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The burden of food allergy among children with asthma at the Korle-Bu Teaching Hospital: a case-control study

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Abstract

Background: Children with asthma (CWA) tend to have food allergies due to the common risk factors and underlying pathologies of asthma and food allergies. In their clinical management, the potential comorbidity with food allergies is often ignored. Little is known about the prevalence and clinical symptoms of food allergies among CWA in Ghana.

Objective: This study determined the prevalence and clinical symptoms of food allergies among CWA at the Korle-Bu Teaching Hospital compared with their non-asthmatic controls

Methods: The study design was a matched case-control involving 118 CWA and 118 non-asthmatic controls recruited from the Korle-Bu Teaching Hospital and a public school, respectively. Sampling was consecutive and purposive. The Allergy-Focused Diet History Questionnaire was used to determine the prevalence and presentation of food allergy in both groups. Descriptive statistics was used to analyse data. Statistical significance was set at $p \leq 0.05$.

Results: The mean age was 7.5 ± 2.8 years (61% males, 39% females). The prevalence of food allergies among CWA was higher than those without asthma (23.7% vs 2.5%; $p < 0.001$), with the majority (53.6%) of the former having multiple allergies and 71.4% reporting symptoms in their upper and lower respiratory airway. Conversely, non-asthmatics mostly showed symptoms of food allergy in the skin (66.7%). Peanut allergy was the commonest among children with asthma (24.5%).

Conclusion: The prevalence of food allergy was significantly higher among CWA. Clinical symptoms were mainly upper and lower respiratory symptoms and could potentially trigger asthmatic attacks. Food allergy investigations should be part of routine asthma management and should be effectively managed by the health care team, including registered dietitians. Adrenaline pens may be prescribed for asthma patients who may be at a higher risk of severe crisis due to greater sensitisation to food allergens to reduce the potential disease burden.

Keywords: Children with asthma, food allergy, clinical symptoms, respiratory symptoms

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INTRODUCTION

Asthma is currently a global health problem as its prevalence among children in many countries continues to rise [1]. The World Health Organisation describes it as the most prevalent non-communicable disease globally among children [2]. Across Africa, the prevalence of asthma has seen a continuous rise from 11.7% in 1990 to 12% and 13.8% in 2000 and 2010 respectively [3]. Among six countries in sub-Saharan Africa, including Ghana, the prevalence of symptomatic asthma among young adolescents in a school-based cross-sectional study ranged from 9.5% in Nigeria to 44.4% in Malawi, with Ghana reporting 24% [4]. Asthma is increasingly becoming widespread in low-and middle-income countries (LMIC), which bear about 90% of the global asthma burden [5,6]. Additionally, asthma severity and symptoms, especially in children and young adolescents in LMIC, have also markedly increased [4,6,7]. Host (genetics and atopy) and

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other factors (microbial exposure, poverty, passive smoking exposure, air pollution, rapid urbanisation and population growth) have been implicated in this current increase [4,8]. The burden of paediatric asthma on health care and families also remains persistently high [9,10].

Report of increasing incidence of exercise-induced bronchospasm (EIB), a proxy for asthma, among Ghanaian children suggests that asthma prevalence among Ghanaian children, especially the urban rich, is on the rise [11,12]. Two separate studies conducted 10 years apart (from 1993-2003) among school children 9-16 years old in Ghana not only reported a rising incidence of EIB but also confirmed its significant association with atopic sensitisation (previously uncommon among this group) and the possible transition from the largely non-allergic EIB to a more allergic EIB within this population over time [11,12]. Food allergies and asthma have been demonstrated to frequently coexist and share similar risk factors and underlying pathology [13,14]. Physician-diagnosed food allergy, multiple allergies and the exhibition of specific IgE antibodies to at least one of the six commonest allergenic foods among asthma patients have been reported [15,16]. Children with food allergies are more likely to be diagnosed with asthma [17] as they tend to have greater sensitisation to food allergens than the general population [17]. In children with many or severe food allergies, a greater correlation between symptomatic food allergy and asthma is observed [17,18].

The tendency for allergic response is determined by whether T-helper 1 or T-helper 2 immune response predominates in an individual. Individuals who develop predominance for T-helper 2 immune response acquire a tendency for immune disorders, including asthma, food allergy and atopic disorders. The tendency to develop a T-helper 2 immune response is determined by an interaction of genetics and environmental factors [19,20]. The prevalence of food allergies among Ghanaian children with asthma has not been widely investigated or documented. Information on the foods that commonly trigger allergic reactions and the associated symptoms among children with asthma also remains scarce. With the rising prevalence of asthma globally, the prevalence of food allergies and associated health risks among asthmatic children is also likely to rise. Therefore, the study aimed to determine the prevalence and clinical symptoms of food allergies among children with asthma (1-13 years) and compare them with their non-asthmatic controls.

MATERIALS AND METHODS

Study design and site

The study design was a matched case-control to compare food allergy levels and the health burden it poses to children with asthma to that of non-asthmatics. Physician-diagnosed children with asthma (1 to 13 years) were recruited from the Asthma Clinics of the Child Health and Polyclinic Departments of the Korle-Bu Teaching Hospital. The Korle-Bu Teaching Hospital was appropriate for this study because it is the premier tertiary healthcare facility in Ghana and is equipped with two asthma clinics that attended to the eligible participants for this study. The asthma clinics of the child health and polyclinic departments are resourced with specialist paediatricians and family physicians/respiratory medicine specialists who are trained in asthma diagnosis. Both clinics run once a week attending to between 4 and 13 patients weekly. Age and sex-matched non-asthmatic controls were recruited from a primary and junior high school located within the hospital environs, following approval by the school to participate.

Study Participants

The study participants were physician-diagnosed asthmatic children (1-13 years) seeking care at the two asthma clinics, whose caregivers provided written consent for participation and who themselves assented to participate in the study. Age (± one year) and sex-matched controls with no previous diagnosis of asthma were recruited from a public primary and junior high school within the hospital's environs. It was the only school that gave approval to participate in the study out of three schools in the hospital environs that were invited to participate. Eligible children were assented to participation, and their parents/guardians provided written consent to participate. Participant recruitment was done between September and December 2022.

Sample size and sampling

The Leslie Kish formula for estimating sample size in studies designed to estimate the population prevalence with good precision was used [21].

$$N = \frac{Z(1-\alpha/2)^2 P(1-P)}{D^2} \quad [21]$$

$Z_{(1-\alpha/2)}$ = 1.96 (the standardised normal deviate score for a two-sided alpha of 0.05)

P = 8% (The overall prevalence of asthmatic patients with food allergies globally [22]

D = 5% (margin of error)

$$N = \frac{(1.96)2\ (0.08\ (1-0.08)}{(0.05)2}$$

$$N = \frac{3.8416 \text{ x } 0.08\ (0.92)}{0.0025}$$

N =113

A minimum of 113 patients were required for the study. We assumed a 10% non-response rate, which was calculated and rounded up to 124. Hence, 124 cases and 124 controls were required. However, 118 cases and 118 controls were eventually recruited for the study due to patient saturation. Consecutive sampling was used to recruit cases. Fifty-nine patients were recruited from each clinic due to the similarity in patient numbers. Purposive sampling was used to recruit age and sex-matched eligible controls from the schools.

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Sampling and data collection procedures

Information on the child's age, sex, clinic where recruited, caregiver/parent/guardian's sex, education and employment status were obtained using a validated semi-structured questionnaire obtained from the first step of the generic WHO STEPS instrument for non-communicable disease risk assessment with mild modification [23].

Determination of Food Allergies

The Allergy Focused Diet History Questionnaire developed by the European Academy of Allergy and Clinical Immunology (EAACI) for the diagnosis of food allergy and determination of the need for nutritional intervention was used to diagnose food allergy among both cases and controls [24]. Allergy-focused history is suggested as fundamental to the establishment of the likelihood of a food allergy diagnosis. The questionnaire is a standardised practical approach by the EAACI for gathering information for the diagnosis of food allergies, which may be adapted to the local context. This tool is not profession-specific and can be used by those less skilled in allergy diagnosis, or as an aide-memoir for those working in the allergy specialist field. It obtains information on symptom and atopy history, food and symptoms, foods eaten and avoided, links food eaten to specific allergens, interprets symptoms and provides an algorithm for diagnosing or excluding food allergies. A slight modification was made to include additional foods that were associated with allergies among participants of this current study, other than what was mentioned in the questionnaire.

Questionnaires were all interviewer-administered by a trained Research Assistant under the guidance of a competent respiratory medicine specialist. Additionally, the questionnaire was pre-tested among a similar population at the main Korle-Bu outpatient department. For all cases, their caregivers/parents/guardians at the clinics were interviewed in person. For controls, teachers at the school and caregivers/parents/guardians were interviewed in person and via phone, respectively, following consent from caregivers/parents/guardians and assent from the parents. The complete interview was done on the phone for parents/guardians. All questionnaires were administered by the same person in English and explained in Akan (local dialect) when caregivers could not understand.

Data analysis

Data was analysed using the Statistical Package for Social Sciences (SPSS) version 23. Outcome indicators were the prevalence of food allergies among asthmatics and their non-asthmatic controls, history and clinical symptoms of food allergy, and the foods that commonly elicited allergic symptoms among participants. Normality was tested using the Shapiro-Wilks test, which indicated skewed data ($p < 0.001$); hence, Mann-Whitney U test was used to compare the age onset of the food allergy. Descriptive statistics (mean and standard deviation) were calculated for continuous variables (e.g., age) and proportions for categorical variables (gender, clinical history and socioeconomic variables). Differences in the prevalence of food allergy between asthmatics and non-asthmatics were determined using the Chi-square or Fisher Exact Test. Statistical significance was set at $p \leq 0.05$, and statistical tables were used to summarise the results.

RESULTS

The socio-demographic information of participants (118 children with asthma and 118 non-asthmatic controls) is displayed in Table 1. The mean age for both groups was 7.5 ± 2.8 years. A significant majority of caregivers were mothers ($p = 0.033$). Over a third were traders, and about two-thirds were educated up to the tertiary level (Table 1). Table 3 reports the history and clinical symptoms of food allergy among children with asthma and their non-asthmatic controls. The age onset of food allergy among children with asthma and non-asthmatic controls ranged from age 1 to 10 years (mean age 4.3 ± 2.3 vs 8.0 ± 3.5 years), respectively. Among asthmatics with food allergy, a quarter (25%) had taken some medication for its management. Allergic reactions occurred mostly in school among both groups. Clinical symptoms of food allergy were mostly in the upper and lower airways presenting as runny nose with or without conjunctivitis, followed by sneezing. Most children showed multiple presentations in more than one part of their bodies (Table 3). Among asthmatic children with food allergies, 53.6% had multiple food allergies (allergic to more than one food item) (Figure 1). Table 4 is a list of the types of food allergies among participants. Allergy to peanuts was the commonest. It was followed by fruits such as pineapple, banana, pawpaw, orange, pear, watermelon) and rice/corn.

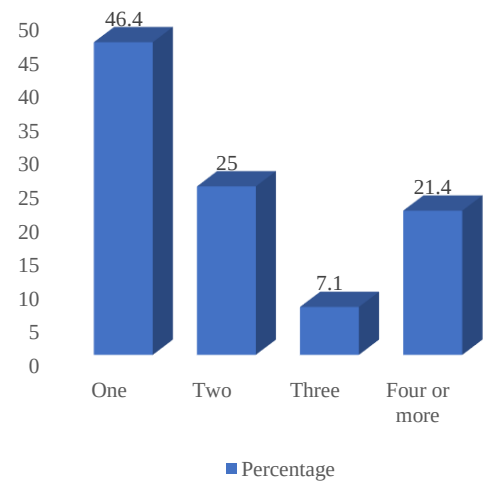

Figure 1. Number of food allergies reported among children with asthma

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Table 1. Socio-demographic information of children and caregivers. Frequency (%)

Variables	Asthmatics (n = 118)	Non-Asthmatics (n = 118)	Total (n = 236)	P-value
Mean Age of Children (years) (Mean ± SD)	7.5 ± 2.8	7.5 ± 2.8	7.5 ± 2.8	0.999[a]
Age Category (Children)				
1 - 5 years	34 (28.8)	34 (28.8)	68 (28.8)	
6 -13 years	84 (71.2)	84 (71.2)	168 (71.2)	0.999
Sex				
Male	72 (61.0)	72 (61.0)	144 (61.0)	
Female	46 (39.0)	46 (39.0)	92 (39.0)	0.999
Caregivers' level of education				
Primary and J.H.S	19 (16.1)	11 (9.3)	30 (12.7)	
Secondary	29 (24.6)	31 (26.3)	60 (25.4)	
Tertiary	70 (59.3)	76 (64.4)	146 (61.9)	0.294
Caregivers' employment status				
Unemployed	16 (13.6)	10 (8.5)	26 (11.0)	
Employed	101 (85.6)	108 (91.5)	209 (88.6)	
Retired	1 (0.8)	0 (0)	1 (0.4)	0.219
Caregivers' Occupation				
Professional/Managerial	40 (33.9)	28 (23.7)	68 (28.8)	
Skilled Manual	23 (19.4)	32 (27.1)	55 (23.3)	
Traders	38 (32.2)	48 (40.7)	86 (36.4)	0.142
Relationship with child				
Mother	102 (86.4)	100 (84.7)	202 (85.6)	
Father	11 (9.3)	18 (15.3)	29 (12.3)	
Grandmother	5 (4.2)	0 (0)	5 (2.1)	0.033*

a Mann-Whitney U-test; ● Fisher exact test, Chi Square analysis; *Significant at $p < 0.05$.

Table 2. Prevalence and age onset of food allergy among asthmatics compared to non-asthmatics

Variable		Asthmatics (n =118)	Non-Asthmatics (n = 118)	P-value
Presence of food allergy				
	Yes	28 (23.7)	3 (2.5)	0.001a
	No	90 (76.3)	115 (97.5)	
	Total	118 (100)	118 (100)	
Age onset of food allergy		4.3 ± 2.3	8.0 ± 3.5	< 0.001 [b]

Fisher's Exact Test a : Significant at $p < 0.05$; b Mann-Whitney U-test ; Significant at $p < 0.05$

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Table 3. History and clinical symptoms of food allergy among asthmatics and non-asthmatics

Variables	Asthmatics (n = 28)	Non-asthmatics (n = 3)	p-value
Age onset of food allergies (Years)			
≤5	22 (78.6)	1 (33.3)	0.156
6-10	6 (21.4)	2 (66.7)	
Use of Medication for food allergy			
Yes	7 (25)	0 (0)	0.800
No	21 (75)	3 (100)	
Where allergic reactions normally took place			
Home	1 (3.6)	0	0.999
School	27 (96.4)	3 (100)	
Clinical symptoms on the skin			
Itching	4 (14.3)	1 (33.3)	0.444
Angio-edema	2 (7.1)	0	
Eczema	1 (3.6)	0	
Urticaria	0 (0)	1 (33.3)	
Clinical symptoms on the mouth			
Itching	3 (10.7)	0 (0)	
Total	3 (10.7)	0 (0)	
Clinical symptoms on the GIT			
Vomiting	2 (7.1)	1 (33.3)	0.632
Clinical symptoms on the Upper and Lower Airway			
Conjunctivitis	1 (3.6)	0	
Nasal itching	2 (7. 1)	0	
Sneezing	3 (10.7)	0	
Runny nose with or without conjunctivitis	9 (32.1)	0	
Chest tightness	1 (3.6)	0	
Wheeze	1 (3.6)	0	
Shortness of breath	1 (3.6)	0	
Stridor	2 (7.1)	0	

Note: Multiple responses possible for an individual child with asthma
Fisher exact test; Chi Square analysis; *Significant at $p < 0.05$.

Table 4.Types of food allergies in asthmatic and non-asthmatic children

Type of Food Allergy	Asthmatics		Non-asthmatics	
	Frequency	Percentages	Frequency	Percentages
Fruits *	10	20.4	0	
Rice and corn	7	14.3	0	
Wheat	1	2.0	0	
Vegetable oil	2	4.1	0	
Milk	5	10.2	0	
Egg	6	12.3	0	
Shellfish	2	4.1	0	
Peanut	12	24.5	1	33.3
Treenut (Cashew)	2	4.1	0	
Kontomire (Cocoyam leaves)	1	2.0	0	
Soyabeans	1	2.0	0	
Potatoes and noodles	0	0	2	66.7
Total	49	100	3	100.0

Note: Multiple responses possible for an individual child with asthma
*Fruits included (pineapple, banana, pawpaw, orange, pear and watermelon)

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DISCUSSION

This study provides evidence that food allergy was significantly higher among children with asthma (23.7%) compared to their age and gender-matched non-asthmatic controls (2.5%, p = 0.001) (Table 2). The mean age for both groups was 7.5 ± 2.8 years, ranging from 1 to 13 years (Table 1). Food allergy prevalence of 24% and 25% have similarly been reported among physician-diagnosed asthmatic urban non-white school-aged students in the United States of America (5-13 years, mean of 7.9 years) and Indian children in predominantly rural areas (≥ 6 years, median age 10 years), respectively [16,25]. The skin prick test was used in the latter study to diagnose food allergy. These similarities are evident despite reported challenges associated with self-reported food allergies [26] and affirm the effectiveness of the Allergy Focused Diet History Questionnaire developed by the European Academy of Allergy and Clinical Immunology (EAACI) for the diagnosis of food allergy [27]. A possible explanation for the higher prevalence of food allergy among asthmatics compared to their non-asthmatic controls in this current study (23.7% vs 2.5 %, p = 0.001) is that the risk of asthma development has been shown to be associated with sensitisation common to allergies.

Food allergy and asthma are both related to atopy (the genetic predisposition to produce immunoglobulin E antibodies in response to allergen exposure) [28,29]. Both are thought to be a part of the type I hypersensitivity immune response that underlies atopic diseases. A significant fraction of people with asthma, especially children, are believed to have allergic asthma with an underlying IgE-mediated hypersensitivity mechanism [30]. The tendency for type 1 hypersensitivity is underlined by the predominance of T-helper 2 lymphocytes' immune response. Individuals with allergies tend to have a predominance of T-helper 2 immune response compared to individuals who do not have allergies but rather have T-helper 1 immune response. T-helper 2 response results in the release of cytokines, including interleukin 4, interleukin 5 and interleukin 13, which recruit eosinophils and thus the tendency for allergic sensitising and increased risk for allergic disorders like asthma and food allergies. This may explain why children with asthma in this current study had a higher prevalence of food allergy than those who did not have asthma [19,20].

The age of onset of food allergies in this current study was significantly earlier among the children with asthma (mean age 4.3 ± 2.3 years) than among non-asthmatic children (8.0 ± 3.5 years; p < 0.001) (Table 2). This could be because allergic sensitisation occurred earlier in children with asthma than in non-asthmatic children and is consistent with findings by Illi et al. [20] that sensitisation to food allergies and asthma occurs early in life (by 2 years). Early introduction (before three months) of food allergens as weaning foods (contrary to the WHO-recommended exclusive breastfeeding for six months, as well as the immaturity of the intestinal barrier and the immune system, may result in primary food sensitivity manifesting through the intestinal pathway to increase risk of developing food allergies [31,32]. Early enrollment of children at preschool, with the potential risk of introduction of food allergens during school feeding, could explain the early development of food allergies in this study. Most participants (96.4%) mentioned that episodes of food allergy often occurred at school (Table 3).

Multiple food allergies were found in 53.6% of children with asthma in this current study (Figure 1). This proportion is much higher compared to the 12% reported in the earlier study carried out among physician-diagnosed asthmatic urban non-white school-aged students in the United States of America [16]. Multiple allergies among asthma patients have been associated with increased asthma morbidity and health resource utilisation (more frequent hospitalisation and controller medication use) [16]. The relatively higher prevalence of multiple allergies in this study thus gives course for concern. A quarter (25%) of asthmatics with food allergies were using some medication to manage food allergies or their symptoms. Comparatively, none of the controls with food allergies had ever used medication for food allergies (Table 3). This may suggest a stronger burden of food allergy on asthmatic children compared to non-asthmatics.

The clinical symptoms of food allergy among a majority of the children with asthma (71.4%) were mainly upper and lower respiratory symptoms, predominantly presenting as runny nose with or without conjunctivitis (32.1%) and sneezing (10.7%). This was followed by symptoms in the skin (14.3%) and mouth (10.7%), presenting in both cases as itching. Among non-asthmatics, food allergy presented in equal proportions (33.3%) as itching or urticaria of the skin and in the GIT as vomiting (Table 3). In a similar study carried out among children with asthma recruited from an asthma clinic in a tertiary care hospital in the southern part of India, the common symptoms of food allergy were respiratory symptoms, including wheezing (54%), cough (19%), rhinorrhea (19%), and sneezing (7%) [33]. The preponderance of respiratory tract-related food allergy symptoms among children with asthma compared with those without asthma could be because the respiratory tract of people with asthma are more sensitised to food allergens than people without asthma.

According to Fong [34], childhood food allergy sensitisation is linked with allergic airway diseases such as rhinitis and asthma in childhood. Both food allergy and asthma may present the same or similar symptoms. The upper and lower airway tract can be affected by IgE-mediated food allergy symptoms. Non-IgE-mediated food allergies tend to manifest gastrointestinal symptoms rather than respiratory and skin. However, the small number of non-asthmatic children with food allergies in this study makes it difficult to attribute the nature of their manifestations to non-IgE-mediated food allergies [20].

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Food allergy can thus initiate or trigger an asthma episode. Having a food allergy may thus predispose one to life-threatening asthma episodes. Conversely, asthma may also predispose one to episodes of life-threatening food allergy [35]. In this current study, peanut allergy was the most common food allergy among asthmatics (24.5%). This was followed by allergies to fruits (pineapple, banana, pawpaw, orange, pear, watermelon) (20.4%), rice and corn (14.3%), egg (12.3%) and milk (10.2%) (Table 4). This finding is consistent with those of other studies that state that peanut allergy is common in children [36,37].

Conclusion

The prevalence of food allergy was significantly higher among children with asthma than children without asthma. The food allergy symptoms among the children with asthma were mostly respiratory compared to those of children without asthma, which were related to skin and gastrointestinal tract. Food allergy investigations should be part of routine asthma management and should be effectively managed by the health care team, including registered dietitians. Adrenaline pens may be prescribed for asthma patients who may be at a higher risk of severe crisis due to greater sensitisation to food allergens to reduce the potential disease burden.

Limitation

Controls were recruited from a primary and junior high school within the hospital environment and may not have been representative of cases recruited from the Department of Child Health in terms of their residence. However, asthma has been closely associated with caregiver socioeconomic status (SES) and urbanisation. There was, however, no significant difference in caregiver SES between both groups.

DECLARATIONS

Ethical consideration

The Institutional Review Board of Korle-Bu Teaching Hospital granted ethical approval for this study (KBTH/MD/G3/22). Before enrolling in the study, caregiver/parent/guardian's informed consent and accent from eligible children were sought. Approval was also sought from the heads of the schools.

Consent to publish

All authors agreed on the content of the final paper.

Funding

None

Competing Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Author contributions

RKSD and ASD participated in the conceptualisation and design of the study. RKSD, ASD and ADH participated in data collection, data analysis, drafting of the manuscript. FDI and ASD participated in a critical review of the manuscript.

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Availability of data

Data is available upon request to the corresponding author.

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