

ORIGINAL

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

Dao To Quyen<sup>1</sup>, Amalia V. Irei<sup>2</sup>, Yuki Sato<sup>3</sup>, Fusao Ota<sup>3</sup>, Yasunori Fujimaki<sup>4</sup>, Tohru Sakai<sup>3</sup>, Daisuke Kunii<sup>3</sup>, Nguyen Cong Khan<sup>1</sup>, and Shigeru Yamamoto<sup>3\*</sup>

<sup>1</sup>Vietnam National Institute of Nutrition, Ha Noi, Viet Nam ; <sup>2</sup>Department of Food Science and Nutrition, Faculty of Human Life and Environment, Nara Women's University, Nara, Japan ; <sup>3</sup>Department of Nutrition, The University of Tokushima School of Medicine, Tokushima, Japan ; and <sup>4</sup>Department of Parasitology, Institute of Tropical Medicine, Nagasaki University, Nagasaki, Japan

**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 the 10<sup>th</sup> to 75<sup>th</sup> percentile compared to <3<sup>rd</sup> 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 symp-

toms, 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

Received for publication February 5, 2004 ; accepted May 30, 2004.

Address correspondence and reprint requests to Shigeru Yamamoto, Ph.D., Department of Internal Nutrition, Institute of Health Biosciences, The University of Tokushima Graduate School, Kuramoto-cho, Tokushima 770-8503, Japan Fax : +81-88-633-9427.

(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  $\pm$  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  $10.1 \pm 0.5$ ). 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<sup>th</sup> to 75<sup>th</sup> 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			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			0.103
No	183	8.2	
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, undadjusted and adjusted by sex, age and area of residence

	Unadjusted			Adjusted		
	OR	95.0% C.I.	<i>p</i> -value	OR	95.0% C.I.	<i>p</i> -value
<i>Anthropometry</i>						
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
<i>Food intake</i>						
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
<i>Nutrient intake</i>						
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
<i>Blood analysis</i>						
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
<i>Parasite infection</i>						
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<sup>2</sup> 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<sup>th</sup> to 75<sup>th</sup> percentile of weight-for-age and height-for-age compared to those in the <3<sup>rd</sup> 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<sup>rd</sup> 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 multi-center 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.

## ACKNOWLEDGMENTS

We acknowledge Ms Nguyen Thi Dang and Mrs. Nguyen Thi Mai in the National Institute of Malariology, Parasitology and Entomology, Hanoi, and Dr. Pham Thanh Yen and Mrs. Nguyen Lan Phuong in the National Institute of Nutrition, Hanoi, for their help in this study. Support for this study was provided by Grants-in-Aid (No 11691211) from the Ministry of Education, Science, Sports, Culture and Technology of Japan.

## REFERENCES

- Emanuel MB : Hay fever, a post industrial revolution epidemic : a history of its growth during the 19 th century. *Clin Allergy* 18 : 295-304, 1988.
- Robertson CF, Heycock E, Bishop J, Nolan T, Olinski A, Phelan P: Prevalence of asthma in Melbourne schoolchildren : changes over 26 years. *BMJ* 302 : 1116-8, 1991.
- Eva RW. Epidemiology of allergic disease in children. *Rhinology* 13 (Suppl) : 5 -12, 1992.
- Aberg N, Hesselmar B, Aberg B, Eriksson B : Increase of asthma, allergic rhinitis and eczema in Swedish schoolchildren. *Clin Exp Allergy* 25 : 815-9, 1995.
- Ministry of Health, Labor and Welfare, Statistics and Information Department : Daily Life and Allergy Symptoms Trends Analysis in Public Health. 1-18, 1992 (in Japanese).
- von Mutius E, Martinez FD, Fritzsche C, Nicolai T, Reitmeir P, Thiemann HH : Differences in the prevalence of asthma and atopic sensitization between East and West Germany. *Am J Respir Crit Care Med* 149 : 358-64, 1994.
- Carey OJ, Cookson JB, Britton J, Tattersfield AE : The effect of lifestyle on wheeze, atopy, and bronchial hyperreactivity in Asian and white children. *Am J Respir Crit Care Med* 154 (2 Pt 1) : 7-40, 1996.
- Weinberg EG : Urbanization and childhood asthma : An African perspective. *J Allergy Clin Immunol* 105 : 224-31, 2000.
- Camargo CA Jr, Weiss ST, Zhang S, Willett WC, Speizer FE : Prospective study of body mass index, weight change, and risk of adult-onset asthma in women. *Arch Intern Med* 159(21) : 2582-8, 1999
- Tullis D : Bronchial asthma with intestinal parasites. *New Engl J Med* 282 : 370, 1970.
- Nascimento Silva MT, Andrade J, Tavares-Neto J. Asthma and ascariasis in children aged two to ten living in a low income suburb. *J Pediatr (Rio J)* May-Jun ; 79(3) : 227-32, 2003.
- Dagoye D, Bekele Z, Woldemichael K, Nida H, Yimam M, Hall A, Venn AJ, Britton JR, Hubbard R, Lewis SA : Wheezing, allergy, and parasite infection in children in urban and rural Ethiopia. *Am J Respir Crit Care Med* 167(10):1369-73, 2003.
- Palmer LJ, Celedon JC, Weiss ST, Wang B, Fang Z, Xu X : *Ascaris lumbricoides* infection is associated with increased risk of childhood asthma and atopy in rural China. *Am J Respir Crit Care Med* 165 (11) : 1489-93, 2002.
- WHO : Expert Committee on Physical Status : the Use and Interpretation of anthropometry. Physical status : the use and interpretation of anthropometry : report of a WHO expert committee. World Health Organization, Geneva, 1995.
- NCHS, CDC Growth charts. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics. [http : //www.cdc.gov/nchs](http://www.cdc.gov/nchs)
- WHO : Basic Laboratory Methods in Medical Parasitology. World Health Organization, Geneva, 1991.
- WHO : Guidelines for the evaluation of soil-transmitted helminthiasis and schistosomiasis at community level. World Health Organization, Geneva, 1998.
- Luder E, Melnik TA, DiMaio M : Association of being overweight with greater asthma symptoms in inner city black and Hispanic children. *J Pediatr* 132(4) : 699-703, 1998.
- Huang SL, Shiao G, Chou P : Association between body mass index and allergy in teenage girls in Taiwan. *Clin Exp Allergy* 29 : 323-329, 1999.
- Chen Y, Dales R, Tang M, Krewski D : Obesity may increase the incidence of asthma in women but not in men : longitudinal observations from the Canadian National Population Health Surveys. *Am J Epidemiol* 155(3) : 191-7, 2002.
- Fan WY, Kouda K, Nakamura H, Takeuchi H : Effect of dietary restriction on spontaneous dermatitis in NC/Nga mice. *Exp Biol Med* 226(11): 1045-1050, 2001.
- Nakamura H, Shimoji K, Kouda K, Tokunaga R, Takeuchi H. An adult with atopic dermatitis and repeated short-term fasting. *J Physiol Anthropol Appl Human Sci* 22(5) : 237-40, 2003.
- Needham C, Kim HT, Hoa NV, Cong LD, Michael

- E, Drake L, Hall A, Bundy DA : Epidemiology of soil-transmitted nematode infections in Ha Nam Province, Vietnam; Trop Med Int Health 3 (11) : 904-12, 1998.
24. Lynch NR, Hagel IA, Palenque ME, Di Prisco MC, Escudero JE, Corao LA, Sandia JA, Ferreira LJ, Botto C, Perez M, Le Souef PN : Relationship between helminthic infection and IgE response in atopic and nonatopic children in a tropical environment. J Allergy Clin Immunol 101(2 Pt 1) : 217-21, 1998.
25. Lynch NR, Hagel I, Perez M, Di Prisco MC, Lopez R, Alvarez N. Effect of anthelmintic treatment on the allergic reactivity of children in a tropical slum. J Allergy Clin Immunol. Sep ; 92(3) : 404-11, 1993.
26. Lynch NR, Palenque M, Hagel I, DiPrisco MC. Clinical improvement of asthma after anthelmintic treatment in a tropical situation. Am J Respir Crit Care Med. Jul ; 156(1) : 50-4, 1997.
27. Heinrich J, Holscher B, Bolte G, Winkler G. Allergic sensitization and diet : ecological analysis in selected European cities. Eur Respir J. Mar ; 17 (3) : 395-402, 2001.