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Original Article

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Prevalence of Immediate-Type Food Allergy and Food-Induced Anaphylaxis in Korean Schoolchildren

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ABSTRACT

Purpose: This study assessed the prevalence, major triggers, and risk factors of food allergy (FA) and food-induced anaphylaxis among Korean school-aged children.
Methods: In 2022, a nationwide school-based survey was conducted using a structured questionnaire. Cluster sampling yielded a representative sample of 12,558 students aged 6–7, 9–10, and 12–13 years from 213 elementary and 103 middle schools in Korea.
Results: The prevalence of self-reported perceived FA was 15.3%; recurrent immediate-type (< 4 hours) FA, 7.8%; and physician-diagnosed FA, 5.5%, with food-induced anaphylaxis in 0.7% of cases. The leading allergens for recurrent immediate-type FA were peach (1.13%), milk (0.82%), egg (0.79%), kiwi (0.65%), walnut (0.62%), peanut (0.62%), apple (0.61%), crab (0.59%), shrimp (0.54%), and pineapple (0.33%). By food group, fruits (3.67%) were most frequent, followed by crustaceans (1.20%), and tree nuts (1.18%). Major anaphylaxis triggers included egg (0.19%), milk (0.11%), walnut (0.10%), peanut (0.09%), and peach (0.06%). Fruit allergy was more common in older age groups, accompanied by increased oral allergy symptoms, suggesting a rising burden of pollen FA syndrome. In these groups, crustaceans were also major allergens. Among tree nuts, walnut was the most common. Perilla seed, a uniquely observed allergen in Korea, had prevalences of 0.11% for allergy and 0.02% for perilla seed–induced anaphylaxis. Multiple food allergies were reported

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by 29.9% of children with FA. Significant risk factors included paternal allergic disease, parental history of FA, delayed complementary food introduction (≥ 7 months), prolonged breastfeeding (≥ 7 months), and current allergic diseases, particularly atopic dermatitis. **Conclusions:** In Korean school-aged children, recurrent immediate-type FA and food-induced anaphylaxis affect 7.8% and 0.7%, respectively. Fruits, milk, egg, tree nuts, and peanuts are the most common triggers, with notable age-related differences. These findings underscore the need for continued surveillance, early identification of high-risk groups, and targeted prevention and management strategies.

Keywords: Food hypersensitivity; anaphylaxis; prevalence; risk factors; child; adolescent

INTRODUCTION

The reported prevalence of food allergy (FA) varies across countries and depends on the research methodology employed. While the global prevalence of asthma, rhinitis, and eczema has been investigated since the early 1990s through the International Study of Asthma and Allergies in Childhood (ISAAC), a comparable global platform for FA and anaphylaxis has yet to be established. At the time ISAAC was initiated, FA was relatively uncommon and more difficult to diagnose accurately than other allergic diseases assessed through questionnaire-based surveys.[1]

Most prevalence studies rely on self-reported data, though some incorporate both allergen sensitization and symptom assessment or use oral food challenges for definitive diagnosis. Consequently, prevalence estimates vary; however, an overall upward trend has been observed worldwide.[2-5] This increase has been most evident in industrialized countries, with growing evidence of similar trends in developing regions.[6]

Determining the national FA prevalence and identifying common allergenic foods are essential for patient management and for guiding public health policy. Given that dietary habits and food cultures differ by country, the spectrum of common allergenic foods also varies. Moreover, globalization and cross-cultural dietary exchange may alter these patterns over time.[7]

FA is more prevalent in children than in adults, and recent reports of rising prevalence among children have raised substantial public health concerns. Assessing FA prevalence in school-aged children and identifying major causative foods are therefore critical for effective public health strategies.[2,4,8] Anaphylaxis is a potentially fatal systemic allergic reaction, with lifetime prevalence estimates ranging from 0.05% to 2%.[9,10] Recent evidence suggests an increasing incidence of food-induced anaphylaxis in children.[11,12]

The present study investigates the prevalence of FA and food-induced anaphylaxis in Korean school-aged children and identifies common causative foods and associated risk factors.

MATERIALS AND METHODS

Study design and participants

A nationwide cross-sectional survey was conducted from September to November 2022, involving 213 elementary and 103 middle schools. Participants were recruited

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using a stratified 2-stage cluster sampling strategy, with schools stratified by geographic region. In Stage 1, schools were selected using probability proportional to size, based on the number of classes. In Stage 2, two classes per school were randomly chosen, and all students in the classes were invited to participate. Data were collected through both field and online surveys. Field survey response rates were 96.6% for elementary schools and 97.6% for middle schools, with the remainder completed online. Questionnaires were completed by parents for elementary school students and by the students themselves for middle school students. The study protocol was approved by the Institutional Review Board of Inje University, Seoul (PAIK: 2022-01-006), and written informed consent was obtained from all parents.

Questionnaire and definitions of FA and food-induced anaphylaxis

FA was assessed using a structured questionnaire. Participants were classified as having "perceived FA, ever" if they answered "yes" to whether the child had experienced allergic symptoms (e.g., hives, itching, cough, dyspnea) to specific foods from birth to the present. Participants who answered "yes" to the question "Did these symptoms recur whenever the suspected food was consumed?" and indicated "less than 4 hours" in response to "Approximately how long after eating the suspected food did the symptoms appear?" were classified as having "recurrent immediate-type FA, ever." All analyses of causative foods, symptoms, and risk factors were based on this group. Cases with a physician-confirmed diagnosis were classified as "diagnosis of FA, ever." Symptoms related to food were classified by organ system. Specifically, oral allergy symptoms were defined as those limited to the oral cavity, such as perioral rash, itching, swelling, or a sensation of oral mucosal swelling. Among participants with "recurrent immediate-type FA, ever," those who experienced ≥ 2 concurrent symptoms involving different organ systems—(1) skin, (2) respiratory, (3) gastrointestinal, and (4) cardiovascular—were classified as having food-induced anaphylaxis, according to recent anaphylaxis guidelines.[13] The questionnaire also collected sociodemographic information and potential risk factors for FA.

Statistical analyses

Sampling weights were constructed to account for differential selection probabilities, nonresponse, and poststratification. Categorical variables are presented as frequencies and weighted percentages, and FA prevalence was calculated using the SURVEYFREQ procedure. Continuous variables were compared using independent *t*-tests, and categorical variables were compared using χ^2 tests when expected counts were adequate, or Fisher's exact test otherwise. Logistic regression analyses were performed to evaluate associations between potential risk factors and FA. Results are reported as adjusted odds ratios (aORs) with 95% confidence intervals. Potential risk factors and covariates included sex, mode of delivery, gestational age, birth weight, parental history of allergic diseases, timing of complementary food introduction, breastfeeding duration, antibiotic exposure in the first year of life, and current allergic diseases. Statistical analyses were performed using R, version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Characteristics of the study population

A total of 12,558 school-aged children participated in this study, including 4,038 aged 6–7 years, 4,251 aged 9–10 years, and 4,269 aged 12–13 years. Boys accounted for 51.2%, 51.3%, and 51.5% of each respective age group (**Table 1**).

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Table 1. Characteristics of participants (n = 12,558)

Characteristics	6- to 7-yr-olds (n = 4,038)	9- to 10-yr-olds (n = 4,251)	12- to 13-yr-olds (n = 4,269)
Sex			
Male	2,037 (51.2)	2,120 (51.3)	2,143 (51.5)
Female	2,001 (48.8)	2,131 (48.7)	2,126 (48.5)
Family history of allergic diseases			
Paternal history of allergic disease	730 (17.9)	746 (17.6)	707 (17.3)
Maternal history of allergic disease	854 (21.3)	883 (20.5)	831 (19.0)
Mode of delivery			
Vaginal delivery	2,332 (57.9)	2,655 (61.8)	2,667 (62.3)
Cesarean section	1,706 (42.1)	1,596 (38.2)	1,602 (37.7)
Gestational period			
≤ 36 wk	523 (12.5)	538 (12.8)	561 (12.3)
37–42 wk	3,434 (85.5)	3,618 (85.3)	3,584 (84.8)
≥ 43 wk	80 (1.9)	94 (1.9)	124 (2.9)
Birth weight			
< 3.1 kg	1,475 (36.5)	1,488 (35.2)	1,492 (35.0)
3.1–3.5 kg	1,802 (44.8)	1,927 (45.1)	1,928 (44.7)
≥ 3.6 kg	758 (18.7)	835 (19.8)	849 (20.3)
Breastfed for ≥ 7 mon	1,573 (39.1)	2,012 (47.5)	2,041 (48.1)
Timing of complementary feeding initiation			
0 to 3 mon of age	237 (5.9)	310 (7.3)	405 (9.5)
4 to 6 mon of age	2,143 (53.2)	2,072 (48.9)	1,863 (43.9)
≥ 7 mon of age	1,645 (40.8)	1,645 (40.8)	1,973 (46.5)
Antibiotics exposure during infancy	1,539 (37.1)	1,553 (35.3)	1,242 (29.1)
Maternal smoking during pregnancy	14 (0.3)	24 (0.5)	25 (0.6)
Maternal smoking during infancy	30 (0.7)	40 (0.9)	47 (1.0)
Household pets during infancy	361 (9.4)	268 (6.7)	234 (5.3)

Data are presented as number (%).

Prevalence of FA and causative foods

The overall prevalence of "perceived FA, ever" was 15.3%, highest among 6- to 7-year-olds (19.3%), followed by 9- to 10-year-olds (16.1%) and 12- to 13-year-olds (10.8%). "Recurrent immediate-type FA, ever" was reported in 7.8% of cases overall (9.7%, 7.8%, and 5.9% by age group, respectively) (**Table 2**). When examining the prevalence of recurrent immediate-type FA by region, Gangwon-do showed the highest prevalence at 10.6%, whereas Jeollabuk-do had the lowest at 5.9% (**Supplementary Fig. S1**). Physician-diagnosed FA was reported in 5.6% of cases overall, decreasing from 6.2% in 6- to 7-year-olds to 4.7% in 12- to 13-year-olds. Peach was the most common individual allergen (1.13%), followed by milk (0.82%), egg (0.79%), kiwi (0.65%), walnut (0.62%), peanut (0.62%), apple (0.61%), crab (0.59%), other fruits (0.58%), and shrimp (0.54%). The ranking of common allergens varied by age group, with peach, egg, milk, walnut, and peanut being most common in children aged 6–7 years; peach, milk, peanut, egg, and kiwi in those aged 9–10 years; and peach, apple, shrimp, crab, and kiwi in those aged 12–13 years. The prevalence of perilla seed allergy was 0.11%; wheat allergy, 0.08%; and buckwheat allergy, 0.06% (**Table 3**, **Fig. 1**).

By food group, fruits were most common (3.67%), followed by crustaceans (1.20%), tree nuts (1.18%), mollusks (0.57%), milk (0.82%), egg (0.80%), and peanut (0.62%) (**Fig. 1**).

Table 2. Prevalence of FA and food-induced anaphylaxis among Korean school-aged children in 2022 (n = 12,558)

Outcome	All ages (n = 12,558)	6–7 yr old (n = 4,038)	9–10 yr old (n = 4,251)	12–13 yr old (n = 4,269)
Perceived FA, ever	1,923 (15.3)	779 (19.3)	684 (16.1)	460 (10.8)
Recurrent immediate-type FA, ever	973 (7.8)	392 (9.7)	330 (7.8)	251 (5.9)
Diagnosis of FA, ever	690 (5.5)	260 (6.4)	248 (5.8)	182 (4.3)
Food-induced anaphylaxis	92 (0.7)	30 (0.7)	32 (0.8)	30 (0.7)

Data are presented as number (%).
FA, food allergy.

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Table 3. Prevalence of recurrent immediate-type food allergy by allergen and age group (n = 12,558)

Rank	All ages (n = 12,558)	%	6- to 7-yr-olds (n = 4,038)	%	9- to 10-yr-olds (n= 4,251)	%	12- to 13-yr-olds (n= 4,269)	%
1	**Peach**	1.13	**Peach**	1.39	**Peach**	1.11	**Peach**	0.93
2	Milk	0.82	Egg	1.33	Milk	0.87	**Apple**	0.94
3	Egg	0.79	Milk	1.21	Peanut	0.80	Shrimp	0.63
4	**Kiwi**	0.65	Walnut	0.96	**Kiwi**	0.75	Crab	0.59
5	Walnut	0.62	Peanut	0.87	Egg	0.75	**Kiwi**	0.52
6	Peanut	0.62	**Kiwi**	0.67	Crab	0.66	Milk	0.4
7	**Apple**	0.61	Shrimp	0.59	Walnut	0.64	Egg	0.33
8	Crab	0.59	Crab	0.52	**Apple**	0.40	Clam	0.30
9	Shrimp	0.54	**Apple**	0.5	Shrimp	0.40	Walnut	0.28
10	**Pineapple**	0.33	**Pineapple**	0.37	**Pineapple**	0.35	**Pineapple**	0.26

The prevalence of perilla seed, wheat, and buckwheat allergies in all age groups were 0.11%, 0.08%, and 0.06%, respectively.
Four fruits—peach, kiwi, apple, and pineapple—are included among the top 10 individual food allergens (highlighted in bold).

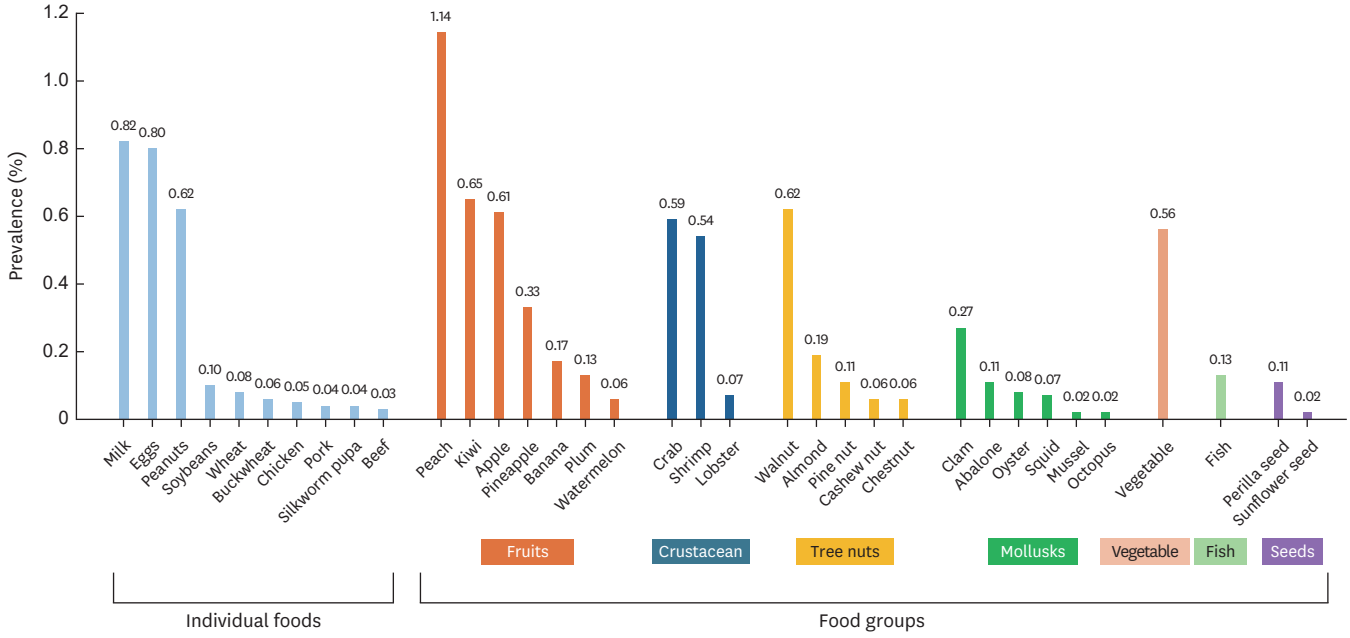

Fig. 1. Common trigger foods for recurrent immediate-type food allergy among Korean school-aged children.

To evaluate age-related trends, Spearman's rank correlation test was performed. The proportion of FA attributable to fruits increased with age (29.06%, 32.43%, and 43.22%, respectively; $\rho = 1.0$, $P < 0.001$), similar to crustacean allergy (8.73%, 11.04%, and 15.25%, respectively; $\rho = 1.0$, $P < 0.001$). In contrast, egg and milk allergies exhibited decreasing trends with age (egg: 9.63%, 7.21%, and 3.95%, $\rho = -1.0$, $P < 0.001$; milk: 8.73%, 8.33%, and 4.8%, $\rho = -1.0$, $P < 0.001$) (**Fig. 2A**). Among individuals with recurrent immediate-type FA, 29.9% (291/973) reported symptoms to 2 or more individual foods, and 9.5% (92/973) reported symptoms to 3 or more individual foods.

Symptoms of food allergies

Across all ages, skin/mucosal symptoms were most frequent (76.8%), followed by oral allergy symptoms (11.2%), respiratory (6.1%), gastrointestinal (5.5%), cardiovascular (0.2%), and neurologic (0.1%) symptoms. Oral allergy symptoms increased with age (9.7%, 11.1%, 14.1%, respectively; $\rho = 1.0$, $P = 0.001$) (**Fig. 2B**).

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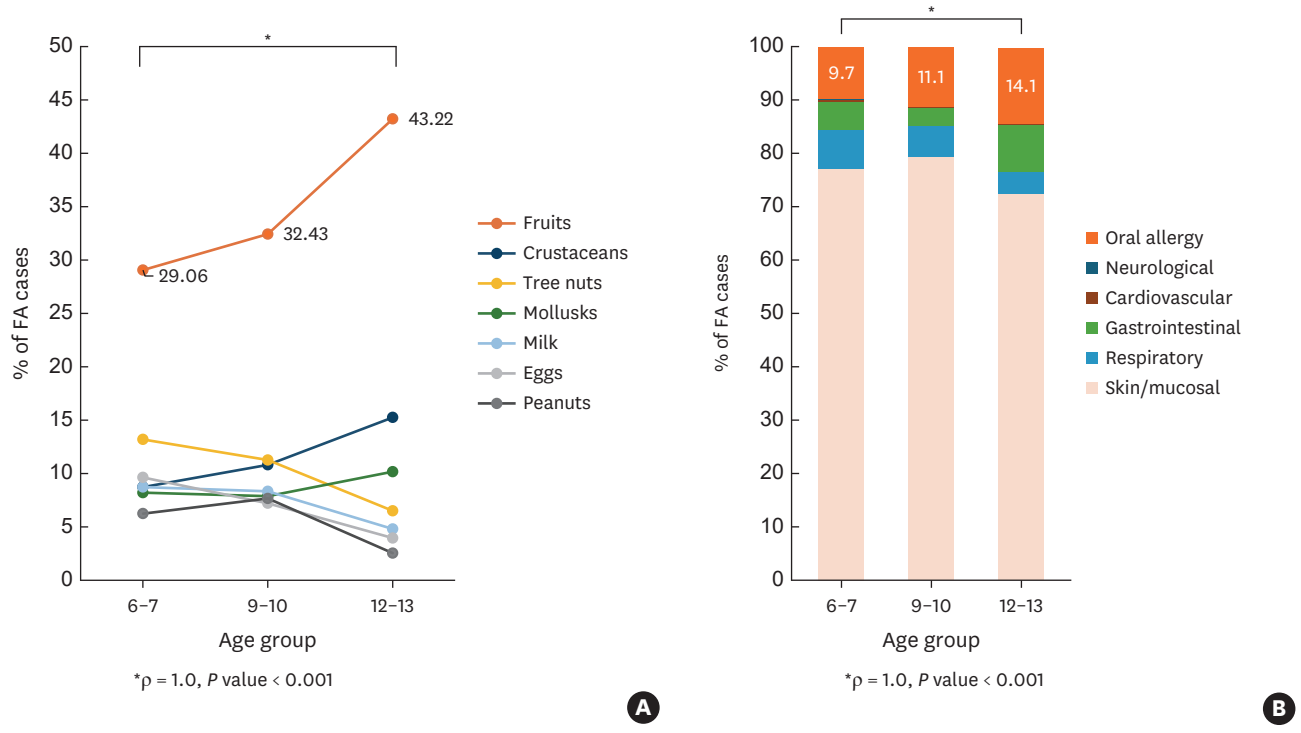

Fig. 2. Common trigger food groups and symptoms of recurrent immediate-type FA by age groups. The proportion of fruit allergy among all FA cases was 29.23% in the 6- to 7-year age group, 32.43% in the 9- to 10-year group, and 42.93% in the 12- to 13-year group, indicating a perfect positive correlation with age (ρ = 1.0, $P < 0.001$) (A). Similarly, oral allergy symptoms increased with age—from 9.7% to 11.1% and 14.1% across the respective age groups, also demonstrating a perfect positive correlation (ρ = 1.0, $P < 0.001$) (B).
FA, food allergy.

Prevalence and causative foods of food-induced anaphylaxis

Food-induced anaphylaxis was reported in 0.7% of participants overall, with similar rates across age groups (0.7% in 6–7 years, 0.8% in 9–10 years, and 0.7% in 12–13 years) (**Table 2**). Examining the prevalence of anaphylaxis caused by individual foods, eggs were the most common trigger, with a prevalence of 0.19%, followed by milk (0.11%), walnut (0.10%), peanut (0.09%), peach (0.09%), kiwi (0.06%), shrimp (0.05%), and almond (0.05%) (**Fig. 3**).

Risk factors for FA

Significant risk factors included paternal allergic disease (aOR, 1.28; $P = 0.001$), parental history of FA (aOR, 2.10; $P < 0.001$), complementary food introduction at ≥ 7 months (aOR, 1.20; $P = 0.012$), breastfeeding ≥ 7 months (aOR, 1.23; $P = 0.002$), and current allergic diseases—atopic dermatitis (aOR, 2.26; $P < 0.001$), asthma (aOR, 1.91; $P = 0.01$), allergic rhinitis (aOR, 1.46; $P < 0.001$), and allergic conjunctivitis (aOR, 1.98; $P < 0.001$) (**Table 4**).

DISCUSSION

Previous studies on the prevalence of FA in Korean children have employed heterogeneous study populations and methodologies. Nationwide surveys conducted in 1995 and 2000 by the Korean Academy of Pediatric Allergy and Respiratory Disease targeted elementary and middle school students.[14] In 2005, the survey population was limited to schools in Seoul, whereas the 2012 survey applied a standardized national design.[15] The prevalence of "symptoms, ever" among elementary school children increased from 9.5% in 2000 to 12.0%

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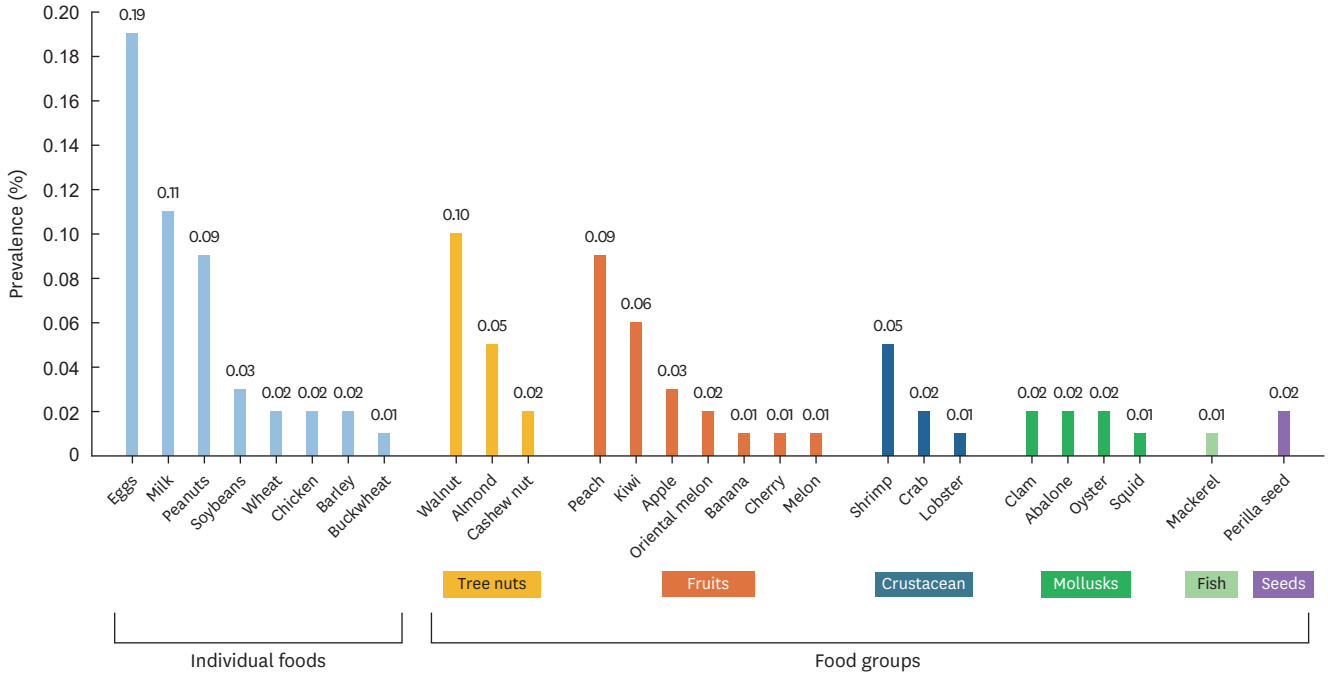

Fig. 3. Common trigger foods for food-induced anaphylaxis among Korean school-aged children.

in 2005 and 14.4% in 2012.[14,15] In a 2015 study, the prevalence of perceived FA symptoms was 17.1%, 17.4%, and 14.7% in children aged 6–7, 9–10, and 12–13 years, respectively.[16] In the present 2022 survey, the corresponding rates were 19.3%, 16.1%, and 10.8%. In 2015, the prevalence of recurrent immediate-type FA with ongoing food avoidance was 4.06%, whereas the prevalence of recurrent, immediate-type FA identified in this study was 7.8%. The prevalence of FA varied substantially by region, ranging from 5.9% to 10.6%. Gangwon-do showed the highest prevalence, whereas Jeollabuk-do had the lowest, potentially reflecting differences in environmental exposures, dietary patterns, and health-care–seeking behaviors, highlighting the need for region-tailored public health approaches. In the current analysis, 9.7% (92 of 973) of children with recurrent immediate-type FA reported symptoms consistent with anaphylaxis, with an overall prevalence of food-induced anaphylaxis of 0.7%, compared with 0.97% in 2015.[16]

In the present survey, the prevalence of fruit allergy was 3.67%, higher than the 1.41% reported for a similar age group in 2015.[16] Peach was the most frequent allergen across all age groups, while in the oldest group, peach, apple, and kiwi ranked among the top 5 allergens. The proportion of fruit allergy among total FA cases increased with age, accompanied by a parallel rise in oral allergy symptoms. Food allergens can be classified into 2 categories based on their sensitization mechanism: Class 1 allergens induce sensitization through the gastrointestinal tract, whereas Class 2 allergens are antigens that arise from cross-reactivity between pollen and certain foods, such as fruits and vegetables.[17] The high prevalence of fruit allergy in school-aged children is likely related to the increasing prevalence of pollen allergy.

In recent years, pollen sensitization rates have risen in Korea, particularly among children and adolescents.[18] In Seoul, climate change has prolonged the pollen season, from 98 days in 1998 to 140 days in 2019. Sensitization to tree pollens such as oak, hazel, and alder has been increasing annually by 0.28% in metropolitan children, with younger age groups

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Table 4. Risk factors for FA in Korean school-aged children

Variables	FA (–)	FA (+)	aOR (95% CI)	*P* value
Sex				
Male	5,821 (50.2)	479 (49.2)	Reference	-
Female	5,764 (49.8)	494 (50.8)	1.13 (0.99–1.3)	0.078
Mode of delivery				
Vaginal delivery	7,041 (60.8)	613 (63.0)		
Cesarean section	4,544 (39.2)	360 (37.0)	0.96 (0.83–1.1)	0.557
Gestational age				
37–42 wk	9,809 (84.7)	827 (85.0)	Reference	-
Preterm	1,500 (12.9)	122 (12.5)	0.98 (0.79–1.21)	0.832
Post term	274 (2.4)	24 (2.5)	1.05 (0.68–1.62)	0.836
Birth weight				
3.1–3.5 kg	5,218 (45.0)	439 (45.1)	Reference	-
< 3.0 kg	4,115 (35.5)	340 (34.9)	0.97 (0.83–1.13)	0.713
≥ 3.6 kg	2,248 (19.4)	194 (19.9)	1 (0.84–1.2)	0.959
Parental history of allergic diseases				
Father	4,467 (38.6)	532 (54.7)	1.28 (1.1–1.48)	0.001
Mother	4,983 (43.0)	550 (56.5)	1.1 (0.94–1.27)	0.230
Parental history of FA	1,360 (11.7)	259 (26.6)	2.1 (1.76–2.49)	< 0.001
Timing of complementary feeding initiation				
4 to 6 mon of age	5,662 (48.9)	443 (45.5)	Reference	-
0 to 3 mon of age	877 (7.6)	78 (8.0)	1.23 (0.95–1.59)	0.125
≥ 7 mon of age	5,042 (43.5)	452 (46.5)	1.2 (1.04–1.38)	0.012
Breastfed for ≥ 7 mon				
No	6,429 (55.5)	476 (48.9)	Reference	-
Yes	5,155 (44.5)	497 (51.1)	1.23 (1.08–1.41)	0.002
Antibiotics exposure within the first yr of life				
No	7,650 (66.0)	574 (59.0)		
Yes	3,935 (34.0)	399 (41.0)	1.1 (0.95–1.26)	0.203
Current atopic dermatitis				
No	10,756 (92.8)	788 (81.0)	Reference	-
Yes	829 (7.2)	185 (19.0)	2.26 (1.88–2.72)	< 0.001
Current allergic rhinitis				
No	8,149 (70.3)	509 (52.3)	Reference	-
Yes	3,436 (29.7)	464 (47.7)	1.46 (1.26–1.7)	< 0.001
Current asthma				
No	11,499 (99.3)	949 (97.5)	Reference	-
Yes	86 (0.7)	24 (2.5)	1.91 (1.17–3.12)	0.01
Current allergic conjunctivitis				
No	10,465 (90.3)	747 (76.8)	Reference	-
Yes	1,120 (9.7)	226 (23.2)	1.98 (1.66–2.36)	< 0.001

Data are presented as number (%).
aORs were adjusted for sex, mode of delivery, gestational age, birth weight, parental history of allergic diseases, timing of complementary food introduction, breastfeeding duration, antibiotic exposure in the first year of life, and current allergic diseases.
FA, food allergy; aOR, adjusted odds ratio; CI, confidence interval.

indicating larger increases.[19] A 2018 Korean study reported that the prevalence of pollen food allergy syndrome (PFAS) in children was higher than previously recognized, with some cases occurring in preschool-aged children.[18,20] Given the extended pollen season, PFAS prevalence is expected to rise in parallel with pollen allergy. In Korean children with pollinosis, PFAS prevalence is 41.4% in those aged 6–10 years and 45.4% in those aged 11–15 years. Although PFAS usually causes mild oropharyngeal symptoms, anaphylaxis occurs in 8.9% of cases, underscoring the need for vigilance.[21] It is essential to monitor the emergence of new FA symptoms to fruits, vegetables, and nuts in school-aged children with pollen allergy.

Crustacean allergy was the second most common food group allergy (1.2%) in this study. Seafood, including crustaceans, mollusks, and fish, accounted for 29.4% of all FA cases

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among 12- to 13-year-olds, with crustaceans representing more than half. Seafood allergy is a well-recognized cause of pediatric anaphylaxis.[22,23] A multicenter study in Thailand, Singapore, Hong Kong, and Qingdao (2019–2022) identified shellfish as the most common cause of anaphylaxis among individuals aged 7–17 years.[24] In this survey, crustacean-induced anaphylaxis comprised 7% of all anaphylaxis cases. The prevalence of crab allergy was 0.59% and shrimp allergy, 0.54%; however, shrimp-induced anaphylaxis (0.05%) was more common than crab-induced anaphylaxis (0.02%). These findings highlight the importance of targeted education and prevention strategies in adolescents, when crustacean allergy prevalence tends to increase.

Perilla seed is a rare allergen in Western countries, but allergic cases have recently been reported in Korea.[25,26] In the present study, its prevalence was 0.11%—exceeding that of sesame, for which no cases were reported in the 2022 survey. Buckwheat, a historically common allergen in Korea and Japan, decreased in prevalence from 0.13% in 2015 to 0.06% in the present study.[16] Silkworm pupa (0.04%) also remains a unique allergen in Korea. Among tree nut allergies in school-aged children (1.18%), walnut was the most common, with a prevalence equal to that of peanut (0.62%). According to a recent study summarizing the international prevalence of tree nut allergies, almonds, cashews, and hazelnuts are more prevalent than walnuts in the United States and Europe.[27] In contrast, walnuts accounted for more than half of tree nut allergies among Korean school-aged children in this study, highlighting the relative importance of walnut allergy in Korea.

Although fruits were the most common food group associated with FA, milk and egg ranked second and third, respectively, indicating their continued importance during school age. Notably, egg and milk were the leading individual triggers of food-induced anaphylaxis. Recent evidence suggests that these allergies may persist into adolescence or adulthood more often than previously believed.[28,29] In Korean children, approximately half of milk allergies resolve by a mean age of 8.7 years, while half of egg allergies resolve by 5.6 years.[30] Nonetheless, a substantial proportion persist into adolescence, where they remain significant causes of anaphylaxis.

In this study, approximately 30% of children with FA had symptoms to 2 or more foods. The high prevalence of multiple food allergies in school-aged children may be partly attributable to the increasing prevalence of fruit and crustacean allergies. Both food groups are well known for extensive cross-reactivity; in particular, fruits in the Prunoideae subfamily (e.g., peach, cherry, apricot, and plum) share a 13-kDa immunoglobulin E (IgE)-binding component, which can lead to broad cross-reactivity among different fruits.[31] Cross-reactivity is also well documented between banana and other plant-derived foods (including kiwi, avocado, persimmon, grape, and durian), occasionally causing severe reactions.[32] Similarly, crustaceans such as shrimp and crab share tropomyosin as a major allergen, resulting in high cross-reactivity.[33]

Multiple food allergies can significantly impair children's quality of life. Affected individuals face dietary restrictions, social limitations, and heightened anxiety, all contributing to substantial emotional burden for patients and caregivers.[34,35] Comprehensive evaluation and individualized management are therefore critical in suspected cases. Patients suspected of having multiple food allergies require thorough diagnosis and management to develop treatment strategies that improve their quality of life.

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Currently, Korean food allergen labeling regulations mandate the declaration of 19 items and 22 foods (egg, milk, buckwheat, peanut, soybean, wheat, mackerel, crab, shrimp, pork, peach, tomato, sulfite, walnut, chicken, beef, squid, shellfish [including oyster, abalone, and mussel], and pine nut).[36] However, several allergens identified in this study—kiwi, apple, pineapple, almond, banana, plum, and perilla seed—are not included in the labeling list. Revision of labeling regulations may be warranted following further large-scale studies in both pediatric and adult populations.

Skin and mucosal symptoms were the most common FA manifestations (76.8%). Pediatric FA can involve the gastrointestinal tract, skin, and respiratory system, with skin symptoms predominating in 50%–70% of cases.[37] In a 2014–2015 Korean study, skin symptoms were reported in 48.7% of children aged 7–12 years and 51.7% of those aged 13–18 years.[23] However, the proportion of skin symptoms decreased as children transitioned into adolescence in the present study. In contrast, oral allergy symptoms, such as itching around the mouth, rashes, and lip swelling, increased with age. This is also thought to be related to the recent rise in PFAS during the school-age years.[38]

Paternal history of allergic disease and parental history of FA were identified as significant risk factors, with atopic dermatitis demonstrating the strongest association (aOR, 2.26) among comorbid allergic diseases. These findings are consistent with prior research.[39-41] Delayed introduction of complementary foods at ≥ 7 months and prolonged breastfeeding for ≥ 7 months were also associated with increased FA risk. Delayed introduction may reduce early allergen exposure, impairing oral tolerance development. Evidence from the LEAP and EAT trials supports early introduction (4–6 months) of allergenic foods to reduce IgE-mediated FA risk.[42,43] The association between prolonged breastfeeding and FA risk may reflect reverse causality, whereby parents extend breastfeeding in response to early allergic symptoms, and may also relate to reduced early dietary diversity.[44] These results should be interpreted with caution, as the cross-sectional design precludes causal inference.

This nationwide survey demonstrates that fruit allergy—particularly to peach—is the most prevalent FA among Korean school-aged children, with its proportion increasing with age and accompanied by a rise in oral allergy symptoms, indicative of the growing burden of PFAS. Crustacean allergies, especially to shrimp and crab, are also common in older children and represent a significant cause of anaphylaxis. Egg and milk, which are major allergens in younger children, also remain important triggers of severe allergic reactions during school years. The high prevalence of multiple food allergies highlights the need for comprehensive management strategies that address both clinical care and quality-of-life concerns in pediatric and adolescent populations. These findings provide essential epidemiologic evidence to guide school-based interventions, community awareness initiatives, and the development of national FA policies in Korea.

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SUPPLEMENTARY MATERIAL

Supplementary Fig. S1

Regional prevalence of recurrent immediate-type food allergy among Korean school-aged children.

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