ORIGINAL

Nutritional factors, parasite infection and allergy in rural and suburban Vietnamese school children

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Abstract : Urban areas often have more allergy than rural areas. Dietary patterns and parasite infection have been suggested as possible related factors. This study evaluated the prevalence of allergy in school children in one rural and suburban area of Vietnam where parasite infection is common. A total of 195 children aged 9 to 13 years old completed a self-administered allergy questionnaire and provided blood and stool samples for analysis. Nutritional status, dietary intake and parasite infection were determined in all participants. Allergy was more common in girls (10.7% vs. 7.6%), suburban children (11.8% vs. 6.9%), children with weight-for-age (16.7% vs. 6.0%) and height-for-age (14.8% vs. 4.9%) in the10th to75th percentile compared to <3rd percentile, and in children without trichuriasis compared to light trichuriasis (12.5%vs. 9.3%), although none of these comparisons were statistically significant. Logistic regression adjusted for sex, age and area of residence revealed no association between allergy and nutritional status, food intake or parasite infection. Intake of riboflavin, however, was negatively associated with allergy (OR=0.00,95% CI:0.00-0.65, *p*=0.038). In conclusion, we were unable to detect any association between allergy and nutritional status, diet, or parasite infection. However, in a population with high undernutrition and parasite infection, the prevalence of allergy was low and the extremely low intake of riboflavin was associated with a higher risk of allergy. J. Med. Invest. 51 : 171-177, August, 2004

Keywords **:** *allergy, nutritional status, diet, parasite infection, Vietnam*

INTRODUCTION

The prevalence of allergic diseases has increased greatly over the last decades in most industrialized countries (1-4). In Japan, The National Research on Allergy that took place in 1992 reported that 33.4% of boys and 36.2% of girls of all ages had allergic symptoms, which represents about 1/3 of the population (5). This recent rise in the prevalence of allergy has been attributed to environmental factors associated with socio-economic growth (6-8). Economic development has led to changes in eating habits that are associated with increased overweight and obesity, and these changes in nutritional status may increase the risk of developing allergy in predisposed people (9).

Despite having been evaluated for decades, the role of parasite infection on allergy prevalence remains unclear (10). Results range from no association (11) and negative association (12) to positive association

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(13) between parasite infection and allergy.

Even though there is a genetic predisposition to develop allergy that is inherited and cannot be modified, the control of the environmental factors that trigger this predisposition is important in preventing allergy. The present study was designed to evaluate the relationship between nutritional status, dietary intake and parasite infection and prevalence of allergy in rural and suburban school children in two communities in Vietnam.

SUBJECTS AND METHODS

Study Population : This study was conducted in two randomly selected communities : Ung Hoa, a small village in the south of Ha Tay, where most habitants are farmers, and in Thanh Tri, a suburban district located in the south of Hanoi. All children at the fifth grade from the only elementary school at each community were invited to participate in the study. From a total of 213 children who provided written consent from their parents to participate in the study, 195 children (91.5%) completed the questionnaire and provided stool and blood samples for analysis. The study protocol was approved by the institutional review board at the Tokushima University, Japan, and the Ethical Committee of the National Institute of Nutrition, Vietnam.

Anthropometry : Height and weight of all participants were measured following WHO recommended procedures (14). Weight was measured with the child dressed in light clothing to the nearest 0.1kg on an electronic digital scale (SECA, Columbia, MD). Height was measured to the nearest 0.1 cm using a locally manufactured wooden board fitted with a measuring tape, a fixed foot-plate and a movable headboard. Body mass index (BMI), defined as the weight (kg) of the individual divided by the square of the height (m), was determined in all children. Weight, height and BMI were expressed as Weight-for-age, Height-for-age and BMI-for-age using the NCHS/WHO reference data (15).

Blood analysis : Blood samples from all participants were collected by venipuncture, and serum was collected and stored at -30°C and transported to Japan for analysis. Total protein and albumin were determined by assay (Wako Pure Chemical Industries, Osaka, Japan) ; total cholesterol and triglycerol were determined by enzymatic assay (Wako Pure Chemical Industries, Osaka, Japan) ; high-density lipoprotein (HDL) and low-density lipoprotein (LDL) were determined by enzymatic assay (Daiichi Pure Chemicals Co., Ltd., Tokyo, Japan) ; and total immunoglobulin E (IgE) was determined by ELISA (Funakoshi Pharmaceutical Co., Osaka, Japan).

Parasite infection : Examination of stool samples for ova of *Ascaris lumbricoides, Trichuris trichiura* and *Hookworm* was performed using the Kato-Katz technique (16). Parasite infection was classified according to the egg count in the stool sample, as specified by WHO (17).

Prevalence of allergy : All participants were requested to complete a questionnaire concerning history of allergy. Cases were defined as those children who reported allergy diagnosed by a physician.

Food and Nutrient Intakes : Daily food and nutrient intakes were estimated from a single 1-d 24-h recall. Portion sizes were estimated using various household tableware items (e.g., plates, glasses, and spoon) and photographs of commonly consumed foods in different portion sizes during the interview.

Statistical methods : The results are expressed as mean±SD. To determine the significance of differences between groups, we used unpaired *t*-test or Mann-Witney *U*-test if the data were not normally distributed. Logistic regression analysis was carried out to estimate the effect of anthropometric values, blood analyses, food intake and nutrient intakes on allergy. Data is presented unadjusted and adjusted for potential confounding effects of sex, age and area of residence. All statistical analyses were performed using SPSS for Windows (version 9.0, City, State, USA).

RESULTS

The study sample consisted of 195 school children between 9 to 13 years of age (mean age 10.1±0.5). Characteristics of the participating children based on absence or presence of allergy are shown in Table 1. Table 2 shows the prevalence of allergy stratified by sex, area of residence, anthropometric values and parasite infection. Even though the prevalence of allergy was higher in girls, suburban areas, 10^{th} to 75^{th} percentile of weight-for-age and height-for-age compared to the lowest percentile, and children without trichuriasis compared to those with light trichuriasis, the differences were not statistically significant. Tables 3 and 4 show food and nutrient intakes of children with and without allergies. A significantly higher intake of starchy roots (14.4 g vs.10.5 g ; p=0.033) and a lower intake of riboflavin (0.28 vs. 0.35 mg ; p=0.046) were observed among allergic children compared to those without

Table 1. Characteristics of the subjects (1)

	Without allergy (n=177)	With allergy (n=18)	*p*-value
Age (years)	10.1±0.5	9.4±0.4	0.395
Height (cm)	129.5±6.7	131.6±5.8	0.199
Weight (kg)	25.0±4.4	25.5±4.7	0.512
BMI	14.6±1.5	14.6±1.9	0.675
Total protein (g/dL)	7.7±0.4	7.6±0.3	0.678
Albumin (g/dL)	4.6±0.4	4.5±0.3	0.507
Total cholesterol (mg/dL)	154.0±22.9	148.5±24.8	0.346
HDL Cholesterol (mg/dL)	49.5±8.8	48.4±8.6	0.620
LDL Cholesterol (mg/dL)	89.5±19.7	84.0±18.9	0.271
Triglyceride (mg/dL)	80.7±37.8	87.5±40.8	0.541
Total IgE (IU/ml)	868.2±1276.0	1661.3±1901.2	0.135

Table 2. Characteristics of the subjects (2)

	n	With allergy (%)	*p*-value
Sex			0.461
Male	92	7.6	
Female	103	10.7	
Area of residence			0.233
Rural	102	6.9	
Suburbs	93	11.8	
Weight/age, percentile			0.204
<3 rd	100	6.0	
3 rd-10 th	45	8.9	
10 th-75 th	48	16.7	
>75 th	2	0.0	
Height/age			0.116
<3 rd	61	4.9	
3 rd-10 th	44	4.5	
10 th-75 th	88	14.8	
>75 th	2	0.0	
BMI/age		14.6	0.387
<3 rd	91	8.8	
3 rd-10 th	95	8.4	
10 th-75 th	9	22.2	
Any parasite infection			0.916
Yes	170	8.8	
No	21	9.5	
Unknown	4		
Ascariasis			0.627
No	90	10.0	
Light	62	6.5	
Moderate	36	11.1	
High	3	0.0	
Unknown	4	25.0	
Trichuriasis			0.190
No	24	12.5	
Light	150	9.3	
Moderate	17	0.0	
Unknown	4	25.0	
Hookworm infection			
No	183	8.2	0.103
Light	8	25.0	
Unknown	4	25.0	

Table 3. Daily food intake (g/day)

	Without allergy (n=177)	With allergy (n=18)	*p*-value
Cereals	317.5±103.7	315.7±106.9	0.650
Starchy roots	10.5±46.2	14.4±36.8	0.033
Pulse	21.1±48.4	10.0±35.6	0.234
Nuts	1.4±8.5	0.8±3.5	0.764
Oil and fat	3.7±5.9	2.2±2.4	0.564
Meat	51.2±51.7	52.6±42.6	0.628
Fish and sea prod.	34.4±60.2	46.7±95.7	0.593
Milk prod./eggs	18.6±40.5	12.2±30.7	0.456
Vegetables	98.8±78.5	105.3±104.0	0.812
Fruits	65.6±96.2	43.1±94.2	0.164
Sauces	5.9±5.6	4.4±5.2	0.327
Sweeteners	1.3±6.3	0.0±0.0	0.276

Table 4. Daily nutrient intakes

	Without allergy (n=177)	With allergy (n=18)	*p*-value
Energy, kcal	1420±401	1397±389	0.611
Carbohydrate, g	248.6±76.2	246.0±72.0	0.648
Protein, g	48.0±16.6	47.9±22.8	0.415
Animal protein, g	17.7±13.1	18.8±18.4	0.674
Animal protein, %	35.1±18.5	34.6±18.0	0.888
Lipids, g	21.4±11.8	20.1±12.6	0.383
Vegetable oil, g	5.4±6.5	4.2±2.7	0.478
Vitamin A, ug	641.7±527.1	572.4±533.3	0.493
Thiamin, mg	0.59±0.22	0.54±0.23	0.329
Riboflavin, mg	0.35±0.16	0.28±0.10	0.046
Niacin, mg	8.0±3.7	7.5±2.2	0.935
Vitamin C, mg	44.8±44.2	38.6±43.4	0.285
Calcium, mg	304.9±241.5	285.7±130.8	0.898
Phosphorus, mg	590.7±190.4	563.2±214.5	0.397
Iron, mg	8.5±3.1	8.3±2.8	0.603

allergy.

Multiple logistic regression was used to assess the effect of anthropometric values as continuous variables, food and nutrient intakes, biochemical values and parasite infection as egg count in feces (Table 5). Obtained unadjusted odds ratio were statistically significant for riboflavin intake (OD=0.00, 95% CI : 0.00-0.43 ; p=0.029) and serum IgE levels (OD=1.00, 95% CI : 1.00-1.00 ; p=0.031). After adjusting for sex, age and area of residence, only riboflavin intake remained significantly associated with allergy (OD=0.00, 95% CI : 0.00-0.65 ; p=0.038).

Table 5. Estimated odd ratio for grouped variables, undajusted and adjusted by sex, age and area of residence

	Unadjusted			Adjusted		
	OR	**95.0% C.I.**	***p*-value**	**OR**	**95.0% C.I.**	***p*-value**
Anthropometry						
Weight	**0.88**	**0.27-2.86**	*0.827*	**1.41**	**0.37-5.39**	*0.616*
Height	**1.11**	**0.69-1.79**	*0.662*	**0.93**	**0.54-1.61**	*0.806*
BMI	**1.17**	**0.13-10.62**	*0.889*	**0.48**	**0.04-6.01**	*0.569*
Food intake						
Cereals	**1.00**	**0.99-1.00**	*0.853*	**1.00**	**0.99-1.00**	*0.931*
Starchy roots	**1.00**	**0.99-1.01**	*0.586*	**1.00**	**0.99-1.01**	*0.849*
Beans	**1.00**	**0.98-1.01**	*0.546*	**1.00**	**0.98-1.01**	*0.586*
Nuts	**0.99**	**0.91-1.08**	*0.799*	**0.99**	**0.90-1.08**	*0.783*
Oil and fat	**0.91**	**0.79-1.06**	*0.244*	**0.88**	**0.74-1.04**	*0.128*
Meat	**1.00**	**0.99-1.01**	*0.930*	**1.00**	**0.99-1.01**	*0.614*
Fish and sea prod.	**1.00**	**1.00-1.01**	*0.300*	**1.00**	**0.99-1.01**	*0.534*
Milk and eggs	**1.00**	**0.98-1.01**	*0.599*	**0.99**	**0.98-1.01**	*0.518*
Vegetables and fruits	**1.00**	**0.99-1.00**	*0.571*	**1.00**	**1.00-1.00**	*0.989*
Nutrient intake						
Energy, kcal	**0.78**	**0.39-1.55**	*0.473*	**0.82**	**0.40-1.68**	*0.587*
Protein, g	**1.00**	**0.96-1.05**	*0.826*	**1.00**	**0.96-1.05**	*0.909*
Lipid, g	**1.00**	**0.95-1.05**	*0.971*	**0.99**	**0.94-1.05**	*0.855*
Iron, mg	**1.19**	**0.89-1.61**	*0.244*	**1.17**	**0.79-1.72**	*0.436*
Vitamin A, ug	**1.00**	**1.00-1.00**	*0.539*	**1.00**	**1.00-1.00**	*0.422*
Thiamin, mg	**3.56**	**0.09-147.04**	*0.503*	**3.20**	**0.06-162.52**	*0.562*
Riboflavin, mg	**0.00**	**0.00-0.43**	*0.029*	**0.00**	**0.00-0.65**	*0.038*
Blood analysis						
Ig E	**1.00**	**1.00-1.00**	*0.031*	**1.00**	**1.00-1.00**	*0.137*
Total protein	**0.71**	**0.14-3.57**	*0.673*	**0.93**	**0.18-4.92**	*0.932*
Albumin	**0.56**	**0.13-2.52**	*0.452*	**0.34**	**0.06-1.95**	*0.225*
Total cholesterol	**1.04**	**0.90-1.20**	*0.584*	**1.05**	**0.91-1.21**	*0.544*
HDL cholesterol	**0.96**	**0.82-1.13**	*0.648*	**0.96**	**0.82-1.13**	*0.632*
LDL cholesterol	**0.95**	**0.82-1.10**	*0.493*	**0.95**	**0.82-1.10**	*0.467*
Triacylglycerol	**1.00**	**0.98-1.02**	*0.973*	**1.00**	**0.98-1.02**	*0.987*
Parasite infection						
Ascariasis, egg/g	**1.00**	**1.00-1.00**	*0.808*	**1.00**	**1.00-1.00**	*0.722*
Trichuriasis, egg/g	**1.00**	**1.00-1.00**	*0.305*	**1.00**	**1.00-1.00**	*0.190*
Hookworm, egg/g	**1.00**	**0.99-1.01**	*0.663*	**1.00**	**0.99-1.02**	*0.561*

DISCUSSION

The aim of the present study was to investigate the relationship between nutritional status, dietary intake, parasite infection and prevalence of allergy in school children in a rural and semi-urban community in Vietnam. We were unable to detect an association between the prevalence of allergy and any of the measured nutritional factors.

The major limitation of our study is the definition of allergy, which relies on self-reported physician-diagnosed allergy. Furthermore, the low prevalence of allergy in both communities may have resulted in inadequate allergy cases necessary to detect biologically meaningful differences. However, anthropometric data, blood sample examination and parasite egg counts in stools were objectively measured.

Several studies have documented a positive association between BMI and allergy. Luder *et al.* found a positive association between overweight and asthma in black and Hispanic children (18) and Huang *et al.* reported a positive association between girls in the highest BMI quintile and risk for asthma symptoms, atopy and rhinitis (19). In adults, Camargo *et al.* found an increased risk of asthma incidence at higher BMI levels in a 4-year longitudinal study (9). Another study reported that a baseline BMI greater than 30kg/m^2 was a significant predictor of asthma incidence in women

(20). In line with these studies stands the observation of improvements in allergy symptoms with dietary restriction and reduction of body weight (21, 22). In the present study we evaluated several categorical (weight-for-age, height-for-age, BMI-for-age) and continuous (weight, height, BMI) anthropometric values, but none of them were associated with allergy. In univariate analysis, the prevalence of allergy tended to be higher among children in the 10^{th} to 75^{th} percentile of weight-for-age and height-for-age compared to those in the <3^{rd} percentile group, but this tendency was not statistically significant. We found no association between anthropometric factors and allergy in the logistic regression model. A plausible explanation for our lack of association is that we had no obese or overweight children in our study population. Moreover, about half of our study sample was below the 3^{rd} percentile of BMI-for-age, and a wider range of BMI, especially at higher values, might be required to observe a statistically significant association between BMI and allergy. The poor diet of most children and the consequent low nutritional status, highly related to the immune system and impairment of cell-mediated responses, might have also played part in our results.

Similarly, no statistically significant differences were observed between allergic and non-allergic children in blood concentrations of IgE, total protein, albumin, total cholesterol, LDL cholesterol, HDL cholesterol and triacylglycerol. Interestingly, no association was observed between IgE and parasite infection in our population (p=0.230, data not shown). In the logistic regression model, unadjusted IgE level was significantly associated with allergy, but this association disappeared after adjusting for sex, age, and area of residence.

In developing tropical countries parasite infection is a major public health problem. More specifically, in some areas of Vietnam parasite infection may reach the total population (23). In our sample, *Hookworm* infection was relatively rare compare to other parasites. Prevalence of *Ascaris lumbricoides* infection was 52.9%, *Trichuris trichiura* infection was 87.4% and *Hookworm* infection was 4.2%.

The results of previous studies on allergy and parasite infection are contradictory, and our parasite data show that prevalence of allergy did not differ between infected and uninfected children. Intensity of infection of any of the three parasites did not change this interpretation. In the logistic regression model there was no evidence of association between allergy and parasite infection.

One possible explanation for the lack of agreement between studies examining the role of parasites in allergy could be that polyclonal stimulation of IgE synthesis is affected by the parasite intensity. At low levels of parasite infection there is enhanced allergic reactivity toward environmental allergens, while heavy parasite infections cause saturation of mast cell receptors and lower allergic responses against specific antigens (24). In our study, parasite infection was light to moderate in intensity, with only three cases of heavy ascariasis, and none of the heavily infected children had allergy. Moreover, in our study sample anti-parasitic treatment was routinely administered due to the high prevalence of parasite infection in the area, and this might have biased our results (25, 26).

Food and nutrient intakes were also evaluated in our study. Even though starchy root intake was significantly higher in children with allergies we found no association in the logistic regression model even after adjusting for sex, age, and area of residence. Riboflavin intake was significantly lower in the allergy group, and it was found to be associated with allergy in the logistic regression model before and after adjustment. Food sources of riboflavin include meat, dairy products and vegetables, and intake of these food groups did not differ between allergic and non-allergic children. Even though the intake of riboflavin was very low in all children, with none of them meeting their recommended intake, the mean intake was 18.9% of the Recommended Dietary Intake (RDA) in children with allergies and 23.3% of the RDA in non-allergic children (p=0.065). Due to concerns regarding milk allergy, milk intake may have been restricted for children with allergies, and this could be reflected in the riboflavin supply. However, milk consumption was rare in our study population and we doubt that concern about milk accounted for this association. Heinrich *et al.* reported previously a similar finding (27). In a multicenter study, they found a consistent association of riboflavin intake and allergy that was marginally significant (OR=0.72, p=0.077). Even though our findings suggest that riboflavin-deficient children might be more susceptible to allergy, further studies are needed to ascertain this association.

In summary, we could not detect a significant association between the prevalence of allergy in Vietnamese school children and their nutritional status, food intake and parasite infection. However, in a population with high undernutrition and parasite infection, the prevalence of allergy was low and the extremely low intake of riboflavin was associated with a higher risk of allergy. Future studies assessing relationships between nutritional factors, parasites, and allergy should have unambiguous definitions of allergy, adequate sample size, and should examine riboflavin intake in the expression of allergy.

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