curves between the groups of interest, although the absolute levels of cumulative incidences were slightly underestimated. In contrast, the age at the first

occurrence of symptoms was missing for 25% of the children reported to have parent-perceived FHSs only. As this proportion in addition had an increasing trend from 19% in the 1-yr old to 29% in the 4-yr old at the time of the survey, the analogous Kaplan–Meier curves for FHS like those for FA would be severely biased and are thus not presented.

Discussion

The combined lifetime prevalence of FHS perceived by the parents only and FA diagnosed by a physician was overall 30% among those 1- to 4-yr-old children living in the province of South-Karelia, southeast Finland. According to the parental reports, altogether 9% of the subjects had a FA diagnosed by physician, and these were more common among boys than girls. The FAs were more commonly caused by essential food items and their combinations, whereas the FHSs were mostly associated with non-essential food items only. Cow's milk was the most often reported source of food-associated symptoms. Restrictions on diets, which were based neither on parentally perceived FHS nor on physician-diagnosed FA, were surprisingly frequent, but their prevalence decreased with age.

Table 2. Prevalence (%; number of cases in parenthesis) of symptoms associated with essential and selected non-essential food items among children aged 1–4 yr, classified by age at survey. The total number of children providing adequate data was 3308 (this being 853, 852, 784 and 819 at aged 1, 2, 3 and 4 yr, respectively)

	Age (years)	Physician- diagnosed % (cases)	Parent- perceived % (cases)	Elimination diets (never tasted a food) % (cases)	Never perceived % (cases)	Illogical answers* % (cases)	Missing data % (cases)
Essential food items							
Milk or milk products	1	5.6 (48)	5.4 (46)	2.8 (24)	84 (714)	0.1 (1)	2.3 (20)
	2	6.7 (57)	6.8 (58)	0.2 (2)	85 (726)	0 (0)	1.1 (9)
	3	7.5 (59)	5.9 (46)	0.1 (1)	85 (663)	0 (0)	1.9 (15)
	4	6.0 (49)	7.6 (62)	0 (0)	85 (695)	0.1 (1)	1.5 (12)
	All	6.4 (213)	6.4 (212)	0.8 (27)	85 (2798)	0.1 (2)	1.7 (56)
Egg	1	1.9 (16)	2.7 (23)	17.9 (153)	74 (632)	0.2 (2)	3.2 (27)
	2	2.2 (19)	4.0 (34)	0.9 (8)	90 (767)	0.5 (4)	2.3 (20)
	3	3.4 (27)	3.6 (28)	0.3 (2)	90 (706)	0.4 (3)	2.3 (18)
	4	3.9 (32)	3.4 (28)	0.1 (1)	90 (738)	0.2 (2)	2.2 (18)
	All	2.8 (94)	3.4 (113)	5.0 (164)	86 (2843)	0.3 (11)	2.5 (83)
Wheat	1	1.6 (14)	2.1 (18)	1.1 (9)	92 (786)	0.4 (3)	2.7 (23)
	2	2.3 (20)	2.0 (17)	0.1 (1)	93 (795)	0.1 (1)	2.1 (18)
	3	3.1 (24)	0.9 (7)	0 (0)	93 (731)	0.1 (1)	2.7 (21)
	4	3.4 (28)	1.1 (9)	0 (0)	93 (765)	0 (0)	2.1 (17)
	All	2.6 (86)	1.5 (51)	0.3 (10)	93 (3077)	0.2 (5)	2.4 (79)
Barley, rye	1	1.3 (11)	1.5 (13)	2.5 (21)	92 (782)	0.2 (2)	2.8 (24)
	2	1.8 (15)	1.8 (15)	0.1 (1)	94 (804)	0 (0)	2.0 (17)
	3	2.0 (16)	1.3 (10)	0.4 (3)	94 (734)	0 (0)	2.7 (21)
	4	2.7 (22)	1.8 (15)	0.1 (1)	93 (763)	0 (0)	2.2 (18)
	All	1.9 (64)	1.6 (53)	0.8 (26)	93 (3083)	0.1 (2)	2.4 (80)
Other cereals: oat, maize, rice, millet or buckwheat	1	1.1 (9)	2.3 (20)	0.4 (3)	93 (794)	0.4 (3)	2.8 (24)
	2	0.9 (8)	2.0 (17)	0.5 (4)	94 (804)	0 (0)	2.2 (19)
	3	1.7 (13)	1.1 (9)	0 (0)	94 (739)	0.1 (1)	2.8 (22)
	4	2.0 (16)	1.5 (12)	0.1 (1)	94 (773)	0 (0)	2.1 (17)
	All	1.4 (46)	1.8 (58)	0.2 (8)	94 (3110)	0.1 (4)	2.5 (82)
<i>Total of essential food items</i>	1	6.8 (58)	7.9 (67)	16.8 (143)	67 (568)	0.4 (3)	1.6 (14)
	2	8.6 (73)	10.7 (91)	1.2 (10)	79 (669)	0 (0)	1.1 (9)
	3	9.9 (78)	8.4 (66)	0.4 (3)	80 (624)	0 (0)	1.7 (13)
	4	8.5 (70)	10.1 (83)	0.2 (2)	80 (652)	0.1 (1)	1.3 (11)
	All	8.4 (279)	9.3 (307)	4.8 (158)	76 (2513)	0.1 (4)	1.4 (47)
Selected non-essential food items							
Nut	1	0 (0)	0.8 (7)	67.1 (572)	29 (249)	0.5 (4)	2.5 (21)
	2	0 (0)	2.0 (17)	18.1 (154)	78 (660)	0.6 (5)	1.9 (16)
	3	0.5 (4)	1.4 (11)	8.5 (67)	87 (682)	0.2 (2)	2.3 (18)
	4	0.4 (3)	1.7 (14)	6.3 (52)	89 (731)	0.2 (2)	2.1 (17)
	All	0.2 (7)	1.5 (49)	25.5 (845)	70 (2322)	0.4 (13)	2.2 (72)
Legumes: peanut, peas, bean, soy, lentil	1	0.7 (6)	1.6 (14)	12.8 (109)	81 (688)	1.6 (14)	2.6 (22)
	2	0.8 (7)	3.2 (27)	2.3 (20)	92 (782)	0.1 (1)	1.8 (15)
	3	1.4 (11)	2.8 (22)	1.3 (10)	92 (721)	0.3 (2)	2.3 (18)
	4	1.5 (12)	2.9 (24)	1.2 (10)	93 (758)	0.1 (1)	1.7 (14)
	All	1.1 (36)	2.6 (87)	4.5 (149)	89 (2949)	0.5 (18)	2.1 (69)
Fish	1	0.2 (2)	3.5 (30)	9.4 (80)	84 (718)	0.2 (2)	2.5 (21)
	2	0.4 (3)	4.7 (40)	1.5 (13)	92 (782)	0 (0)	1.6 (14)
	3	0.9 (7)	3.6 (28)	0.9 (7)	92 (724)	0.1 (1)	2.2 (17)
	4	1.0 (8)	4.2 (34)	0.6 (5)	93 (758)	0.1 (1)	1.6 (13)
	All	0.6 (20)	4.0 (132)	3.2 (105)	90 (2982)	0.1 (4)	2.0 (65)
Strawberry, chocolate, tomato	1	0.1 (1)	6.6 (56)	14.3 (122)	74 (634)	2.1 (18)	2.6 (22)
	2	0.4 (3)	13.8 (118)	0.8 (7)	83 (706)	0.2 (2)	1.9 (16)
	3	0.9 (7)	12.6 (99)	0.5 (4)	84 (657)	0.1 (1)	2.0 (16)
	4	2.1 (17)	13.4 (110)	0.1 (1)	83 (680)	0 (0)	1.3 (11)
	All	0.8 (28)	11.6 (383)	4.1 (134)	81 (2677)	0.6 (21)	2.0 (65)
Citrus fruit	1	0.1 (1)	3.5 (30)	29.2 (249)	64 (549)	0.1 (1)	2.7 (23)
	2	0 (0)	7.2 (61)	3.1 (26)	88 (751)	0 (0)	1.6 (14)
	3	0.4 (3)	6.5 (51)	1.5 (12)	90 (704)	0 (0)	1.8 (14)
	4	1.3 (11)	5.1 (42)	0.5 (4)	92 (749)	0.1 (1)	1.5 (12)
	All	0.5 (15)	5.6 (184)	8.8 (291)	83 (2753)	0.1 (2)	1.9 (63)

Table 2. *Continued*

	Age (years)	Physician- diagnosed % (cases)	Parent- perceived % (cases)	Elimination diets (never tasted a food) % (cases)	Never perceived % (cases)	Illogical answers* % (cases)	Missing data % (cases)
Fruit: apple, pear, cherry, peach, banana	1	0.4 (3)	6.6 (56)	0.1 (1)	91 (772)	0.2 (2)	2.2 (19)
	2	0.2 (2)	6.8 (58)	0.1 (1)	91 (774)	0 (0)	2.0 (17)
	3	0.8 (6)	6.6 (52)	0 (0)	90 (709)	0.3 (2)	1.9 (15)
	4	1.3 (11)	6.0 (49)	0.1 (1)	91 (743)	0.2 (2)	1.6 (13)
	All	0.7 (22)	6.5 (215)	0.1 (3)	91 (2998)	0.2 (6)	1.9 (64)
Total†	1	7.5 (64)	15.7 (134)	54.6 (466)	21 (175)	0.4 (3)	1.3 (11)
	2	9.3 (79)	25.1 (214)	11.2 (95)	54 (457)	0 (0)	0.8 (7)
	3	10.8 (85)	21.4 (168)	5.2 (41)	61 (480)	0.1 (1)	1.1 (9)
	4	9.8 (80)	21.6 (177)	3.4 (28)	64 (526)	0 (0)	1.0 (8)
	All	9.3 (308)	20.9 (693)	19.0 (630)	50 (1638)	0.1 (4)	1.1 (35)

*A child must have eaten or tasted a given food item to be eligible as having food allergy or hypersensitivity to that particular item; otherwise the answer could be illogical.

†The total includes the items listed in this table but also all the other food items explicitly inquired in the baseline questionnaire (e.g. root crops, spices, additives, berries, meat and poultry).

Table 3. Prevalence (% , number of cases in parenthesis) of various combinations of physician-diagnosed food allergies, food hypersensitivities perceived by parents only, and of elimination diets (never tasted a food in spite of no indication of food allergy or hypersensitivity). N = 3308 children aged 1–4 yr

	Food-associated symptoms			
	Physician-diagnosed % (cases)	Perceived by parents only % (cases)	Physician-diagnosed or parent-perceived* % (cases)	Elimination diets % (cases)
Milk (including milk products)				
Alone	3.7 (122)	5.2 (173)	8.0 (266)	0.3 (9)
And wheat	0.2 (7)	0.0 (1)	0.2 (8)	0 (0)
And egg	0.8 (26)	0.3 (10)	1.2 (41)	0.3 (9)
And other cereals	0.2 (7)	0.3 (9)	0.6 (20)	0 (0)
And egg and other cereals	0.1 (2)	0 (0)	0.2 (5)	0.0 (1)
And wheat and other cereals	0.8 (26)	0.2 (6)	1.1 (38)	0 (0)
And wheat and egg	0.0 (1)	0.0 (1)	0.1 (3)	0 (0)
And wheat, egg and other cereals	0.7 (22)	0.1 (4)	1.3 (44)	0 (0)
Total for milk	6.4 (213)	6.2 (204)	12.8 (425)	0.6 (19)
Wheat				
Alone	0.3 (10)	0.2 (6)	0.4 (14)	0 (0)
And egg	0.1 (4)	0.0 (1)	0.1 (3)	0.0 (1)
And other cereals	0.2 (7)	0.2 (5)	0.4 (13)	0.0 (1)
And egg and other cereals	0.3 (9)	0.1 (4)	0.4 (14)	0.0 (1)
Total for wheat (excluding milk)	0.9 (30)	0.5 (16)	1.3 (44)	0.1 (3)
Eggs				
Alone	0.9 (30)	1.9 (63)	2.8 (92)	2.5 (84)
And other cereals	0 (0)	0.1 (3)	0.2 (5)	0.4 (13)
Total for eggs (excluding milk and wheat)	0.9 (30)	2.0 (66)	2.9 (97)	2.9 (97)
Other cereals (excluding milk and wheat and egg)	0.2 (6)	0.4 (14)	0.6 (20)	0.6 (19)
Combinations of essential food items	8.4 (279)	9.1 (300)	17.7 (586)	4.2 (138)
Non-essential food items alone	0.9 (29)	11.9 (393)	12.5 (415)	14.9 (492)
Total	9.3 (308)	20.9 (693)	30.3 (1001)	19.0 (630)

*The figures referring to any combination of food allergies due to essential food items may include additional parental-perceived symptoms for some other essential food items not included in that specific combination. Therefore, the total numbers and percentages reported in the third column are not direct sums of those in the first two columns.

The main strength of this study lies on the population base: the parents of all the children within a defined geographical area and age range were invited to participate, without any biasing clinical or other selection criteria (16), like in some previous studies on patients in specialized

care (28–31). Thus, more representative prevalence estimates on FAs and FHSs in a general child population were obtained. The response rate (overall nearly 70%) was relatively high. Even though one may expect that the parents' participation to the study would have been

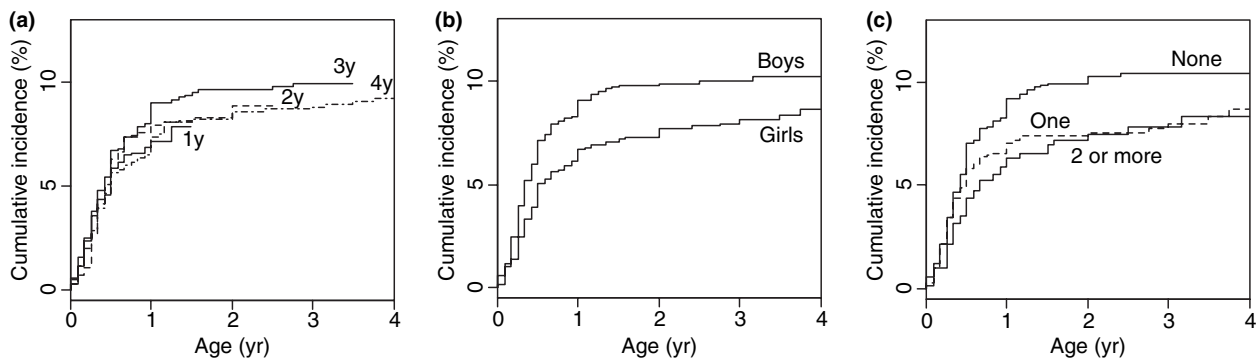


Fig. 1. Kaplan-Meier curves showing the cumulative incidence of first occurrence of any food allergy diagnosed by a physician in subgroups defined by (a) age at survey, (b) gender and (c) number of older siblings in the family. The age at first occurrence was based on retrospective assessment by parents, being available for 285 cases of food allergy among 3285 participants.

affected by the presence or absence of allergic problems in their child, our yet undocumented indirect evidence gives some assurance that no essential systematic difference existed between respondents and non-respondents in this regard. Also, with due reservations the results can be generalized to similar populations in Finland at least, but in broad qualitative terms probably also to other Nordic countries. We also used sound, piloted methods.

The main limitation of this study is to inherent any questionnaire study, in that the results were based on parents' perceptions and recollections of their children's condition and on the items included in the questionnaire. The outcome assessment was thus susceptible to misclassification bias of unknown degree. In order to confirm the FAs but simultaneously to avoid selection bias, we should have examined each child in the study population by double-blind placebo-controlled food challenge (20) and on every single food item. This is ethically, practically and financially out of the question in epidemiological studies with a large unselected population. However, the objective of our study concerned the extent of the burden caused by FHS and FA from the perspective of public health and primary care setting. Hence, parental reports, even with all their subjectivity, provide an adequate and major information source for the assessment of the problem in this context, because parental perceptions have direct consequences on the demand of pertinent health services as well as on the composition of diets of the children. Nevertheless, the relationship of parental reports with the 'objective' reality regarding FAs merits careful assessment, to which more effort will be devoted in future contributions to be produced from our research project.

In the present study, we have good reasons to believe that parental reports on FAs diagnosed by physician were overall not severely biased, considering among other things that the nurse at the child health clinic performed a check-up of the questionnaires and helped in completing them if needed. Differences exist in the physicians' way of making such a diagnosis (32), and this variability may be transmitted to communications with parents, who may understand that a diagnosis of FA had been made on the basis of a remission of symptoms achieved with a dietary elimination, or because of an abnormal test result. On the other hand, a substantial amount of misclassification may be suspected to exist as to symptoms of FHS perceived by the parents only. Evidence of a recall bias associated with this was provided e.g. by our observation, that the overall prevalences of FHS were somewhat lower in children aged 3 yr or more at the time of survey than in those 2 yr of age, while for physician-diagnosed FA the direction of contrast between these age categories was vice versa. Moreover, among the children with FHS the proportion of missing answers on the age of the child, when symptoms were first perceived, was overall very high (25%), being also positively associated with the age of the child at the time of survey. The food-associated symptoms may be mild and transient, and would have been defined as food intolerance or adverse reactions in other studies (6, 17).

The observed occurrences of FAs or FHSs may seem overestimates as compared with the results of studies in which FAs have been verified by hospital examinations (1, 4, 9, 11, 14, 15, 19, 33). The occurrences of FAs and FHSs for different food items will naturally vary between unselected and hospital populations, so that the prevalences and incidences quoted can scarcely

be expected to be comparable. By the age of 3 yr, the observed lifetime prevalence (11%) and cumulative incidences (8–10% from the Kaplan–Meier curves of the two oldest age groups) of FA reported by the parents were higher in the present study than the cumulative incidence (6%) of FHS in the UK study (15), based on a clear, convincing clinical history and open food challenge. The difference may be explained by the different study designs and the possible underestimation in the latter caused by the number of parents who declined to confirm the food challenges. Compared with our results the lifetime prevalence of parent-perceived FHS in a Norwegian population-based study was slightly higher at 2 yr of age but lower at 1 yr (17), whereas in the UK study it was slightly higher at 1 and 3 yr of age (14, 15).

In the German birth cohort study (MAS), IgE concentrations were found to increase up to the age of 10, with higher values in boys than in girls (34). Several other studies (35–38), with one exception (39), have also found male gender to be associated with an increased risk of allergic diseases, and the cohort study from the Isle of Wight reported a similar gender difference for FAs (40), whereas a Swedish study reported higher prevalence of FA among girls (35). In our results this difference was apparent only in FA, but not in FHS. The IgE-mediated mechanism may be more common among physician-diagnosed FAs than among parent-perceived FHSs, apparently because it will be reflected in the testing methods.

Food allergies diagnosed by a physician were reported to be less common when the child had one or more older siblings than when the index child was the oldest or the only child. Better hygiene or fewer respiratory infections, and possibly closer attention paid to milder symptoms when a first-born child is concerned, may both partly explain this difference. Our finding is in accordance with other reports of lower occurrences of allergic diseases associated with the presence and number of siblings (35, 39, 41).

The lifetime prevalence of cow's milk allergy was higher among 2-yr olds than in an another previous Finnish study (7% vs. 2%) (19, 33). On the other hand, egg allergy among 2-yr olds was more prevalent in a previous study (7%, confirmed by home challenge) than here (2%, diagnosed by a physician) (18). It is of interest that the parents in the previous Finnish and Norwegian studies and in the present one all perceived milk-associated symptoms in 10–13% of the children (17, 19). The total prevalence of symptoms associated with fish (5%) is in good

agreement with a previous result (6%) reported from Finland (18), but was slightly higher than that (3%) in Norway (17) at 2 yr of age, as well as those in Sweden and Iceland (3.1% and 2.2%, respectively) at 19 months of age (11). The low prevalence of reported fish allergy at 2 yr of age in the present study is in good accordance with the UK study (0.4% vs. 0.5%) (15).

Symptoms associated with nuts seem to be rare in Finland in early childhood (Table 2). At the same time nuts are the most commonly eliminated food item as well, which explains the rareness of manifest nut allergy during the first years of life in this population. The prevalence of reported symptoms associated with nut were lower in Sweden and Iceland (0.3% and 0%) (11) than in our study (2%), whereas our figure was at the same level as the cumulative incidence of adverse reactions for nut at 2 yr of age in Norway (17). None of the parents reported symptoms associated with sesame seed or sunflower seed in this study. As these items are very rare components of diet in Finland, we are not able to obtain any good estimate of 'true' seed allergy in this population. Hence, at least there is no discordance with the low prevalences reported from The Isle of Wight (UK, 0.3–1.4%), Israel (0.2%) and Spain (2.5%, among hospital patients) (15, 9, 28).

To estimate the prevalence of physician-diagnosed FA and parent-perceived FHS among children, a question on whether the child had ever tasted certain food items, i.e. on elimination diets, must be included in the questionnaire. Such diets were not reported in the Norwegian study (4, 5, 17), but the prevalence of avoiding certain foods was rarer among 1-yr olds in the UK study than in the present work (14). Our results indicate that the exclusion of fish from the diet is rarer between 1- and 2-yr olds in Finland nowadays than it was 25 yr ago, 9% and 2% vs. 14% and 5% respectively (18). The differences may be explained by variability in defining elimination diets between studies.

Even though dietary restrictions were common in our population, their prevalence decreased with age. Most of them concerned nutritionally unimportant foods such as nuts. A child's diet normally becomes diversified in a stepwise manner during the first 2 yr, but this process may be delayed when food-associated symptoms are suspected and being investigated. Food neophobia may partly explain the delay in introducing new food items into a child's diet (42). Eating and refusal habits develop during childhood and these may have unknown effects on the individual's future health.

Acknowledgments

We sincerely thank all the nurses in the child health clinics of South Karelia for their active co-operation. We also thank Mr Markku Koiranen for skilful technical assistance with the data management. This research was mainly funded by the Social Insurance Institution of Finland, but also by the hospital districts of South Karelia, northern Ostrobothnia and Pirkanmaa, Lappeenranta City Council, the Finnish Cultural Foundation (Lahja and Lauri Hotinen Fund), the Viipuri Tuberculosis Foundation, the Tyyni Tani Foundation, Kymenlaakson Terveysturva, the Allergy Foundation, the Medical Society Duodecim in South Karelia, and the Academy of Finland (ESA Läärä's Research Grant for the Senior Scientists no. 120146).

Conflicts of interest

None declared.

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