

REGULAR ARTICLE

Association of food allergy with asthma severity and atopic diseases in Jewish and Arab adolescents

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ABSTRACT

Aim: To investigate the prevalence of reported food allergy and its association with atopic diseases and asthma severity among Jewish and Arab adolescents.

Subjects and methods: The self-report questionnaire of the International Study of Asthma and Allergies in Childhood (ISAAC) was administered to adolescents aged 13–14 years from randomly selected junior high schools in Israel. Questions regarding food allergy were added.

Results: A total of 11 171 questionnaires were available for analysis. Food allergy was reported by 3.6% of participants: 1.9% milk, 0.6% egg, 0.6% peanut and 0.4% sesame. On multivariate analysis, food allergy was strongly associated with current asthma (OR, 2.5; 95% CI, 1.8–3.3), atopic eczema (OR, 3.2; 95% CI, 2.4–4.3) and allergic rhinitis (OR, 2.4; 95% CI, 1.8–3.1). Arabs were significantly more allergic to peanut (OR, 2.5; 95% CI, 1.5–4.1), egg (OR, 3.5; 95% CI, 2.1–5.9) and sesame (OR, 2.3; 95% CI, 1.2–4.5) than Jews, and less allergic to milk (OR, 0.6; 95% CI, 0.4–0.9). Asthmatic subjects with food allergy had significantly more parameters of severe asthma than those without food allergy ($p < 0.001$).

Conclusions: The prevalence of allergy to specific foods differs between Jews and Arabs. Asthmatic adolescents with food allergy report more severe asthma than those without food allergy.

INTRODUCTION

Although adolescents apparently have the highest rate of fatal and near-fatal allergic reactions of all age groups (1,2), data on food allergy and food avoidance in this population remain sparse. Only a few large-cohort prevalence studies have been conducted on allergies to different foods, mainly in North America (3,4) and Europe (5–7), and even fewer have focused on adolescents (8,9). According to estimates from the UK, the prevalence of food allergy in adolescents is about 2.3% (8). Moreover, findings indicate that the rate may be increasing (4,10), raising concerns among clinicians.

In the USA, milk, egg and peanut account for the majority of food-induced allergic reactions in children (11). However, food allergies vary worldwide probably owing to the different ages at which foods are introduced to infants and the different methods of food preparation. To gain a better understanding of the pathophysiology of food allergy, epidemiologic studies comparing the overall and specific prevalence of food allergy among countries and population groups are necessary.

Several studies, using various designs and methodologies, have reported a relationship between food allergy and other

manifestations of atopy in both children and adults (12,13). Children (mean age, 10.4 ± 0.7 years) with a reported food allergy had a significantly higher rate of asthma and allergic rhinitis (13) as well as eczema (12) than children without an allergy. The few studies that addressed the association of food allergy and asthma severity (14,15) found that children sensitized to foods had significantly higher rates of

Key notes

- Reported food allergy in adolescents is strongly associated with current asthma, atopic eczema and allergic rhinitis.
- Arab adolescents are significantly more allergic to peanut, egg and sesame than Jewish children, and less allergic to milk.
- Asthmatic adolescents (both Arabs and Jews) with food allergy have more severe asthma than those without food allergy. More intensive management of this high-risk group of adolescents is recommended.

hospitalization for asthma ($p < 0.01$) and required more steroid medications ($p = 0.025$) (14).

The aim of the present study was to evaluate the prevalence of allergy to milk, egg, peanut and sesame among Jewish and Arab adolescents, the age group at highest risk of fatal food anaphylaxis. In addition, we investigated the possible association between food allergy and asthma severity using a validated questionnaire of the International Study of Asthma and Allergies in Childhood (ISAAC) (16).

METHODS

Sample

The study was cross-sectional, population-based study, conducted as part of the third ISAAC in a national sample of 13- to 14-year-old schoolchildren in Israel. One hundred and six schools were chosen at random from a list of all junior high schools in the country. Each school was considered a sampling unit, and for each unit sampled, all children attending its eighth grade were included in the study. The number of schools selected from each district was weighted for the total number of eighth-grade pupils in that district and the number of children attending each school. As Jews and Arabs generally attend separate schools, sampling was carried out for each population group separately.

Questionnaire

The standard written core questionnaire for atopic diseases including allergic rhinitis, atopic eczema and asthma developed by the ISAAC (16) was used in the present study. Questions regarding food allergy were added to the questionnaire, as well as questions on demographic and social factors. Subjects were asked if they are allergic to food and therefore not allowed to eat it (yes or no). If yes, they were asked to circle one or more of the following foods: milk, egg, peanut, sesame or others (and to specify the food item). The questionnaire was given to each group of children in their native language (Hebrew or Arabic). To ensure similarity in the interpretation of different questions, the questionnaire was translated from Hebrew to Arabic and then back to Hebrew. All questionnaires were filled out anonymously in class. Teachers were instructed not to help the children with the answers.

Definitions

As previously described (17), children who answered 'yes' to the question 'Do you have asthma or spastic bronchitis?' were considered to have asthma. Children who reported often having itchy rash in a typical distribution were considered to have atopic eczema. They were also asked if they suffer from allergic rhinitis. Children who reported having asthma or allergic rhinitis or atopic eczema were considered atopic.

Only children who answered 'yes' to the question on allergy to a food, they are not allowed to eat, and then marked one or more of the following types of food listed in the next question (milk, egg, peanut and sesame) were considered to have food allergy for the present analysis.

Statistical analysis

Statistical analyses were performed using the SPSS package (version 14; Chicago, IL, USA). Comparisons of the prevalence of allergy to four kinds of food by population group (Arabs, Jews) and atopic diseases (current asthma, allergic rhinitis, atopic eczema) were performed with chi-square test, and odds ratios were calculated. Multivariate logistic regression models controlling for possible confounders (like population group, other allergic diseases and parents with asthma) were fitted to the data to evaluate variables associated with food allergy, and the adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated.

Ethics

The study was approved by the Ethics Committee of Rabin Medical Center.

RESULTS

Response rate

The sampling process yielded a study population of 14 187 children from 106 schools 10 894 Jews and 3293 Arabs. Of these, 11 772 children filled out the questionnaire (9039 Jews and 2733 Arabs) for an overall response rate of 82.9%. An additional 601 questionnaires were excluded for the present analysis because the responses for food allergy were incomplete. Thus, the questionnaires of 11 171 children were available for analysis: 80.3% Jews and 19.7% Arabs.

Atopic diseases

The prevalence of current asthma in the whole study population (11 772 schoolchildren) was 7.2% (7.2% for the Jewish children, 7.0% for the Arab children), of allergic rhinitis, 11.2% (10.9% for Jews, 12.1% for Arabs) and of atopic eczema, 6.9% (6.7% for Jews, 7.8% for Arabs).

Prevalence of food allergy by atopic disease

We report the prevalence of allergy to the four most common foods: milk, egg, peanut and sesame. Of the 11 171 children, 398 (3.6%) reported allergy to at least one of these foods. The most allergenic food was milk, with a rate of 1.9%, compared to 0.6% for egg, 0.6% for peanut and 0.4% for sesame.

Table 1 shows the prevalence of allergy to each food by population group and atopic disease. Compared to Jewish children, Arab children were more allergic to eggs, peanut and sesame ($p < 0.001$) and less allergic to milk ($p = 0.08$). There was no difference in prevalence of food allergy by sex or country of origin (Israel or other; findings not shown). Children who reported on asthma, wheezing in the last 12 months, allergic rhinitis or eczema were significantly more allergic to any food than children without atopy.

On multivariate analysis (Table 2), Arabs were significantly more allergic to at least one food than Jewish children (OR, 1.4; 95% CI, 1.1–1.8); they were less allergic only to milk (OR, 0.6; 95% CI, 0.4–0.9). Children with asthma or atopic eczema or allergic rhinitis were significantly more allergic to at least one food than nonatopic children (OR,

Table 1 The prevalence of food allergies by population group and atopic diseases

	Food allergy		Milk allergy		Egg allergy		Peanut allergy		Sesame allergy	
	n (%)	OR (95% CI) p value	n (%)	OR (95% CI) p value	n (%)	OR (95% CI) p value	n (%)	OR (95% CI) p value	n (%)	OR (95% CI) p value
Population group										
Jews N = 8757	277 (3.2)	1.6 (1.3–2.0)	179 (2.0)	0.7 (0.5–1.0)	35 (0.4)	3.6 (2.2–5.7)	38 (0.4)	2.8 (1.7–4.5)	25 (0.3)	3.2 (1.8–5.7)
Arabs N = 2414	121 (5.0)	<0.001	36 (1.5)	0.08	34 (1.4)	<0.001	29 (1.2)	<0.001	22 (0.9)	<0.001
Current asthma										
Yes N = 762	83 (10.9)	3.9 (3.1–5.1)	42 (5.5)	3.5 (2.5–4.9)	16 (2.1)	4.2 (2.4–7.3)	13 (1.7)	3.4 (1.8–6.2)	12 (1.6)	4.7 (2.4–9.1)
No N = 10 339	311 (3.0)	<0.001	170 (1.6)	<0.001	53 (0.5)	<0.001	53 (0.5)	<0.001	35 (0.3)	<0.001
Wheezing past 12 months										
Yes N = 1615	122 (7.6)	2.8 (2.2–3.4)	64 (4.0)	2.6 (1.9–3.5)	20 (1.2)	2.4 (1.4–4.0)	23 (1.4)	3.1 (1.9–5.2)	15 (0.9)	2.7 (1.5–5.1)
No N = 9380	270 (2.9)	<0.001	146 (1.6)	<0.001	49 (0.5)	0.001	43 (0.5)	<0.001	32 (0.3)	<0.001
Allergic rhinitis										
Yes N = 1219	112 (9.2)	3.4 (2.7–4.3)	65 (5.3)	3.7 (2.8–5.0)	21 (1.7)	3.5 (2.1–5.9)	17 (1.4)	2.8 (1.6–4.9)	9 (0.7)	1.9 (0.9–4.0)
No N = 9715	278 (2.9)	<0.001	144 (1.5)	<0.001	48 (0.5)	<0.001	49 (0.5)	<0.001	37 (0.4)	0.07
Atopic eczema										
Yes N = 753	89 (11.8)	4.4 (3.4–5.6)	38 (5.0)	3.1 (2.2–4.4)	20 (2.7)	5.7 (3.4–9.7)	15 (2.0)	4.1 (2.3–7.3)	16 (2.1)	7.2 (3.9–13.2)
No N = 10 296	305 (3.0)	<0.001	174 (1.7)	<0.001	49 (0.5)	<0.001	51 (0.5)	<0.001	31 (0.3)	<0.001
Parents with asthma										
Yes N = 845	57 (6.7)	2.2 (1.7–3.0)	34 (4.0)	2.5 (1.7–3.6)	16 (1.9)	4.2 (2.4–7.5)	5 (0.6)	0.9 (0.4–2.5)	2 (0.2)	0.6 (0.2–2.6)
No N = 9594	300 (3.1)	<0.001	161 (1.7)	<0.001	44 (0.5)	<0.001	58 (0.6)	0.96	37 (0.4)	0.49

Table 2 Adjusted odds ratios (95% confidence intervals) for reported food allergies in adolescents*

Factor	Food allergy	Milk allergy	Egg allergy	Peanut allergy	Sesame allergy
Arabs	1.4 (1.1–1.8) p = 0.005	0.6 (0.4–0.9) p = 0.02	3.5 (2.1–5.9) p < 0.001	2.5 (1.5–4.1) p = 0.001	2.3 (1.2–4.5) p = 0.011
Current asthma	2.5 (1.8–3.3) p < 0.001	1.9 (1.3–2.9) p = 0.003	2.6 (1.4–5.1) p = 0.004	2.4 (1.2–4.9) p = 0.012	4.6 (2.1–10.1) p < 0.001
Atopic eczema	3.2 (2.4–4.3) p < 0.001	2.3 (1.5–3.4) p < 0.001	3.2 (1.7–5.9) p < 0.001	3.5 (1.9–6.5) p < 0.001	6.4 (3.2–12.9) p < 0.001
Allergic rhinitis	2.4 (1.8–3.1) p < 0.001	2.8 (2.0–4.0) p < 0.001	1.9 (1.1–3.7) p = 0.03	2.1 (1.1–3.9) p = 0.02	0.9 (0.3–2.1) p = 0.85
Parents with asthma	1.5 (1.1–2.1) p = 0.01	1.7 (1.1–2.5) p = 0.02	2.9 (1.5–5.3) p = 0.001	0.6 (0.2–1.7) p = 0.37	0.4 (0.1–1.6) p = 0.18

*Adjusted for all other factors listed in the table.

2.4; 95% CI, 1.7–3.6; OR, 3.6; 95% CI, 2.7–4.8; OR, 1.5; 95% CI, 1.0–2.0, respectively). Children who reported on food allergy had significantly more current asthma, past history of asthma, atopic eczema and allergic rhinitis than children who did not ($p < 0.001$; Table 3).

Food allergy and severity of asthma

The ISAAC questionnaire includes several questions regarding asthma severity. Table 4 shows that asthmatic adolescents who reported food allergy had significantly more parameters of severe asthma (night-time symptoms, emergency room visits, hospitalization, permanent treatment, etc.) than asthmatic children who did not report food allergy ($p < 0.001$).

DISCUSSION

This is the first study to investigate self-reported food allergy in two population groups of 13- to 14-year-olds with an

association to atopic diseases using a standardized questionnaire (ISAAC).

A previous study from the UK (8) reported food hypersensitivity in 11.6% of 11-year-olds and 12.4% of 15-year-olds. However, after confirmation by open food challenge and positive skin prick test, together with a positive history of adverse reactions, the final prevalence was 2.3% in both age groups. In the present study of adolescents (eighth graders) in Israel, only 3.6% reported allergy to the four most allergenic foods in the country: milk, egg, peanut and sesame. To ensure that the children were not reporting mild reactions or reactions in early childhood to food to which they later developed tolerance, we asked them if they are allergic to any food and are therefore not allowed to eat it. As the study was anonymous, we could not measure IgE levels or perform oral challenge; however, our results were closer to those achieved by confirmation with food challenge and skin prick test (8) rather than those based on history alone.

Table 3 Prevalence of asthma, allergic rhinitis and atopic eczema by the presence of food allergy

	With food allergy n/N (%)	Without food allergy n/N (%)	OR (95% CI)	p-value
Current asthma	83/394 (21.1)	679/10 707 (6.3)	3.9 (3.1–5.1)	<0.001
Asthma ever	108/387 (27.9)	1428/10 516 (13.6)	2.5 (1.9–3.1)	<0.001
Allergic rhinitis	112/390 (28.7)	1107/10 544 (10.5)	3.4 (2.7–4.3)	<0.001
Atopic eczema	89/394 (22.6)	664/10 655 (6.2)	4.4 (3.4–5.6)	<0.001

Table 4 Parameters of asthma severity in adolescents with asthma by the presence of food allergy

	With food allergy n/N (%)	Without food allergy n/N (%)	OR (95% CI)	p-value
More than 12 exacerbations per year	23/81 28.4%	78/661 11.8%	2.9 (1.7–5.1)	<0.001
Night-time symptoms once a week or more	23/80 28.8%	92/661 13.9%	2.5 (1.5–4.2)	0.001
Severe exacerbations (speech-limiting)	45/82 54.9%	175/666 26.3%	3.4 (2.1–5.4)	<0.001
Permanent treatment for asthma	48/82 58.5%	199/668 29.8%	3.3 (2.1–5.3)	<0.001
ER visit in past 12 months	27/81 33.3%	86/665 12.9%	3.4 (2.0–5.6)	<0.001
Hospitalized in past 12 months	17/80 21.3%	48/666 7.2%	3.5 (1.9–6.4)	<0.001
Follow-up by a specialist	43/82 52.4%	182/663 27.5%	2.9 (1.8–4.6)	<0.001

ER = emergency room.

The most common food allergen in our cohort was milk, for which the rate was about threefold higher than for egg and peanut. This difference could be attributed to food intolerance (lactase deficiency) in a few cases. The prevalence of lactase deficiency among children in Israel, both Arabs and Jews is not known. In addition, some of the children may have avoided milk because of an assumed 'allergy' in response to campaigns in Israel and other Western countries insinuating (despite the lack of scientific evidence) that milk and dairy products can cause such symptoms as cough and asthma exacerbations. Therefore, we assume the actual prevalence of milk allergy is lower than found here.

The prevalence of peanut allergy in our study was 0.6%. The prevalence of self-reported peanut allergy in 2008 in the USA was 1.4% (10). Other studies described rates among children exceeding 1% (6,7). An article from Asia, reported that the prevalence of reported peanut allergy with convincing history among 14–16 years adolescents in Singapore and Philippines, was 0.47% and 0.43%, respectively. In contrast, the Singapore expatriate population, born in western countries, showed a higher prevalence of 1.2%. Either Asians or white subjects born in the west were at higher risk to peanut allergy. They concluded that environmental factors, that are yet to be defined, are likely to be responsible for that observation (18).

One questionnaire-based study comparing peanut allergy between Jewish children from the UK and Israel found that

in the 12- to 18-year age group, the rate was 0.19% (5/2537) in the Israeli group and 1.03% (15/1458) in the British group (19). The difference in findings in Israeli children between this study and ours might be explained by differences in study design, sampling (excluding Arabs, for example) and method (questionnaire). The considerably lower rate in Israeli children in both the earlier study and ours than in the British children may be related to the finding that peanut are introduced to children much earlier in Israel than in the UK (19), suggesting that early consumption of peanut is associated with a low prevalence of peanut allergy in later life.

The prevalence of sesame allergy in the present study was 0.4%. Rates in the literature range between 0% and 0.79% in different countries (20,21). Previous studies from Israel reported a relatively high prevalence of sesame allergy in infancy (0–2 years) (22) after an average follow-up of 3–6 years; 20–30% of patients developed tolerance (23).

The significantly lower rate of milk allergy in the Arab adolescents than the Jewish is in agreement with the results of a study from Israel (24) that reported on lower rates of IgE-mediated cow's milk protein allergy among Arab children that may be due to the early age at which milk is introduced to infants in the Arab population (already with breastfeeding) relative to Jewish children. As previously described with respect to peanut allergy (19), early exposures can be protective against food allergy.

It was reported that children sensitized to foods had higher rates of asthma hospitalization and required more steroid medication (12). One case-controlled study from UK (25) reported that food allergy was independently associated with life-threatening asthma in children (1–16 years). The present study is the first large cross-sectional study to show that asthmatic adolescents with food allergy report significantly more parameters indicative of severe asthma, such as emergency room visits, hospitalization and number of exacerbations per year, compared to asthmatic adolescents without food allergy. This is compatible with recent findings in younger children for peanut and milk allergy (13).

Studies have shown that patients with coexisting asthma and food allergy are the most likely to develop severe anaphylactic reaction to peanut and tree nuts, and also to egg and milk (26). According to a recent epidemiologic survey of anaphylaxis using a UK database, patients with asthma have a greater risk of anaphylaxis than patients without asthma, and the risk is greater in those with severe than with mild-moderate asthma (27). These data, together with our finding of a significant association between food allergy and severe asthma, and previous finding of risk taking in this age group (9), suggest that asthmatic teenagers with food allergy are at greatest risk of fatal food anaphylaxis.

The present study was limited by the use of adolescent self-reports. As this was a nationwide anonymous study, we could not perform confirmatory tests (such as serum specific IgE), and therefore, the prevalence of allergic diseases may have been slightly overestimated. However, a recent article concluded that in the absence of anaphylaxis, primary reliance on serum food specific IgE testing is not sufficient, and oral food challenge may be indicated (28). This was beyond the scope of this study. Concerning the reliability of the reports of atopic diseases and asthma severity, the ISAAC questionnaire is a validated instrument used worldwide (16). Furthermore, earlier studies found that children's self-reports on respiratory symptoms and asthma were valid, and their reports tended to improve with age (29), and that school-age children were able to report effectively on their own general health and well-being (30).

In summary, asthmatic adolescents with food allergy report more severe asthma than asthmatic adolescents without food allergy, and they are therefore at greater risk of fatal or near-fatal anaphylaxis. This group should be targeted for preventive education and treatment. More studies in different population groups are needed to further investigate the variability of food allergies around the world.

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