

REGULAR ARTICLE

Allergy in day care children: prevalence and environmental risk factors

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Abstract

Aim: To investigate the prevalence of atopic disease among Finnish day care children and the relationship between atopy and environmental factors.

Methods: A cross-sectional study of 594 day care children aged 1–6 years from Helsinki, Finland. Each child's history of atopic diseases and environmental exposure was collected in a questionnaire completed by the parents.

Results: The prevalence of diagnosed asthma was 0.9% for the 1–3-year olds and 5.5% for the 4–6-year olds, atopic eczema/dermatitis was 16% in both groups, and allergic rhinitis 5% in the younger group, 9% in the older group. According to multivariable logistic regression models, breastfeeding (exclusive ≥ 4 months or partial ≥ 6 months) reduced the risk of atopic diseases (OR = 0.60; CI₉₅ 0.39–0.93, $p = 0.021$). Atopic diseases were more common in the oldest age group, 5–6-year olds, compared to the youngest, 1–2-year olds (OR = 2.18; CI₉₅ 1.14–4.15, $p = 0.018$). One parent with atopic disease increased the child's risk (OR = 1.89; CI₉₅ 1.20–2.97, $p = 0.006$), more so if both parents had a history (OR = 3.17; CI₉₅ 1.48–6.78, $p = 0.003$).

Conclusion: Our results support the hypothesis that breastfeeding for at least six months may protect against atopic diseases. The child's greater age (5–6 years) and parental history of atopic diseases increased the risk of atopy.

INTRODUCTION

The prevalence of childhood atopy and asthma has increased in the developed countries. The high prevalence of atopic diseases in industrialized countries contrasts with the low prevalence in Eastern Europe, with a lifestyle similar to that of Western Europe 40 years ago. Atopic diseases are a group of diseases that includes asthma, allergic rhinitis, atopic dermatitis, food allergy and hay fever. These diseases are multifactorial, brought about by various families, genetic and environmental influences. Some of the risk factors currently under investigation include: genetic atopic predisposition, early childhood allergen exposure and sensitization, occurrence of viral respiratory infections in young children, childhood obesity, immunologic predisposition, air pollution, NO₂, SO₂, ozone, diesel particles, maternal smoking during pregnancy, parental smoking in early childhood, house-dust-mite allergens, furred pets, day care attendance and absence of breastfeeding (1).

There is an ongoing debate whether breastfeeding has a protecting effect against atopy and asthma. Many studies have shown a protective effect (2–4), and a thorough multidisciplinary review showed a protective effect of breastfeeding on risk of asthma, recurrent wheeze and atopic dermatitis (5). However, other large studies suggest no effect (6) or an increased risk of allergy and asthma associated

with breastfeeding (7). The knowledge of long-term effects is limited (8,9).

Many other risk and protective factors have been theorized, too. Pets at home are associated with an increased risk of asthma (10) but, on the other hand, children raised on a farm have a reduced prevalence of allergic diseases (11). Then again, attendance at day care is associated with an increased risk of asthma (12) but the presence of siblings appears to protect against the development of eczema and hay fever (13), which emphasizes the importance of early exposure. In addition, common respiratory tract infections might protect against atopic diseases in childhood (14) and reduce the risk of developing asthma in older age (15). Maternal smoking is associated with an increased risk of asthma (16).

The risk and protective factors may vary from country to country, for instance because of differences in the duration of breastfeeding and the amount of environmental toxins etc. Many previous Finnish studies about relation of breastfeeding and allergy risk are conducted in 70's and 80's (8,17,18), and therefore the environmental factors affecting the infants, for example bacterial exposure, has changed dramatically. Therefore, the aim of this study was to investigate the environmental factors of childhood asthma and atopic diseases in an urban Finnish day care population, representing a Nordic country with high atopy rate. The number

of older siblings, breastfeeding, parental smoking, day care attendance, furry pets at home and a parental history of atopic disease were studied as well as the overall prevalence of atopic diseases in childhood.

PATIENTS AND METHODS

Study population and data collection

The study was a cross-sectional study of 594 children aged 1–6 years from 18 day care centres in the City of Helsinki, Finland. Information on the children's history of atopic disease and environmental factors was collected by means of a structured questionnaire filled in by the parents during year 1998. The study coordinator checked the questionnaires and supplied missing data with the help of the parents. The local ethics committee approved the study.

Variables

The parents were asked about their own and their children's history of atopic diseases (asthma, atopic eczema/dermatitis or allergic rhinitis diagnosed by a physician). The questionnaire also included questions about the length of exclusive and partial breastfeeding, the overall length of day care attendance, the history of the child's respiratory symptoms, the number of adults and siblings in the family, the size of house space per person, possible water and mould damage at home during the past 12 months, furred pets at home and parental smoking, age and educational level.

Statistical analyses

The history of the child's atopic diseases was the primary outcome variable of the study. The prevalence of atopic diseases was estimated in two age groups: for 1–3 years and 4–6 years of age. The 95% confidence intervals (CI₉₅) were calculated using the approximate normal method or the exact method, whichever was appropriate. In addition, the prevalence of known risk factors was estimated.

Univariable logistic regression analyses were performed in order to study the associations between child's characteristics, environmental factors and atopic diseases. Variables indicating statistical association with the outcome variable ($p < 0.10$) were considered potential risk or protective factors of atopic diseases and were introduced into the stepwise multivariable model. The criteria for entering and removing a variable were: probability of F-to-enter ≤ 0.10 and probability of F-to-remove ≥ 0.15 . The results are given with adjusted odds ratios (OR with CI₉₅). The baseline and outcome variables are presented separately for the two age groups, the 1–3-year olds and the 4–6-year olds, because the prevalence of atopic diseases differed between these two age groups. Data were analysed with SPSS (version 11.5; SPSS Inc, Chicago, IL, USA).

RESULTS

The prevalence of atopic diseases and environmental factors

Of the 594 children who participated in the study, 51% were boys and 49%, girls, 37% were 1–3-year olds and

63%, 4–6-year olds. Of all the children, 22% was reported to have atopic disease diagnosed by a physician (Table 1). The prevalence of asthma was 0.9% for the 1–3-year olds and 5.5% in for the 4–6-year olds, the prevalence of atopic eczema/dermatitis, 16% for both age groups and the prevalence of allergic rhinitis, 4.6% for the younger age group and 9.3% for the older age group (Table 1). Of all the children, 33% had been exclusively breastfed for at least four months and 63% partially breastfed for at least six months. Younger age group had more often been exclusively breastfed for at least four months compared to the older group (40% vs. 29%, $p = 0.007$). Highly educated mothers had breastfed their children for longer than less educated mothers: 41% of mothers with a comprehensive school education, 60% of those with vocational training and 82% of those with further academic education had breastfed their children partially for at least six months ($p < 0.001$). Overall, 33% of the parents smoked and 3% of the parents smoked indoors at home. Of the children, 20% had furred pets at home.

Factors associated with atopic diseases

The univariable logistic regression models

According to the univariable analysis logistic regression models, exclusive breastfeeding for at least four months (OR = 0.57, CI₉₅ 0.36–0.90) and partial breastfeeding for at least six months (OR = 0.54, CI₉₅ 0.36–0.82) were associated with a reduced risk of atopic disease (Table 2). The risk of atopic disease was significantly higher in children who had been fed with infant formula before the age of one month than children who had started the infant formula between the ages of 1.5 and three months (OR = 2.09, CI₉₅ 1.09–4.02). Infant formula as the only nutrition, before starting any complementary food, also increased the risk of atopic disease compared to breastfeeding (OR = 1.74, CI₉₅ 1.09–2.77). Atopic disease was less common in girls than in boys, but not statistically significantly (OR = 0.69, CI₉₅ 0.46–1.03). The risk of atopic disease was higher in children whose mothers had a history of atopic disease than those with non-allergic mothers (OR = 2.19, CI₉₅ 1.46–3.28). A parent's history of atopic disease was associated with increased risk of atopic disease and the risk was even more pronounced if both parents had a history of atopic disease (OR = 2.85, CI₉₅ 1.35–5.98) compared to families where only one parent had a history of atopic disease (OR = 1.91, CI₉₅ 1.23–2.96). Water and mould damage at home was a significant risk factor for atopic diseases (OR = 2.01, CI₉₅ 1.13–3.59).

The multivariable stepwise logistic regression model

The association between demographic variables and atopic diseases was analysed further by multivariable stepwise logistic regression (Table 3). Variables considered as possible risk factors or protective factors for atopic diseases (in univariable analysis p -value < 0.10) were introduced into the model. The variables in the final model were: the child's age, the length of exclusive/partial breastfeeding, the mother's greater age (≥ 35 years) and atopic disease on the part of at least one parent. In this model the child's greater age

Table 1 Characteristics of the children attending day care centres. Results are given separately for children 1–3 years of age and 4–6 years of age. Figures are percentages unless otherwise stated

Characteristic		1–3 years n = 221	4–6 years n = 373	All n = 594
Boys/girls		48/52	52/48	51/49
Age, years (range)				1.3–6.8
Atopic disease, % (range)*	Asthma	0.9 (0.1–3.3)	5.5 (3.3–8.3)	3.8 (2.4–5.7)
	Atopic eczema/dermatitis	16 (11–21)	16 (12–20)	16 (13–19)
	Allergic rhinitis	4.6 (2.2–8.3)	9.3 (6.6–12.8)	7.6 (5.6–10.0)
	Any of above	20 (15–25)	23 (18–27)	22 (18–25)
Breastfeeding (months)	Exclusive ≥ 4	40	29	33
	Partial ≥ 6	62	63	63
Age of starting	0–1	32	34	33
Complementary food (months)	1.5–3	18	22	21
	>3	39	27	32
	None	11	17	15
Length of formula feeding (months)	None	12	18	16
	≤ 6	23	18	20
	6.5–11	49	40	43
	≥ 11.5	17	24	21
Infant formula as only nutrition	No	82	80	80
Before any complementary food	Yes	18	20	20
Duration of day care attendance (months)	<12	51	16	29
	12–23	35	17	24
	≥ 24	15	67	47
Siblings	None	28	15	20
	1	54	59	57
	≥ 2	18	26	23
House area (m ²)/person	<20	35	34	35
	20–25	35	35	35
	>25	29	30	30
Smoking parent	Yes	33	34	33
Parent smoking indoors at home	Yes	4.6	2.4	3.2
Furry pets at home	Yes	18	22	20
Water or mould damage at home	Yes	11	10	10
Mother's education	Comprehensive school	11	17	14
	Vocational training	62	60	61
	Academic degree	27	23	25
Father's education	Comprehensive school	12	15	14
	Vocational training	53	57	55
	Academic degree	35	28	31
Mother's age (years)	(range)	22–47	23–51	22–51
	<35	60	41	48
	≥ 35	40	59	52
Father's age (years)	(range)	23–57	23–58	22–58
	<35	47	28	35
	≥ 35	53	72	65
Atopic disease*	In mother	35	37	36
	In father	27	20	23
	At least one parent	53	50	51

*Diagnosed by a physician.

(OR = 2.18, CI₉₅ 1.14–4.15) and parental history of allergy was associated with increased risk of atopic disease. Allergy in one parent increased the risk (OR = 1.89, CI₉₅ 1.20–2.97), and the risk was even more pronounced if both parents had a history of allergy (OR = 3.17, CI₉₅ 1.48–6.78). Partial breastfeeding for at least six months reduced the risk of atopic disease (OR = 0.60, CI₉₅ 0.39–0.93). The mother's greater age (≥ 35 years) tended to reduce the risk of atopic

disease, but not statistically significantly (OR = 0.67, CI₉₅ 0.43–1.04).

DISCUSSION

We found the prevalence of atopic eczema/dermatitis, asthma and allergic rhinitis to be 16%, 8% and 4%, respectively, among 4–6-year olds children and 16%, 5% and

Table 2 Association between demographic, nutritional and environmental variables and atopy (asthma/atopic eczema/allergic rhinitis), diagnosed by a physician, based on separate logistic univariable regression analyses.

Variable		Atopy (%)	OR	CI ₉₅	p-value
Sex	Male	24.7	1.00		
	Female	18.5	0.69	0.46–1.03	0.067
Age (years)	1–2	16.5	1.00		
	3–4	20.5	1.30	0.71–2.37	0.393
	5–6	24.9	1.68	0.94–3.00	0.081
Breastfeeding, exclusive (months)	<4	24.9	1.00		
	≥4	16.0	0.57	0.36–0.90	0.016
Breastfeeding, partial (months)	<6	28.3	1.00		
	≥6	17.7	0.54	0.36–0.82	0.003
The age of starting	1–3	21.7	1.00		
Complementary food (months)	3.5	22.2	1.03	0.69–1.53	0.890
The age of starting	0–1	29.8	2.09	1.09–4.02	0.027
infant formula (months)	1.5–3	27.0	1.82	0.90–3.69	0.097
	3.5	13.6	0.78	0.38–1.60	0.494
	None	16.9	1.00		
Infant formula as only nutrition	No	19.6	1.00		
Before any complementary food	Yes	29.7	1.74	1.09–2.77	0.021
Duration of day care attendance (months)	<–12	21.6	1.00		
	13–23	21.6	1.01	0.58–1.75	0.990
	≥24	22.3	1.05	0.66–1.67	0.850
Siblings	None	25.0	1.00		
	≥1	20.9	0.79	0.49–1.27	0.336
House area (m ²)/person	<20	18.7	1.00		
	20–25	24.9	1.44	0.89–2.33	0.135
	>25	22.0	1.22	0.74–2.03	0.433
Smoking parent	No	21.8	1.00		
	Yes	21.4	0.97	0.64–1.48	0.903
Parent smoking indoors at home	No	21.5	1.00		
	Yes	26.3	1.30	0.46–3.69	0.617
Furry pets at home	No	22.9	1.00		
	Yes	16.7	0.67	0.40–1.14	0.139
Water or mould damage at home	No	20.3	1.00		
	Yes	33.9	2.01	1.13–3.59	0.018
Mother's education	Comprehensive school	19.5	1.00		
	Vocational training	23.4	1.26	0.69–2.29	0.451
	Academic degree	18.2	0.92	0.46–1.83	0.805
Father's education	Comprehensive school	20.0	1.00		
	Vocational training	21.0	1.06	0.57–1.99	0.853
	Academic degree	22.7	1.17	0.60–2.29	0.640
Mother's age (years)	<35	24.6	1.00		
	≥35	19.0	0.72	0.48–1.07	0.105
Father's age (years)	<35	23.9	1.00		
	≥35	20.1	0.80	0.53–1.22	0.303
Atopic disease*	In mother	30.0	2.19	1.46–3.28	<0.001
	In father	25.0	1.37	0.85–2.19	0.196
	In one parent	25.1	1.91	1.23–2.96	0.004
	In both	33.3	2.85	1.35–5.98	0.006

*Diagnosed by a physician.

1%, respectively, among 1–3-year olds children attending day care. These numbers are highly comparable with the previous Finnish reports (19). The prevalence of childhood asthma and regular medication for asthma has increased during the past 20 years in eastern Finland (20).

The results of the present study support the findings that exclusive breastfeeding for at least four months and partial breastfeeding for at least six months has a protective effect

against atopic disease (asthma/atopic eczema/allergic rhinitis). In our study the prevalence of exclusive breastfeeding for at least four months was 33% and the prevalence of partial breastfeeding for at least six months, 63%. The association between breastfeeding and atopic diseases has been investigated in many studies, but the evidence remains controversial. According to a thorough multidisciplinary review, breastfeeding reduces risk of asthma, recurrent wheeze and

Table 3 Atopic disease (asthma/atopic eczema/allergic rhinitis), diagnosed by a physician, in 1–6 years children explained by demographic, nutritional and environmental variables, based on multivariable logistic regression analysis

Explaining variable		OR	CI ₉₅ for OR	p-value
Age*	3–4 years	1.46	0.76–2.81	0.252
	5–6 years	2.18	1.14–4.15	0.018
Allergy**	In one parent	1.89	1.20–2.97	0.006
	In both parents	3.17	1.48–6.78	0.003
Partial breastfeeding ≥ 6 month		0.60	0.39–0.93	0.021
Mother's age ≥ 35 years		0.67	0.43–1.04	0.073

*Reference group = age <3 years.

**Reference group = no allergy in parents.

atopic dermatitis in all children, regardless of atopic risk (5). However, many studies have shown that breastfeeding, on opposite, increases atopic risk (7). The mean duration of breastfeeding differs dramatically between countries and seems to be fundamental for the effect. The mean length of exclusive breastfeeding is very short in many studies with negative findings (7). Several studies from other Nordic countries, for example Sweden, with long duration of breastfeeding, have found protective effect of breastfeeding against atopic diseases and asthma (2–4). In Scandinavia the prevalence of breastfeeding is extremely high (exclusive breastfeeding ≥ 4 months 68% in Sweden) (21), compared to southern Europe, for example Italy, where the prevalence of breastfeeding is fairly low (partial breastfeeding ≥ 3 months 65%) (22). In Finland the new recommendation for exclusive breastfeeding is six months. The effect of breastfeeding may show a U-shaped effect: in a Finnish study a protective effect was found with 4–6 months exclusive breastfeeding whereas extended breastfeeding increased the risk (8). This was shown to be the case for childhood asthma in another Finnish study (23).

Still one explanation for the controversial results might be the variation between countries in breast milk's environmental toxins with possible immunomodulatory effects. Breastfed infants are reported to get high dioxin and polychlorinated biphenyl load at least in Taiwan (24) and the Netherlands (25). This confirms that studies should not be generalized to countries with different breastfeeding figures and environmental factors.

Our results support the findings that highly educated mothers breastfeed their children longer (21), and we also noted that young maternal age was positively associated with the absence of breastfeeding. This accords with Bråbäck and Hedberg (26), who found that the only independent determinants of asthma were maternal age, birth weight and multiple gestation and that maternal age and birth weight had opposite effects on asthma and allergic rhinitis.

A possible mechanism behind the positive effects of breast milk against atopic diseases is that human milk contains immunomodulatory components (e.g. cells, cytokines, long-chain fatty acids and IgA) that enhance the maturation of the immune system in the newborn infant (27). In addition, formula-fed children are exposed to cow's milk protein earlier than breastfed children. Human milk has also been

found to be a source of bifidobacteria and lactic acid bacteria for the infant gut and this may play an important role in the prevention of neonatal infectious diseases (28). On the other hand, the breast milk of atopic mothers may contain such cytokines and soluble CD14s that affect the development of atopic manifestations in infants (29).

The present data support the findings that a parental history of allergy increases the risk of childhood atopic diseases and that the risk is further increased if both parents have atopic disease (16). We observed a trend that atopic disease was more common in boys than in girls, but this did not reach statistical significance. Mail gender is considered as a risk factor of developing allergic diseases. Recent studies suggest sex-related differences in the relationship between breastfeeding and allergic diseases: breastfeeding may be a protective factor especially among boys (30).

In conclusion, in these urban Finnish day care children, exclusive breastfeeding for at least four months and partial breastfeeding for at least six months were associated with a reduced risk of atopic diseases. Even though some studies have shown controversial results, exclusive breastfeeding for 4 to 6 months should remain the keystone for promoting health.

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