Original article

Prevalence of food sensitization and helminth infection among primary school children in Ibadan, southwest Nigeria

Background: *Food allergy is a problem of the western world, however, cases of food allergy have also been found in developing countries. In Nigeria, the prevalence of food allergy is scarce while the association of food sensitization with helminthiasis is unknown.* ***Objective:*** *This study was designed to determine the prevalence of sensitization to food among Nigerian school children and its relation to intestinal helminthiasis.* ***Methods:*** *A total of 128 participants were recruited from CAC Primary School, Sango, Ibadan, Nigeria. Skin Prick Test using freshly prepared food allergens was carried out. Stool samples were collected from them to screen for ova of parasites using concentration method.* ***Results:*** *A total of 26 (20.3%) out of 128 participants were SPT positive for various food allergens, while 16 (12.5%) had helminthic infection. There was however an equal distribution of helminthic infection among students who were food allergen SPT positive and negative. There was also no association between gender and susceptibility to food allergy.* ***Conclusion:*** *Sensitization to food is common in school children, and intestinal helminthiasis seems to have no influence on its prevalence.*

Keywords: MPO, inflammatory response, neonates, sepsis.

Ayodele A. Adelakun and Olatunbosun G. Arinola*

Departments of Chemical Pathology and Immunology, University of Ibadan, Nigeria.*

Correspondence:
Prof. O.G. Arinola
E-mail:*drarinolaog64 @ yahoo.com*

INTRODUCTION

Food allergy constitutes a growing problem in the western world and its incidence seems to be on the increase.[1] Children experience food allergies more than adults as tolerance develops with increasing age. In developed countries, the prevalence of food allergy in children is 6-10%, while it is 3-4% in adults[2]. In developing countries, such as Nigeria, report on prevalence of food allergy is scarce but study on prevalence of environmental allergy is extensive[3,4,5,6]. In developed countries, almost all (90%) reported food allergic reactions are caused by cow's milk and dairy products, hen's egg, peanuts, nuts, gluten containing cereals (e.g. wheat, rye, barley), sesame, soybeans, mustard, fish, crustaceans and shellfish[7,8,9], hence they are referred to as "priority food allergens". Other less common allergenic foods include legumes, fruit juices (e.g. kiwifruit, apple, grape) and vegetables (e.g., celeriac, carrots and onions)[10]; but the types and prevalence of food allergy varies with geographical location.[11,12,13,14,15]

The Centers for Disease Control and Prevention documented an 18% increase in the prevalence of reported food allergy in children in the United States of America (USA) within a decade, while a comparable observation was made within the same period in China.[1,16] Foods causing most allergies in Africa are egg white, peanut, milk, soy, seafoods, pineapple, vegetable oil and pork.[17,18,19] Antigens present in food induce a systemic non-responsiveness termed 'oral-tolerance'[20]. However, a failure to develop tolerance or a breakdown in tolerance in certain individuals results in excessive production of food-specific immunoglobulin E (IgE) antibodies. In these individuals, mast cell-bound IgE molecules are present in the gastrointestinal tract. Upon ingestion, food allergens bind to mast cell-bound IgE and cross-link the IgE molecules leading to the release of inflammatory mediators from the mast cell, causing smooth muscle contraction and vasodilatation.[21]

Human intestinal helminthiases are rampant in the tropics because of favourable climatic, environmental and socio-cultural factors that permit their transmission for greater part of the year[22]. These factors predispose school-aged children to be at greater risk of helminthiasis.[23,24] In Nigeria, commonly encountered helminthes are *Ascaris lumbricoides*, *Trichuris trichiura*, hookworm and schistosomes.[25,26,27] Evidence exists that helminthes modulate the host immune system to guarantee their own survival[28] and also induce regulatory responses that dampen the activity of effector cells.[29] The modulatory effect of helminthes on the immune

system has led to the exploration of its use as therapy in autoimmune diseases and immune disorders.

Epidemiological studies have shown inverse associations between environmental allergen skin test reaction and various helminthic infections namely *Ascaris lumbricoides*,[30,31] *Trichuris trichiura*,[30,32] hookworm,[29] and *Schistosoma*.[33,34] Also, previous studies focused on identifying co-morbid conditions of food allergy such as allergic rhinitis, atopic dermatitis, and asthma in developed countries.[35,36,37,38] This present study is therefore designed to determine the prevalence of food sensitization in an emerging country – Nigeria and to find out the association between helminth infection, gender and food sensitization.

METHODS

Participants

A total of 128 pupils (60 boys and 68 girls; age range 5 to 13 years) were recruited from primary schools in Ibadan, Southwestern Nigeria. Ethical clearance was obtained from the State Ministry of Health (Oyo State) while permission was obtained from the State Universal Basic Education Board as well as Local Government Universal Basic Education Authority. Parental informed assent was obtained on behalf of each pupil.

Food allergens

The food allergens used were fresh cow's milk, egg, fish, crayfish, groundnut, soya, wheat, pineapple, vegetable and cassava obtained locally from the market. Allergens were aseptically prepared described as follows: Foods with hard consistency (fish, crayfish, groundnut, soya, wheat, vegetable and cassava) were oven-dried, ground and diluted in buffered saline at 1:3 w/v dilution[39]. Fresh cow's milk and cooked egg white were used directly. All procedures were carried out under sterile conditions.

Skin Prick Test

Skin Prick Test (SPT) was carried out on all participants using the food allergens mentioned above as described by Arinola *et al*[40]. The wheal diameter was measured with a millimeter ruler and wheal diameter greater than 3mm was considered as positive reaction.

Sample Collection and Analysis

Stool sample was collected into a universal container. The stool sample was microscopically examined for ova after concentration method as previously described by Arinola *et al* [41].

Statistical Methods

Statistical analysis was done using statistical package *SPSS* version 17.0 and association between variables was determined by Chi-square (X^2) at 0.05 level of significance.

RESULTS

Out of the 128 participants, 26 (20.3%) were positive for the tested food allergens of which 16 were females and 10 males. Also, 16 (12.5%) students had helminthic infection, 11 of them were females and 5 were males. There were no gender differences in the prevalence of helminthic infection or food sensitization ($p > 0.05$). (Table 1).

As shown in table 2, a total of 14 (10.9%) students out of 128 had *Ascaris lumbricoides* infection, while 2 (1.6%) had hookworm infection. Five (8.3%) males had *Ascaris lumbricoides* infection while 9 (13.2%) females had *Ascaris lumbricoides* infection. Hookworm infection was seen in only 2 (2.9%) of the females.

In Table 3, from the 16 positive cases of helminth infection, 8 had positive SPT for the tested foods, while the remaining 8 had negative SPTs There was also an equal distribution of 7 *Ascaris lumbricoides* to 1 hookworm infection in food allergy positive as well as food allergy negative students.

Sensitization to groundnut was the most prevalent food allergy, followed by milk, soybeans, wheat and cassava. There was however no sensitization to fish or vegetables in any of the students. Among the males, the most prevalent food allergens were groundnut, soybeans, wheat and crayfish; followed by milk, cassava, pineapple and egg. On the contrary, among the females, the most prevalent food allergens were groundnut and milk; none of the females was however susceptible to crayfish allergen; as in table 4.

Fourteen school children (6 males and 8 females) had single food allergy, while 12 school children (4 males and 8 females) had multiple food allergies (Table 5).

Table 1. Gender-based prevalence of food allergy and helminth infection among school children.

		Male (n = 60) (46.9%)	**Female (n = 68) (53.1%)**	**Total (n = 128)**	**X^2**
Helminth infection	Positive	5 (8.3%)	11 (16.2%)	16 (12.5%)	0.181
	Negative	55 (91.7%)	57 (83.8%)	112 (87.5%)	
Food sensitization	Positive	10 (16.7%)	16 (23.5%)	26 (20.3%)	0.336
	Negative	50 (83.3%)	52 (76.5%)	102 (79.7%)	

Table 2. Types of helminths species in school children.

	Male (n = 60)	**Female (n = 68)**	**Total (n = 128)**
Ascaris lumbricoides	5 (8.3%)	9 (13.2%)	14 (10.9%)
Hookworm	0 (0%)	2 (2.9%)	2 (1.6%)
Total	5 (8.3%)	11 (16.2%)	16 (12.5%)

Table 3. Prevalence of food allergy among school children with different species of helminthic infections.

	HELMINTH POSITIVE n = 16		**Total**
	Ascaris lumbricoides	**Hookworm**	
Food allergy positive	7 (43.75%)	1 (6.25%)	8 (50%)
Food allergy negative	7 (43.75%)	1 (6.25%)	8 (50%)

Table 4. Prevalence of types of food allergies among both sexes in the school children.

	MALES (n = 60)	**FEMALES (n = 68)**	**TOTAL (n = 128)**
Milk	2 (1.6%)	5 (3.9%)	7 (5.5%)
Egg	2 (1.6%)	1 (0.8%)	3 (2.3%)
Fish	0 (0%)	0 (0%)	0 (0%)
Crayfish	3 (2.3%)	0 (0%)	3 (2.3%)
Groundnut	3 (2.3%)	5 (3.9%)	8 (6.3%)
Soybeans	3 (2.3%)	4 (3.1%)	7 (5.5%)
Wheat	3 (2.3%)	3 (2.3%)	6 (4.7%)
Pineapple	2 (1.6%)	3 (2.3%)	5 (3.9%)
Vegetables	0 (0%)	0 (0%)	0 (0%)
Cassava	2 (1.6%)	4 (3.1%)	6 (4.7%)

Table 5. Prevalence of combination types of food sensitization in relation to gender.

	Allergen	Males (n=60)	Females (n=68)	Total (n =128)
Single allergies	Milk	0 (0%)	2 (1.6%)	2 (1.6%)
	Egg	1 (0.8%)	1 (0.8%)	2 (1.6%)
	Crayfish	2 (1.6%)	0 (0%)	2 (1.6%)
	Groundnut	1 (0.8%)	1 (0.8%)	2 (1.6%)
	Soybeans	1 (0.8%)	2 (1.6%)	3 (2.3%)
	Wheat	0 (0%)	1 (0.8%)	1 (0.8%)
	Pineapple	1 (0.8%)	1 (0.8%)	2 (1.6%)
	Sub-total	**6 (4.7%)**	**8 (6.3%)**	**14 (10.9%)**
Multiple allergies	Milk + wheat	1 (0.8%)	0 (0%)	1 (0.8%)
	Milk + cassava	0 (0%)	1 (0.8%)	1 (0.8%)
	Milk + soya	0 (0%)	1 (0.8%)	1 (0.8%)
	Egg + cassava	1 (0.8%)	0 (0%)	1 (0.8%)
	Groundnut + pineapple	0 (0%)	1 (0.8%)	1 (0.8%)
	Groundnut + wheat	0 (0%)	1 (0.8%)	1 (0.8%)
	Groundnut + soya	1 (0.8%)	0 (0%)	1 (0.8%)
	Soya + cassava	0 (0%)	1 (0.8%)	1 (0.8%)
	Wheat + pineapple	0 (0%)	1 (0.8%)	1 (0.8%)
	Milk + groundnut + wheat	0 (0%)	1 (0.8%)	1 (0.8%)
	Groundnut +soya + wheat + cassava	0 (0%)	1 (0.8%)	1 (0.8%)
	Milk + crayfish + groundnut + pineapple + cassava	1 (0.8%)	0 (0%)	1 (0.8%)
	Sub-total	**4 (3.1%)**	**8 (6.3%)**	**12 (9.4%)**
OVERALL TOTAL	**OVERALL TOTAL**	**10 (7.8%)**	**16 (12.5%)**	**26 (20.3%)**

DISCUSSION

Previous reports showed that the prevalence of food allergy varies from country to country, with a higher prevalence rate found in developed countries[1,16,42,43]. Reports of food allergy in developing countries are scarce, however, environmental allergies have been studied[3, 4,5,6,44]. The recent rise in prevalence of food allergy in western countries[45,46] has necessitated our need to investigate such prevalence in tropical countries. Also, it has been noted that helminthic infections are widespread in tropical countries and the hygiene hypothesis suggests that due to the prevalence of helminthes in tropical countries, allergic diseases might be scarce.

From the present study, we observed that total prevalence of food allergy among the study population is 20.3%. Pawankar *et al*[47] reported an allergy prevalence of 20-30% in Africa, this was however not restricted to food allergy. In this study, the food with the highest prevalence of reactivity was groundnut (6.3%); followed by soya (5.5%) and milk (5.5%). Others were cassava (4.7%), wheat (4.7%), pineapple (4.7%), pineapple (3.9%), egg (2.3%) and crayfish (2.3%). These food allergens have also been reported in other parts of Africa[17, 18, 19]. Previous reports in western countries showed that groundnut, milk, soya, egg, seafoods, sesame and wheat are 'priority food allergens'[48,49,50,51]. This is in agreement with our present findings.

Osborne *et al* [52] reported prevalence rates of egg white (16.5%), peanut (8.5%) and cow milk (5.6%) among Australian children. This order of prevalence came in contrast to our observation; however, there was a comparable prevalence rate of cow's milk allergy. This lends support to the report of Ouahidi *et al*[15] that the types and prevalence of food allergy vary with geographical location. Furthermore, in South Africa, Els *et al*[53], reported the following prevalence of food allergens: groundnut (9%), egg white (7%), wheat (4%), fish (4%), and milk (3%). These values are relatively higher than what we observed. This might be due to higher level of 'westernization' in South Africa compared to our study location.

Among the male school children, 3 (2.3%) of them each had a positive reactivity to groundnut, wheat, soybeans and crayfish; while 2 (1.6%) reacted positively to milk, egg, pineapple and cassava (Table 4). However, among the female school children, the highest prevalence of positivity was for groundnut and milk (3.9% each), followed by soybeans and cassava (3.1% each), wheat (2.3%), pineapple (2.3%) and egg (0.8%) (Table 4). None of the school children were sensitive to fish or vegetables. There was no gender difference in the prevalence of food sensitization among the school

children. This might be related to similar environmental factors impacting on the type of food sensitivity observed in them.

In this study, 12.5% of the school children had helminthic infection. This is comparable to the findings of Odu *et al*[27] who reported a prevalence of 15.7% among school-aged children. The intestinal helminthes observed in our study were *Ascaris lumbricoides* and hookworm. Various studies have demonstrated the presence of other intestinal helminthes – *Ascaris lumbricoides, Trichuris trichiura,* hookworm and schistosomes – across Nigeria[25,26,27]. Other studies in rural areas across Nigeria, among school-aged children showed higher prevalence rates[54,55]. Jimenez-Gonzalez *et al*[56] also reported a prevalence of 34.0% among inhabitants of a rural community in Mexico. This shows that rural communities have a higher prevalence of helminthic infections compared with urban communities. Our present study also shows that helminthic infection is not gender-specific as we found no significant difference in the prevalence between the sexes (male- compared with female-school children).

The percentage of present and absent sensitization to food allergens was comparable among the helminth infected children. It may therefore be hypothesized that immunoregulation by helminth infection did not affect response to food allergens. Various studies have reported interaction between helminthic infection and allergy[28,57,58,59]. Helminths regulate host immune response, in a way that enhances their survival in the host and limits host tissue damage. However, despite strong T-helper 2-type (Th2) polarization of immune response by helminthic infection, chronic helminthic infections do not induce clinical symptoms of allergy. This paradoxical phenomenon was explained by the report of Maizels and Yazdanbakhsh[60] that chronic helminth infections protect against allergic diseases. It was also added that the hyporesponsiveness induced by helminthiasis is not only directed toward parasite antigens but seems to be extended to 'bystander' antigens, such as vaccine antigens or other pathogens[61].

CONCLUSION

The study showed that both sensitization to food and helminth infection are prevalent among school children but helminth infection or gender have no influence on the prevalence of food sensitization.

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