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The reported prevalence of food allergy among school-aged children in Bahrain

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Abstract
Allergic diseases have been continuously studied and monitored, while the topic of food allergy (FA) lags with only a few prevalence studies conducted in certain countries. The main aim of this study was to estimate the prevalence of FA in school-aged children in the Kingdom of Bahrain. A cross-sectional design was used on a randomized sample of school-aged children in Bahrain. An electronic questionnaire inquiring about demographic data and history of FA and its details was administered through school administrations between October and December 2020. Data was obtained from 1370 participants, comprising 822 males and 548 females. The prevalence of a reported history of FA in school-aged children in Bahrain was calculated as 15.5%. Furthermore, 9.9% of children reported a current FA. The most common experienced symptoms were skin symptoms followed by gastrointestinal symptoms. Moreover, 7% of children reported experiencing anaphylaxis, low blood pressure, or shock. This research concluded that the reported prevalence of FA history among school-aged children in Bahrain was higher than that observed in other studies estimating at 15.5%, with 9.9% persisting up to the time of the study. The most common single food allergen was found to be egg. The findings of this study provide a baseline for future larger studies to obtain more in-depth results.

Introduction

Food allergy (FA) refers to a constellation of symptoms representing the body's immunological reaction to certain antigens present in food.[1] These symptoms can either be Immunoglobulin E (IgE) or non-Immunoglobulin E (non-IgE) mediated. Categorization is important when deciding on diagnosis because tests such as those measure IgE levels might reflect only IgE-mediated reactions and report an FA prevalence lower than what is truly present. Furthermore, tests detect antigen sensitization which is not necessarily translated into the appearance of signs and symptoms deeming no clinical relevance.[2-4] Thus, several patients might be reported as allergic while they can tolerate test-positive foods.[5-7]

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The prevalence of FA is reported to be on the rise alongside other allergic diseases such as asthma, allergic rhinitis, and eczema.[3,7,8] These diseases have been continuously studied and monitored, while data on FA has been lagging. Despite some prevalence studies regarding children in areas such as the United States (US) and Europe, many other countries, especially in the Middle East, lack data on FA.[9]

Published research have shown discrepancy in methodologies; some used parents-reported questionnaires while others used skin prick tests and/or oral challenge tests; this is because the optimal method of diagnosis in research setting has not yet been determined.[1,4,7] In medical practice, clinical history remains the most important aspect in assessment of FA, especially with non-IgE-mediated FA.[10] Furthermore, despite it being not ideal in research setting, oral challenge test remains the gold standard diagnostic test for confirmation of FA.[3,6,10,11]

A study conducted in the US using a population-based questionnaire concluded that the prevalence is higher than previously reported, estimating up to 8%.[12] Moreover, in South Korea, the estimated prevalence of a history of FA was 7%, while a study in Portugal showed a prevalence of 4.6%.[13,14] In the Arabian Gulf region, a study conducted on school-aged children in Al Ain in the United Arab Emirates (UAE) estimated an 8% prevalence.[15] All these studies used parent-reported questionnaires to determine their results.

Majority of children outgrow FA by 5 years, making allergies below this age a temporary occurrence.[16] On the other hand, those who do not outgrow their allergies are prone to physical and psychological complications, raising the importance of filling the gap on missing data.[8] According to available literature and to the best of our knowledge, statistics on the issue is limited in the Arabian Gulf. Therefore, the aim of this study is to estimate the prevalence of FA among school-aged children in the Kingdom of Bahrain, thus filling the missing gap in data and providing an initial step toward future research.

Materials and Methods

Study setting and design

This study was designed as a cross-sectional study and was conducted on school-aged children attending primary public and private schools in Bahrain between October and December 2020.

Sample size and sampling technique

All primary public and private schools, 180 schools, were randomized to obtain a sample of nine private schools, five primary public boys' schools, and four primary public girls' schools. The aim was a minimum of 385 children to achieve a 95% confidence interval and a margin of error of 5% according to Cochran's sample size formula. Upon approaching the selected schools, four private schools did not cooperate. Thus, we considered increasing the sample size by 10% as compensation.

Participants

Students from Grades 1–6, aged around 6–12 years, were targeted. The inclusion criteria were guardians who received the distributed questionnaire from the selected school administrations and were able to complete the questionnaire in Arabic or English.

Questionnaire development

The questionnaire was developed by the researchers mainly based on a population study conducted in the US and supported by similar questions from the literature. The main questionnaire used as a reference was developed by pediatricians, one of whom was an allergist, researchers, and an expert panel and was tested prior to use; the research was published by Gupta et al. in 2011[12] in the Pediatrics Journal upon completion. The questions obtained from this study were those related to demographic data as well as to the most common allergens. To ensure quality and account for updates on the diagnosis of FA, questions were compared to the latest National Institute for Health and Clinical Excellence Guidelines for the diagnosis of FA.[17]

The questionnaire included three main parts, demographic data, questions focusing on feeding, and FA details. Upon completion, three certified clinical nutritionists from three different hospitals in the country assessed the questionnaire in terms of meeting the set objectives.

To ensure applicability and forward validity of the questionnaire, the questions were translated to Arabic by one of the researchers and one naïve individual and then combined as one questionnaire. The questionnaire was made into an electronic version using Google Forms and a pilot study, including 30 participants targeted by a convenient sample, was conducted prior to its distribution to allow for understandability.

Data collection/Procedures

An electronic version of the developed questionnaire was made available online using Google Forms. The selected schools' administrations were approached, the authorization letter was submitted, and the purpose of the research was explained. Upon the schools' approval, the administration distributed the questionnaire electronically to parents of students from Grades 1–6 to recruit those aged 6–12 years. The questionnaire remained available online for 2 months for submission.

Statistical analysis

The data obtained were analyzed using SPSS version 23. Frequencies and percentages were computed for the categorical variables. Chi-squared test was used to determine whether there is a significant relationship between variables. $P < 0.05$ was considered statistically significant.

Results

A total of 1370 children, 822 males and 548 females, participated in the research. The mean age of children was 8.2 years, with a standard deviation of 1.7 years. Bahraini children composed 78.2%, with 41.8% being between 7 and 8 years old. Out of the 1370 children, only 985 caregivers answered the question relating to household income. Table 1 demonstrates the demographic details. In this study, "Governate" refers to the geographical distribution of cities throughout the Kingdom of Bahrain.

Furthermore, Table 2 shows the further history regarding the child's feeding, medical conditions, and family history.

The results of the main questions regarding food allergy are shown in Table 3, while Table 4 shows the reported prevalence of food allergy at the time of the study.

The majority of children (88.7%) experienced skin symptoms. This was followed by 65.7% who experienced gastrointestinal (GI) symptoms, with abdominal pain being the commonest symptom. As for respiratory symptoms, 46.5% experienced such symptoms with cough being the most prevalent respiratory symptom. Fifteen children were reported to have experienced anaphylaxis, low blood pressure, or shock which comprised 7% of the allergic children.

A total of 182 children answered the question relating to the duration from exposure to onset of symptoms. It was reported that 36.8% experienced a reaction within 30 min, 31.9% between 30 min and 2 h, and 31.3% after 2 h. The mode of diagnosis was also inquired in this survey, where nearly half (49.3%) were diagnosed by a family member with 21.6% depending only on this method to label an FA. Those diagnosed clinically by a physician were reported as 65.7%, by IgE blood tests were 28.6%, by skin prick test were 26.3%, and by oral challenge test were 9.9%. As for their treatment, 96.2% reported avoiding the food causing the allergy, while 51.2% require medications. Those using epinephrine were calculated as 1.4%, and those using antihistamine drugs were 18.8%.

Chi-squared test was used to determine the relationship between categorical variables in this study. These values are shown in Tables 5 and 6. A P-value > 0.05 was calculated in terms of relationship between FA and governorates, age, gender, and household income, while $P < 0.05$ was shown between nationality and the presence of FA, indicating a statistical significance between the two variables. Furthermore, P-values > 0.05 were noted between the prevalence of FA and breastfeeding, duration of breastfeeding, and age of introduction of formula, indicating no statistical significance. In addition, there was no statistical significance between FA prevalence and those who were exclusively breastfed or formula fed in comparison to both types of feeding together in either current or previous

Table 1 Demographic characteristics of the children.

	n (%)
Governorate (n = 1368)	
Muharraq	126 (9.2)
Capital	283 (20.7)
Northern	622 (45.5)
Southern	337 (24.6)
Age (n = 1370)	
5-6 years	248 (18.1)
7-8 years	572 (41.8)
9-10 years	412 (30.1)
>10 years	138 (10.1)
Gender (n = 1370)	
Male	822 (60)
Female	548 (40)
Nationality (n = 1370)	
Bahraini	1072 (78.2)
Non-Bahraini	298 (21.8)
Household monthly income (n = 985)	
BD ≤ 500	457 (46.4)
BD 501-1000	298 (30.3)
BD 1001-2000	117 (11.9)
BD > 2000	113 (11.5)

Table 2 History of the child in terms of breastfeeding, formula feeding, age of food introduction, medical conditions, and family history of food allergy.

	n (%)
Breastfeeding (n = 1370)	
Yes	1107 (80.8)
No	263 (19.2)
Duration of breastfeeding (n = 1101)	
≤6 months	325 (29.5)
7-12 months	247 (22.4)
13-18 months	168 (15.3)
>18 months	361 (32.8)
Formula feeding (n = 1370)	
Yes	984 (71.8)
No	386 (28.2)
Age at which you introduced formula feeding (n = 944)	
≤6 months	718 (76.1)
7-12 months	121 (12.8)
13-18 months	31 (3.3)
>18 months	74 (7.8)
Age at which you introduced food (n = 1339)	
≤6 months	1031 (77)
7- 2 months	221 (16.5)
13-18 months	27 (2)
>18 months	60 (4.5)
Medical condition (n = 1370)	
None	1002 (73.1)
Asthma	81 (5.9)
Eczema	148 (10.8)
Allergic rhinitis	70 (5.1)
Others	143 (10.4)
Family members with a food allergy (n = 1370)	
Yes	265 (19.3)
No	1105 (80.7)
Relationship to the child (n = 253)	
Parent	95 (37.5)
Brother/Sister	83 (32.8)
Others	75 (29.6)

Table 3 Frequencies and percentages of a history of food allergy.

	n (%)
Ever had a food allergy (n = 1370)	
Yes	213 (15.5)
No	1157 (84.5)
Age of child when he first developed the food allergy (n = 198)	
<1 year	81 (40.9)
1-3 years	66 (33.3)
>3 years	51 (25.8)
Persistent food allergy (n = 213)	
Yes	135 (63.4)
No	78 (36.6)
Food to which the child has been allergic (n = 213)	
Peanut	38 (17.8)
Milk	35 (16.4)
Shellfish	36 (16.9)
Tree nut	31 (14.6)
Egg	67 (31.5)
Fish	17 (8)
Strawberry	46 (21.6)
Wheat	14 (6.6)
Soy	15 (7)
Others	87 (40.8)
Age of introduction of allergic food (n = 191)	
≤6 months	44 (23)
7-12 months	68 (35.6)
13-24 months	35 (18.3)
>24 months	44 (23)
Food to which the child still is allergic	
Peanut (n = 38)	32 (84.2)
Milk (n = 35)	11 (31.4)
Shellfish (n = 36)	25 (69.4)
Tree nut (n = 31)	28 (90.3)
Egg (n = 67)	42 (62.7)
Fish (n = 17)	11 (64.7)
Strawberry (n = 46)	23 (50)
Wheat (n = 14)	9 (64.3)
Soy (n = 15)	8 (53.3)
Others (n = 87)	40 (46)

Table 4 Frequencies and percentages of current food allergy in terms of the total population.

	n (%)
Still have the food allergy (n = 1370)	
Yes	135 (9.9)
No	78 (5.7)
Food to which the child still is allergic (n = 213)	
Peanut	32 (15)
Milk	11 (5.2)
Shellfish	25 (11.7)
Tree nut	28 (13.1)
Egg	42 (19.7)
Fish	11 (5.2)
Strawberry	23 (10.8)
Wheat	9 (4.2)
Soy	8 (3.8)
Others	40 (18.8)

allergy history. On the other hand, the prevalence of FA and formula feeding itself had a P-value < 0.05 in terms of a history of FA, indicating a statistical significance between the two. However, a similar relationship was not found for the current status of FA ($P = 0.074$).

Moreover, Table 6 also indicates the relationship between FA and medical conditions. A P-value < 0.001 was calculated between the prevalence of FA, history and current, and the presence of a medical condition, asthma and atopic dermatitis.

Discussion

This study analyzed the parent-reported data and concluded that the reported prevalence of a history of FA among the studied population was 15.5%. Parents reporting a current FA were estimated at 9.9%. The most prevalent allergic food was eggs, with the most common symptoms being skin symptoms followed by GI symptoms. There was no difference in FA prevalence based on residence, age, gender, or household income in this study. These values were either in range or somewhat higher than those reported in the previous studies conducted worldwide.

Before interpreting and comparing our data, it is of value to shed light on the pathophysiological mechanism of FA. The mechanism differs, in which IgE FA activates an immune response through IgE, while non-IgE-mediated FA is cell mediated; a mixed pattern of allergy can also occur.[18] Furthermore, tolerance to a previous allergy is possible through immune response changes such as reduction in allergen-specific IgE production or developing food-specific IgG among other changes.[19] This information can provide an explanation to the 5.6% reduction between a history of FA and a persistent FA reported in this study.

Comparison of these results with published data was challenging due to differences in methods, used definitions, sample differences, and the lack of recent studies. For instance, the neighboring Al Ain city reported 8.1% with a history of FA and 4.5% with a current allergy in 2009, where only a physician-diagnosed FA was considered as a positive allergy. Similarly, in 2010, a US study estimated the prevalence to be 8% for children under 18 years old based on symptoms for a classification of an FA.[12] Furthermore, in the capital of Lithuania, 46.9% reported an FA with only 5.5% testing positive for an IgE-mediated allergy.[8]

Additionally, in 2014 and 2016, Park et al. and Ontiveros et al. published a paper in Seoul and in Mexico, respectively, based on school-aged children, which had close results to those reported currently in Bahrain. The prevalence in Seoul was reported as 15.1%, and in Mexico it was 10% for ever experiencing a FA. However, in terms of current FA, the current research estimated a higher prevalence at 9.9%, while the Korean estimate reported a prevalence of 3.7% and the Mexican estimate of 3.5%, where only children with a reaction within 4 h and 2 h, respectively, were considered.[13,20] It is worth mentioning that IgE-mediated FA develops a reaction mainly within the first

Table 5 Relationship between demographical characteristics and the prevalence of food allergy.

	Ever had a food allergy			Still have the food allergy		
	Yes	No		Yes	No	
Characteristics	**n (%)**	**n (%)**	**P**	**n (%)**	**n (%)**	**P**
Governorate						
Muharraq	21 (16.7)	105 (83.3)	0.725	13 (61.9)	8 (38.1)	0.934
Capital	44 (15.5)	239 (84.5)		26 (59.1)	18 (40.9)	
Northern	89 (14.3)	533 (85.7)		57 (64)	32 (36)	
Southern	57 (16.9)	280 (83.1)		37 (64.9)	20 (35.1)	
Age						
5–6 years	48 (19.4)	200 (80.6)	0.256	27 (56.3)	21 (43.8)	0.194
7–8 years	89 (15.6)	483 (84.4)		63 (70.8)	26 (29.2)	
9–10 years	56 (13.6)	356 (86.4)		35 (62.5)	21 (37.5)	
>10 years	20 (14.5)	118 (85.5)		10 (50)	10 (50)	
Gender						
Male	134 (16.3)	688 (83.7)	0.345	83 (61.9)	51 (38.1)	0.570
Female	79 (14.4)	469 (85.6)		52 (65.8)	27 (34.2)	
Nationality						
Bahraini	181 (16.9)	891 (83.1)	0.010	109 (60.2)	72 (39.8)	0.023
Non-Bahraini	32 (10.7)	266 (89.3)		26 (81.3)	6 (18.8)	
Household monthly income						
≤500 BD	61 (13.3)	396 (86.7)	0.191	37 (60.7)	24 (39.3)	0.704
501–1000 BD	47 (15.8)	251 (84.2)		29 (61.7)	18 (38.3)	
1001–2000 BD	23 (19.7)	94 (80.3)		17 (73.9)	6 (26.1)	
>2000 BD	12 (10.6)	101 (89.4)		8 (66.7)	4 (33.3)	

Table 6 Relationship between the child's history in terms of feeding history, age of food introduction, and medical conditions and the prevalence of food allergy.

	Ever had a food allergy			Still have the food allergy		
	Yes	No		Yes	No	
Characteristics	**n (%)**	**n (%)**	**P**	**n (%)**	**n (%)**	**P**
Breastfeeding						
Yes	164 (14.8)	943 (85.2)	0.125	106 (64.6)	58 (35.4)	0.487
No	49 (18.6)	214 (81.4)		29 (59.2)	20 (40.8)	
Duration of breastfeeding						
≤6 months	48 (14.8)	277 (85.2)	0.853	30 (62.5)	18 (37.5)	0.944
7–12 months	41 (16.6)	206 (83.4)		28 (68.3)	13 (31.7)	
13–18 months	24 (14.3)	144 (85.7)		15 (62.5)	9 (37.5)	
>18 months	51 (14.1)	310 (85.9)		33 (64.7)	18 (35.3)	
Feeding						
Only breastfeeding	45 (11.9)	333 (88.1)	0.055	34 (75.6)	11 (24.4)	0.166
Only formula	47 (18.4)	208 (81.6)		28 (59.6)	19 (40.4)	
Both	119 (16.3)	610 (83.7)		72 (60.5)	47 (39.5)	
Formula feeding						
Yes	166 (16.9)	818 (83.1)	0.031	100 (60.2)	66 (39.8)	0.074
No	47 (12.2)	339 (87.8)		35 (74.5)	12 (25.5)	
Age at which you introduced formula feeding						
≤6 months	127 (17.7)	591 (82.3)	0.355	75 (59.1)	52 (40.9)	0.138
7–12 months	24 (19.8)	97 (80.2)		13 (54.2)	11 (45.8)	
13–18 months	3 (9.7)	28 (90.3)		3 (100)	0 (0)	
>18 months	9 (12.2)	65 (87.8)		8 (88.9)	1 (11.1)	

(*Continues*)

Table 6 (Continued)

	Ever had a food allergy			Still have the food allergy		
	Yes	No		Yes	No	
Characteristics	**n (%)**	**n (%)**	**P**	**n (%)**	**n (%)**	**P**
Age at which you introduced food						
≤6 months	164 (15.9)	867 (84.1)	0.834	101 (61.6)	63 (38.4)	0.138
7–12 months	33 (14.9)	188 (85.1)		24 (72.7)	9 (27.3)	
13–18 months	4 (14.8)	23 (85.2)		1 (25)	3 (75)	
>18 months	7 (11.7)	53 (88.3)		6 (85.7)	1 (14.3)	
Medical condition						
Yes	125 (34)	243 (66)	<0.001	96 (76.8)	29 (23.2)	<0.001
No	88 (8.8)	914 (91.2)		39 (44.3)	49 (55.7)	
Asthma						
Yes	33 (40.7)	48 (59.3)	<0.001	30 (90.9)	3 (9.1)	<0.001
No	180 (14)	1109 (86)		105 (58.3)	75 (41.7)	
Eczema						
Yes	75 (50.7)	73 (49.3)	<0.001	62 (82.7)	13 (17.3)	<0.001
No	138 (11.3)	1084 (88.7)		73 (52.9)	65 (47.1)	
Allergic rhinitis						
Yes	25 (35.7)	45 (64.3)	<0.001	19 (76)	6 (24)	0.163
No	188 (14.5)	1112 (85.5)		116 (61.7)	72 (38.3)	
Others						
Yes	34 (23.8)	109 (76.2)	0.004	21 (61.8)	13 (38.2)	0.831
No	179 (14.6)	1048 (85.4)		114 (63.7)	65 (36.3)	

minutes to 2 h of exposure in contrast to non-IgE-mediated FA which might take longer for symptoms to appear.[4,21] Thus, the time frame set by these studies is common for IgE-mediated responses, leaving those with possible non-IgE-mediated FA behind. Furthermore, Jorge et al.[14] reported lower values at 1.4% which were results of only probable IgE-mediated FA. These factors along with the difference in years would partially explain the differences seen in prevalence between studies.

It has been reported in several studies that parent-reported questionnaires tend to overestimate the prevalence.[3,7] This might be due to parents overestimating symptoms or confusing a true FA with food intolerances.[7] To attempt reduction of such error, the mode of diagnosis was inquired in this survey; it was reported that 49.3% had a diagnosis by a family member, with 21.6% depending solely on this method to label an FA. 65.7% of the FA cases were diagnosed clinically by a physician, 28.6% by IgE blood tests, 26.3% by skin prick test, and 9.9% by oral challenge test. These results leave us uncertain about 21.6% of children who were diagnosed only by a family member, and thus the diagnosis might not be of absolute certainty. Suppose the current study also only considered a physician assessment and/or laboratory testing, the prevalence would drop to 12.2%. Furthermore, if this study would consider a food reaction only within 2 h similar to some studies, the prevalence would further drop to 9.1% in terms of a history of FA.

During this study, the age at which an FA was first noticed was inquired and estimated at 40.9% before 1 year of age. This indicates that FA can start as early as the first year of life and might even be higher than allergies noted later. These results are supported by current knowledge that FAs are often noticed in the first 2 years of life.[1] In terms of the age of allergen introduction, the highest age of introduction was below 1 year. However, this might be because weaning and experimentation with food simply starts during the first year of age rather than a causal relationship. Furthermore, it has been stressed upon that antenatal, postnatal, and maternal factors among many other factors might contribute to the development of an allergy and not merely the time of introduction of food.[19]

This study reported that 45.1% of children who reported an FA in Bahrain were allergic to more than one food (Table 3). This was also concluded in the study by Gupta et al.,[12] where 30.4% of children reported more than one FA. These values raise concern regarding nutritional deficiencies that might be caused in such children due to exclusion of foods from their diets.[4]

Similar to our results, eggs was reported as the most common single allergen in other countries including UAE, South Korea, and Portugal. On the other hand, in the US, egg allergy was reported as only 0.8%. These differences might indicate that environmental factors such as culture-specific food or geographic locations influence prevalence of specific FA; this is difficult to determine accurately due to difference in methodologies across the studies.[4,7,22]

This study also focused on the prevalence of current FA (Table 3) and found that milk is the most common allergen that a child might outgrow with age. However, tree nuts and peanuts accounted for the highest prevalence of a persistent allergy, indicating that an allergy to nuts is unlikely to subside with age. These allergens are some which that have been studied in detail. It was established that allergies toward cow's milk and hen's egg often disappear with age, while allergies to peanuts and tree nuts persist into

adulthood or develop later in life.[1] This gives more value to the obtained results because it goes hand in hand with current knowledge.

Food allergy symptoms vary between skin, GI, respiratory, and more severe life-threatening symptoms. Similar to this study, UAE and South Korea reported skin symptoms as the commonest, while Lithuania and Mexico reported GI symptoms being more common. Additionally, Portugal conveyed mucocutaneous symptoms being more frequent with IgE-mediated allergies as opposed to the addition of GI symptoms in non-IgE-mediated allergies. In terms of anaphylaxis, South Korea reported a similar rate at 7.6% as this study, while a higher rate, 36%, was reported in the UAE, and a lower value of 1.2% was reported in Mexico. Despite results varying slightly between countries, it is reasonable to conclude and additionally emphasize that skin and GI symptoms are the most common symptoms associated with FA.[22]

Moreover, in the US population, the most severe symptoms were reported with tree nuts and peanuts followed by shellfish, with the least severe symptoms seen with strawberries. In Bahrain, anaphylaxis was highest among those allergic to peanuts and eggs followed by tree nuts and shellfish. This can translate into the possibility of certain foods such as peanuts and shellfish causing more severe reactions than others.

It has been well established that children who have a history of other atopic diseases such as asthma, eczema, and allergic rhinitis have a higher rate of FA and vice versa.[5] This was also shown by the Al Ain study published in Al Ain, which was further supported with a P-value < 0.001 calculated between the prevalence of FA, history and current, and the presence of asthma and eczema. This translates into allergic diseases being more likely present as constellation in a child.

A history of FA in a family member was reported by 265 children in our sample. Among them, 42.6% had a child who also had an FA. A statistically significant relationship was found between the presence of a family history of FA and a child's personal history of FA. It seems that FA might have some genetic predisposition.[7] This was further demonstrated by Mathias et al.,[23] who reported that the incidence of FA in children was significantly higher with parental history of FA.

Despite avoidance of offending food being the mainstay of treatment of FA, some might need lifesaving medications, such as epinephrine, or simply to relieve symptoms in case of accidental exposure.[1,3] Our estimate showed that the vast majority (96.2%) reported avoidance of the offending food as the mainstay of management, with 1.4% having used epinephrine injections and 18.8% requiring antihistamine drugs. This sheds light on the importance of education as well as auto-injectors, which are not readily available, as a lifesaving medication for those at risk of anaphylaxis or severe symptoms. Furthermore, current research is ongoing in regards to oral immunotherapy as a cure for FA as it is acknowledged that accidental exposure might occur and cause serious adverse effects.[7]

In terms of nationality, Bahraini children were significantly more likely to have an allergy compared to non-Bahrainis. However, the opposite was seen with current FAs. Difference between races was observed in the US where African Americans and Asians had higher odds of having FA when compared to Caucasians and Hispanics. However, this was also translated into these children having a lower odd of receiving a formal diagnosis. This might be the case in Bahrain as well because Bahraini children would receive free medical care as opposed to many non-Bahraini children. Nevertheless, it is vital to mention that our study sought nationality rather than race, making this interpretation difficult and in need of future studies to explore contributing environmental or ethnic factors.

This study also explored the relationship between the prevalence of FA and breastfeeding, duration of breastfeeding, and age of introduction of formula (Table 6). Our results demonstrated that there is no statistical significance between these variables or between FA prevalence among those who were exclusively breastfed or formula fed in comparison to both types of feeding together in either current or previous allergy history. Such relationship was also reported in Al Ain study and concluded that FA was not related to exclusive breastfeeding in the first 6 months of age or the early introduction of food. Despite such results, the prevalence of FA in those who were formula fed was higher and seen to be statistically significant in our study in terms of a history of FA ever. Furthermore, this study inquired about the duration of breastfeeding and its relation to FA, and no statistical significance was found.

Nevertheless, the duration of breastfeeding was analyzed without determining whether it belonged to the exclusive breastfed group or both breast- and formula-fed groups. Such factors were deemed important in the study by Mathias et al. who analyzed in depth the duration and type of feeding in relation to FA and concluded that any other modes of feeding in comparison to being breastfed exclusively at the breast or exclusively formula fed in the first 3 months increased the risk of an FA.

Studies such as that published by Jorge at al. in 2017[14] suggested that not testing for FA using methods such as IgE, skin prick testing, and oral challenges to be a limitation. However, tests such as the oral challenge tests require specialized and well-equipped settings and are not always necessary for the diagnosis especially if other methods such as elimination of food have already confirmed the allergy.[24] Furthermore, tests might underreport true FA if testing was only targeted to IgE-mediated allergies.

This study is not without limitations. The gathered data depended on parents recalling and reporting information, which raised the issue of recall bias. We acknowledge that this study has reported a higher prevalence than those reported in all other studies. This might be due to parents' confusion between FA and intolerances, and further assessment of those who reported an FA is required. Therefore, current results can be considered as a food hypersensitivity until further clarification is conducted especially because recent literature has suggested that some allergies are due to food additive allergy rather than a true FA.[25]

Furthermore, participation was voluntary in the randomly selected schools; thus, parents who had children with a positive FA might have been keener to answer, causing a higher estimate in our population. In terms of statistical analysis, we acknowledge that not adjusting for confounders was a limitation.

Conclusion

In conclusion, results from this research calculated the reported prevalence of FA history among school-aged children in Bahrain as 15.5%, where 9.9% had a persistent allergy at the time of the study. There was no significant difference calculated between females and males. The most common single FA in Bahrain was found to be allergy toward eggs. This information provides the initial step toward future larger studies to obtain more in-depth results. This is aimed to improve awareness and aid those with current FA and their parents as well as children who might suffer an allergy in the future.

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Statement of Ethics

Study approval statement

This study protocol and questionnaire were reviewed and approved by the research committee of the University of Bahrain followed by the Scientific Research Department at the Ministry of Education, under the ID number 20170042.

Consent to participate statement

A written explanation was available prior to voluntarily answering and submitting the questionnaire electronically. This was considered as consent to participation and was approved by both the research committee at the University of Bahrain and the Scientific Research Department at the Ministry of Education.

Conflict of Interest Statement

There is no conflict of interest to disclose by the authors.

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References

1. Keet C, Wood R. Food allergy in children: Prevalence, natural history, and monitoring for resolution [Internet]. [cited 2021 Feb 18]. UpToDate. 2019;1–27. Available from: https://www.uptodate.com/contents/food-allergy-in-children-prevalence-natural-history-and-monitoring-for-resolution?search=foodallergychildren&source=search_result&selectedTitle=2~150&usage_type=default&display_rank=2
2. Walsh J, O'Flynn N. Diagnosis and assessment of food allergy in children and young people in primary care and community settings: NICE clinical guideline. Br J Gen Pract. 2011;61(588):473–5. https://doi.org/10.3399/bjgp11X583498
3. Barni S, Liccioli G, Sarti L, Giovannini M, Novembre E, Mori F. Immunoglobulin E (IgE)-mediated food allergy in children: Epidemiology, pathogenesis, diagnosis, prevention, and management. Medicina (Lithuania). 2020;56(3):111. https://doi.org/10.3390/medicina56030111
4. Gargano D, Appanna R, Santonicola A, de Bartolomeis F, Stellato C, Cianferoni A, et al. Food allergy and intolerance: A narrative review on nutritional concerns. Nutrients. 2021;13(5):1638. https://doi.org/10.3390/nu13051638
5. Burks W. History and physical examination in the patient with possible food allergy [Internet]. [cited 2021 Feb 18]. UpToDate. 2015;1–13. Available from: https://www.uptodate.com/contents/history-and-physical-examination-in-the-patient-with-possible-food-allergy?search=foodallergychildren&source=search_result&selectedTitle=4~150&usage_type=default&display_rank=4#H10
6. Gupta M, Cox A, Nowak-Węgrzyn A, Wang J. Diagnosis of food allergy. Immunol Allergy Clin North Am. 2018;38(1):39–52. https://doi.org/10.1016/j.iac.2017.09.004
7. Loh W, Tang MLK. The epidemiology of food allergy in the global context. Int J Environ Res Public Health. 2018;15(9):2043. https://doi.org/10.3390/ijerph15092043
8. Kavaliunas A, Šurkiene G, Dubakiene R, Stukas R, Žagminas K, Šaulyte J, et al. Europrevall survey on prevalence and pattern of self-reported adverse reactions to food and food allergies among primary schoolchildren in Vilnius, Lithuania. Medicina (Lithuania). 2012;48(5):265–71.
9. Prescott SL, Pawankar R, Allen KJ, Campbell DE, Sinn JKH, Fiocchi A, et al. A global survey of changing patterns of food allergy burden in children. World Allergy Organ J. 2013;6(1):21. https://doi.org/10.1186/1939-4551-6-21
10. Labrosse R, Graham F, Caubet JC. Non-ige-mediated gastrointestinal food allergies in children: An update. Nutrients. 2020;12(7):2086. https://doi.org/10.3390/nu12072086
11. Luo Y, Zhang GQ, Li ZY. The diagnostic value of APT for food allergy in children: A systematic review and meta-analysis. Pediatr Allergy Immunol. 2019;30(4):451–61. https://doi.org/10.1111/pai.13031
12. Gupta RS, Springston EE, Warrier MR, Smith B, Kumar R, Pongracic J, et al. The prevalence, severity, and distribution of childhood food allergy in the United States. Pediatrics. 2011;128(1):e9. https://doi.org/10.1542/peds.2011-0204
13. Park M, Kim D, Ahn K, Kim J, Han Y. Prevalence of immediate-type food allergy in early childhood in Seoul. Allergy Asthma Immunol Res. 2014;6(2):131–6. https://doi.org/10.4168/aair.2014.6.2.131
14. Jorge A, Soares E, Sarinho E, Lorente F, Gama J, Taborda-Barata L. Prevalence and clinical features of adverse food reactions in Portuguese children. Allergy Asthma Clin Immunol. 2017;13:40. https://doi.org/10.1186/s13223-017-0212-y
15. Al-Hammadi S, Al-Maskari F, Bernsen R. Prevalence of food allergy among children in Al-Ain City, United Arab Emirates. Int Arch Allergy Immunol. 2010;151(4):336–42. https://doi.org/10.1159/000250442
16. Radlović N, Leković Z, Radlović V, Simić D, Ristić D, Vuletić B. Food allergy in children. Srp Arh Celok Lek [Internet]. [cited 2019 Apr 1]. 2016;144(1–2):99–103. https://doi.org/10.2298/sarh1602099r. Available from: www.srpskiarhiv.rs
17. Food allergy in under 19s: Assessment and diagnosis [Internet]. [cited 2022 Nov 30]. Available from: https://www.medscape.co.uk/viewarticle/food-allergy-under-19s-assessment-and-diagnosis-2022a1001bqh
18. Cianferoni A. Non-IgE-mediated food allergy [Internet]. Curr Pediatr Rev. [cited 2022 Nov 19]. 2020;16(2):95–105. Available from: https://www.eurekaselect.com/176310/article

19. Campbell DE, Boyle RJ, Thornton CA, Prescott SL. Mechanisms of allergic disease—environmental and genetic determinants for the development of allergy. Clin Exp Allergy. 2015;45(5):844–58. https://doi.org/10.1111/cea.12531
20. Ontiveros N, Valdez-Meza EE, Vergara-Jiménez MJ, Canizalez-Román A, Borzutzky A, Cabrera-Chávez F. Parent-reported prevalence of food allergy in Mexican schoolchildren: A population-based study. Allergol Immunopathol (Madr). 2016;44(6):563–70. https://doi.org/10.1016/j.aller.2016.03.003
21. Anvari S, Miller J, Yeh CY, Davis CM. IgE-mediated food allergy [Internet]. Clin Rev Allergy Immunol. [cited 2022 Nov 19]. 2019;57(2):244–60. Available from: https://link.springer.com/article/10.1007/s12016-018-8710-3
22. Lyons SA, Clausen M, Knulst AC, Ballmer-Weber BK, Fernandez-Rivas M, Barreales L, et al. Prevalence of food sensitization and food allergy in children across Europe. J Allergy Clin Immunol Pract. 2020;8(8):2736–46. https://doi.org/10.1016/j.jaip.2020.04.020
23. Mathias JG, Zhang H, Soto-Ramirez N, and Karmaus W. The association of infant feeding patterns with food allergy symptoms and food allergy in early childhood. International Breastfeeding J., 2019;14(1). https://doi.org/10.1186/s13006-019-0241-x
24. Burks W, Scott S, TePas E. Diagnostic evaluation of food allergy—UpToDate [Internet]. [cited 2021 Feb 18]. UpToDate. 2017; 1–15. Available from: https://www.uptodate.com/contents/diagnostic-evaluation-of-food-allergy?search=foodallergychildren&source=search_result&selectedTitle=3~150&usage_type=default&display_rank=3
25. Sadighara P, Safta M, Limam I, Ghanati K, Nazari Z, Karami M, et al. Association between food additives and prevalence of allergic reactions in children: A systematic review. Rev Environ Health. 2022. https://doi.org/10.1515/reveh-2021-0158