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Allergen sensitisation among chronic respiratory diseases in urban and rural areas of the South of Viet Nam

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SUMMARY

OBJECTIVE: To evaluate the prevalence of and risk factors for allergen sensitisation among patients with chronic respiratory disease (CRD) in southern Viet Nam.

DESIGN: An environmental questionnaire and skin prick tests for airborne and food allergens were administered to patients with CRD, defined as individuals with respiratory symptoms and lung function defects.

RESULTS: Of 610 CRD patients, 56% had chronic obstructive pulmonary disease and 31% were asthma patients; 80% were males. The most frequent sensitisers were dust mites (*Dermatophagoides farinae* 22%, *Blomia tropicalis* 19%, *Dermatophagoides pteronyssinus* 18%) and cockroach droppings (13%). Among study participants, 37% were from rural settings and 36% from urban areas, whereas 27% had migrated from rural to urban areas. Compared with people from rural areas, being born in urban areas was a risk factor for sensitisation to mites (OR 1.56, 95%CI 1.11–2.20, $P < 0.02$). In multivariate analysis, place of birth remained a risk factor for mite sensitisation. Compared with the native urban population, the risk of mite sensitisation was not significantly different among patients born in rural areas and those migrating to urban areas.

CONCLUSION: Dust mites and cockroach droppings were the most frequent allergens among people with CRD in the south of Viet Nam. Compared with the urban population, being native of rural areas was protective against mite sensitisation, but this effect ceased to be significant after migration from rural to urban areas.

KEY WORDS: allergies; chronic obstructive pulmonary disease; asthma; native rural; migration

MORE THAN 90% of cases of mortality and total disability due to chronic respiratory diseases (CRDs) have been observed in low- and middle-income countries.[1] CRDs include asthma and rhinitis, chronic obstructive pulmonary disease (COPD), occupational lung disease, sleep-related respiratory disorders, pulmonary hypertension, bronchiectasis and interstitial lung diseases. The major risks for CRD are tobacco smoke, indoor and outdoor pollution, occupational factors, pulmonary tuberculosis (TB) sequelae and allergen sensitisation.[2,3]

In southern Viet Nam, available data on the prevalence and risk factors for patients with CRD are few.[4] Since 2001, Viet Nam has benefited from a yearly economic growth of >7% that has promoted the development of a western lifestyle, combined with rapid domestic migration of rural populations toward urban areas. Among Vietnamese people living in rural areas, use of solid fuels for cooking or heating has been associated with severe respiratory infections and defects in maturation of lung tissue among children.[5,6] Besides exposure to biomass fumes, rural populations are frequently exposed to parasitic infection by helminths (hookworms and ascarids), and exposed to airborne endotoxins, both of which confer protection against allergen sensitisation.[7,8]

We investigated the prevalence of and risk factors for sensitisation to allergens among patients with CRD, and their relationship with living in rural or urban areas, and being native of urban areas or migrants in southern Viet Nam.

METHODS

General design and population selection

Approximately 1000 out-patients with respiratory symptoms were seen every day from 2014 to 2015 at Pham Ngoc Thach Hospital, the referral centre for respiratory diseases in Ho Chi Minh City for the study period.[9] Based on sputum analyses, chest X-ray and a screening questionnaire (mainly for cough, phlegm, chest tightness and dyspnoea for $\geqslant 3$

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months), about 700 patients were excluded from the study due to active TB, cancer or acute infectious diseases; the remaining 300 patients underwent lung function testing (LFT). Patients with significant lung defects ($n = 120$) were invited to participate in the study by random sampling (1/10) and after providing written informed consent; 5–6 patients were included daily, to give a total of 610 patients.

A standardised questionnaire and skin prick tests (SPTs) were administered after stopping bronchodilators for >24 h and anti-histamines for 5 days. Study participants were categorised in five age groups (20–43, 44–53, 53–59, 60–64 and 65–90 years) and an identical number of patients were recruited for each group.

The study protocol was approved by the Ethics Committee of Pham Ngoc Thach Hospital, Ho Chi Minh City, Viet Nam (CS/PT/13/12), and was enrolled in the ClinicalTrials.gov database (NCT02517983).

Questionnaire

The questionnaire (Appendix) was adapted for the Vietnamese population from validated questionnaires for the evaluation of patients with CRD and indoor air pollution (European Community Respiratory Health Survey-1 [ECRHS1] and ECRHS 2).*[10,11] The questionnaire contained questions on demographic information, medical history, smoking habits, occupational history, type of dwelling and details about exposure to indoor pollution. Each patient was asked to identify his/her type of accommodation used from options provided in images (Appendix Figure A).

Pulmonary function test

Lung function parameters were measured using a Master Screen PFT (Carefusion Ltd, Höchberg, Germany) according to recommendations by the American Thoracic Society/European Respiratory Society (ERS).[12] A post-bronchodilator (400 μg inhaled salbutamol) increase of >200 ml and/or <12% in forced expiratory volume in 1 s (FEV_1) compared with baseline values was deemed significant. Values for East Asian populations were used as predicted values.[13] Lung diffusing capacity for carbon monoxide (DL_{CO}) results were obtained using the gas dilution method. Measurements were taken by the same technician, who was trained according to ERS guidelines.[14]

COPD was defined as a post-bronchodilator FEV_1/FVC (forced vital capacity) ratio of <0.7 and a FEV_1 increase of <200 ml and/or <12% compared with basal values (Global Initiative for Chronic Obstructive Lung Disease guidelines). An asthma patient was defined as a patient with basal $FEV_1/FVC \leqslant 0.75$ and a post-bronchodilator FEV_1 increase of >200 ml and >12% compared with baseline values (Global Initiative for Asthma guidelines). Restrictive lung disease was defined as a baseline FEV_1/FVC ratio of >0.75 and vital capacity and/or FVC of <80% of the predicted value. The fourth group, 'other CRDs', comprised patients with 0.70 <pre-FEV_1/FVC <0.75 and/or decreased DL_{CO} <80% of the predicted value.

Skin prick tests

SPTs were performed according to European Academy of Allergy and Clinical Immunology guidelines using allergen extracts to prick the Stallerpoint® (Stallergenes Laboratories, Antony, France) on the back followed by pricking the skin ('prick-to-prick' method).

Fourteen commercial airborne allergens (*Dermatophagoides pteronyssinus* [DPT], *Dermatophagoides farinae* [DPF], *Blomia tropicalis*, *Glycyphagus domesticus*, cockroach droppings, cat dander, dog dander, latex, pine, birch, orchard grass, *Alternaria alternata*, *Cladosporium* mix, *Aspergillus* mix) and three food allergen (peanut, hazelnut, soya) extracts were provided by Stallergenes Laboratories. Ten native food allergens (beef, pork, albumen, egg yolk, shrimp, mackerel, crab, oyster, lobster, rice) were obtained from a local supermarket and maintained at –20°C. All tests included positive (histamine) and negative controls.

A positive SPT was defined as a wheal diameter of $\geqslant$4 mm compared with the negative control recorded after 15 min.[16] Allergen sensitisation was defined as a positive SPT reaction to $\geqslant$1 allergen. Airborne allergy was a positive SPT reaction to $\geqslant$1 airborne allergen. Mite allergy was a positive SPT to DPT and/or DPF and/or *Blomia*. Food allergy was a positive SPT reaction to $\geqslant$1 food allergen.

Statistical analyses

Mean values are presented with ±95% confidence intervals (CIs). We used logistic regression analysis to identify predictors of allergen sensitisation among patients with CRD. A multivariate model was used to evaluate confounders (i.e., significant parameters from the bivariate analysis). The χ^2 test was used to test differences in risk factors among the clinical groups. For ordinal variables, trend χ^2 was applied. All statistic analyses were performed using SPSS v23.0 (IBM, Armonk, NY, USA). $P < 0.05$ was considered significant.

RESULTS

Population characteristics

Of the 610 patients, 80.2% were males, 64.3% were born (37.2% were still living) in rural areas, 59.7%

* The appendix is available in the online version of this article, at http://www.ingentaconnect.com/content/iuatld/ijtld/2018/00000022/00000002/art000 .....

Table 1 Prevalence of COPD and other diseases among patients with CRD

Disease	*n* (%)
Asthma	186 (30.5)
No allergenic sensitisation	57 (30.6)
Female	6 (10.5)
Male	51 (89.5)
Allergenic sensitisation	129 (69.4)
Female	30 (23.3)
Male	99 (76.7)
COPD	340 (55.7)
Non-smoker	70 (20.6)
Female	51 (72.9)
Male	19 (27.1)
Smoker	270 (79.4)
Female	4 (1.5)
Male	266 (98.5)
Other	84 (13.8)

COPD = chronic obstructive pulmonary disease; CRD = chronic respiratory disease.

were active workers, 22.6% had a history of TB and 18.9% had been treated with an anthelmintic agent in the previous year; the mean age (±SD) was 54.3 years (±13.1); 27.4% were never smokers, 41.9% were ex-smokers and 30.7% were current smokers; 60.2% had >10 pack-years of cumulative smoking. Respectively 45.9%, 55.1% and 71.8% had pets, rats or cockroaches at home; 21.0% were exposed to fumes from wood cooking and 82.3% to burning incense at home.

Prevalence of chronic respiratory disease and lung function

Of the study population, 55.7% had COPD, 30.5% were asthma patients, 3.6% had restrictive disease and 10.2% had other CRDs. The last two groups were combined as 'other' (13.8%). Among COPD patients, 79.4% were smokers and 20.6% non-smokers (mainly female). Among asthma patients, 69.4% were sensitised to allergens (Table 1).

Compared with non-smokers, heavy smokers (i.e., ⩾10 pack-years) had more severe lung function defects: post-bronchodilator FEV_1/FVC (65.1%, 95%CI 63.9–66.7 vs. 57.1%, 95%CI 55.9–58.2; $P < 0.0001$) and FEV_1 (65.8% of predicted value, 95%CI 63.5–68.2 vs. 55.9, 95%CI 54.0–57.8; $P < 0.0001$) and total diffusion (90.4% of predicted value, 95%CI 88.0–92.8 vs. 74.3, 95%CI 72.1–76.5; $P < 0.0001$).

Prevalence of allergen sensitisation

Sensitisation to at least one allergen was observed in 80.7% of patients: 59.2% were sensitised to airborne allergens, 35.6% to mites and 31.1% to food allergens. The Figure shows the prevalence of positive SPT for each allergen and the mean wheal diameter of the skin reaction in sensitised patients.

Patients were more frequently sensitised to indoor than to outdoor allergens. DPF (22%), *B. tropicalis* (18.7%), DPT (17.9%) and cockroach droppings (12.6%) were the most frequent allergens. Food sensitisation (mainly soya, hazelnut and peanut) was less prevalent.

Risk factors for allergen sensitisation on bivariate analysis

All patient characteristics were analysed as risks factors for sensitisation to mites, and airborne or food allergens using bivariate logistic regression analysis.

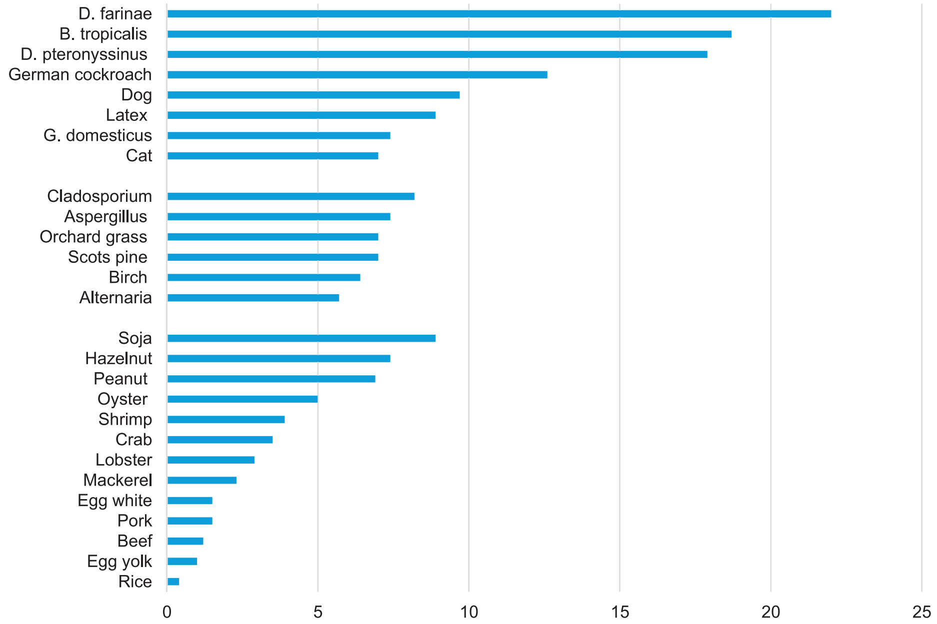

Figure The prevalence of positive skin prick test and mean diameter in mm (±95%CI) of the
?1 wheal reaction among patients with chronic respiratory diseases. CI = confidence interval.

Table 2 Demographic and socio-economic characteristics of the study patients

	n (%)	HDM+ *n* (%)	OR (95%CI)	*P* value	Airborne allergen+ *n* (%)	OR (95%CI)	*P* value	*n* (%)	Food allergen+ *n* (%)	OR (95%CI)	*P* value
Total	610							519			
Sex											
Female	121 (19.8)	52 (43.0)	1	NS	79 (65.3)	1	NS	95 (18.3)	43 (45.3)	1*	0.001*
Male	489 (80.2)	165 (33.7)	0.68 (0.45–1.01)		282 (57.7)	0.74 (0.48–1.09)		424 (81.7)	118 (27.8)	0.47 (0.30–0.74)	
Age, years											
20–43	128 (21.0)	74 (57.8)	1*	0.000* *P* trend	96 (75.0)	1*	0.001* *P* trend	104 (20.0)	44 (42.3)	1*	0.001* *P* trend
44–52	125 (20.5)	46 (36.8)	0.42 (0.26–0.70)*		79 (63.2)	0.57 (0.33–0.98)*		97 (18.7)	33 (34.0)	0.70 (0.40–1.25)	
53–59	127 (20.8)	39 (30.7)	0.32 (0.19–0.54)*		77 (60.6)	0.51 (0.30–0.88)*		107 (20.6)	30 (28.0)	0.53 (0.30–0.94)*	
60–64	97 (15.9)	30 (30.9)	0.33 (0.19–0.57)*		48 (49.5)	0.33 (0.19–0.57)*		78 (15.0)	29 (37.2)	0.81 (0.44–1.47)	
65–90	133 (21.8)	28 (21.1)	0.19 (0.11–0.34)*		61 (45.9)	0.28 (0.17–0.48)*		133 (25.6)	25 (18.8)	0.32 (0.18–0.57)*	
Place of birth, place of residence											
Rural, rural	227 (37.2)	64 (28.2)	1*	0.002* *P* trend	139 (61.2)	1	NS	227 (43.7)	66 (29.1)	1	NS
Rural, urban	165 (27.0)	61 (37.0)	1.49 (0.97–2.29)		93 (56.4)	0.82 (0.54–1.23)		129 (24.9)	44 (34.1)	1.26 (0.79–2.01)	
Urban, urban	218 (35.8)	92 (42.2)	1.86 (1.25–2.76)*		129 (59.2)	0.92 (0.63–1.34)		163 (31.4)	51 (31.3)	1.11 (0.72–1.72)	
Place of birth											
Rural	392 (64.3)	125 (31.9)	1	0.011*	248 (63.3)	1*	0.006*	352 (67.82)	109 (31.0)	1	NS
Urban	218 (35.7)	92 (42.2)	1.56 (1.11–2.20)		113 (51.8)	0.63 (0.45–0.87)		167 (32.18)	52 (31.1)	1.01 (0.67–1.50)	
Active profession											
No	246 (40.3)	67 (27.2)	1	0.000*	121 (49.2)	1*	0.001*	213 (41.0)	65 (30.5)	1	NS
Yes	364 (59.7)	150 (41.2)	1.87 (1.32–2.66)		240 (65.9)	2.00 (1.44–2.78)		306 (59.0)	96 (31.4)	1.04 (0.71–1.52)	
Farmer											
No	433 (71.0)	166 (38.3)	1*	0.026*	252 (58.2)	1	NS	353 (68.0)	113 (32.0)	1	NS
Yes	177 (29.0)	51 (28.8)	0.65 (0.45–0.95)		109 (61.6)	1.15 (0.81–1.65)		166 (32.0)	48 (28.9)	0.86 (0.58–1.29)	
Level of education											
Primary	163 (26.7)	43 (26.4)	1*	0.000* *P* trend	78 (47.9)	1*	0.007* *P* trend	144 (27.7)	34 (23.6)	1*	0.010* *P* trend
Secondary	174 (28.5)	65 (37.4)	1.66 (1.05–2.65)*		110 (63.2)	1.87 (1.21–2.89)*		154 (29.7)	45 (29.2)	1.34 (0.80–2.24)	
High school	151 (24.8)	47 (31.1)	1.26 (0.77–2.06)		95 (62.9)	1.85 (1.18–2.90)*		127 (24.5)	48 (37.8)	1.97 (1.16–3.33)*	
Post-secondary	122 (20.0)	62 (50.8)	2.88 (1.75–4.74)*		78 (63.9)	1.93 (1.19–3.12)*		94 (18.1)	34 (36.2)	1.83 (1.04–3.24)*	

* Significance at 5% level.
HDM = house dust mite; OR = odds ratio; CI = confidence interval; NS = not significant.

Table 3 Medical history, clinical diagnosis and smoking habits of study patients

	n (%)	HDM+ *n* (%)	OR (95%CI)	*P* value	Airborne allergen+ *n* (%)	OR (95%CI)	*P* value	*n* (%)	Food allergen+ *n* (%)	OR (95%CI)	*P* value
Total	610							519			
History of tuberculosis											
No	472 (77.4)	179 (37.9)	1*	0.025*	290 (61.4)	1*	0.036*	404 (77.8)	127 (31.4)	1	NS
Yes	138 (22.6)	38 (27.5)	0.62 (0.41–0.94)		71 (51.4)	0.67 (0.45–0.97)		115 (22.2)	34 (29.6)	0.92 (0.58–1.44)	
Previous use of antihelminthic agents											
No	495 (81.1)	171 (34.5)	1	NS	290 (58.6)	1	NS	426 (82.1)	128 (30.0)	1	NS
Yes	115 (18.9)	46 (40.0)	1.26 (0.83–1.92)		71 (61.7)	1.14 (0.75–1.73)		93 (17.9)	33 (35.5)	1.28 (0.80–2.05)	
Clinical diagnosis											
COPD	340 (55.7)	91 (26.8)	1*	0.000*	169 (49.7)	1*	0.000*	283 (54.5)	74 (26.1)	1*	0.030*
Asthma	186 (30.5)	87 (46.8)	2.40 (1.65–3.50)*		129 (69.4)	2.29 (1.57–3.34)*		165 (31.8)	62 (37.6)	1.70 (1.23–2.57)*	
Other	84 (13.8)	39 (46.4)	2.37 (1.45–3.88)*		63 (75.0)	3.04 (1.77–5.19)*		71 (13.7)	25 (35.2)	1.54 (0.88–2.67)	
Pack-year ⩾10											
No	243 (39.8)	121 (49.8)	1*	0.000*	168 (69.1)	1*	0.001*	202 (38.9)	84 (41.6)	1*	0.001*
Yes	367 (60.2)	96 (26.2)	0.36 (0.25–0.50)		193 (52.6)	0.50 (0.35–0.70)		317 (61.1)	77 (24.3)	0.45 (0.31–0.66)	
Smoking status											
Never-smoker	167 (27.4)	76 (45.5)	1*	0.006*	112 (67.1)	1	NS	135 (26.0)	63 (46.7)	1*	0.000*
Ex-smoker	232 (38.0)	78 (30.5)	0.52 (0.35–0.79)*		131 (56.5)	0.64 (0.42–0.96)		207 (39.9)	59 (25.1)	0.38 (0.24–0.61)*	
Current smoker	211 (34.6)	63 (33.7)	0.61 (0.40–0.94)*		118 (55.9)	0.62 (0.41–0.95)		177 (34.1)	46 (26.0)	0.40 (0.25–0.65)*	

* Significance at the 5% level.
HDM = house dust mite; OR = odds ratio; CI = confidence interval; NS = not significant.

Detailed data are given in Table 2 (demographic and socio-economic factors), Table 3 (medical history, clinical factors and smoking habits) and Table 4 (type of accommodation).

Women had a higher risk of food allergy. Age was negatively correlated with the risk of sensitisation for each group of allergen. To be born and to live in a rural area were protective factors against mite sensitisation, compared with patients native to or living in urban areas. This protective effect ceased to be significant in patients born in rural areas who migrated to urban areas. An active occupation and high level of education were associated with greater sensitisation, whereas being a farmer was protective against mite sensitisation (Table 2).

A history of TB was protective against sensitisations but previous treatment with anthelmintic agents was not (Table 3). Compared with COPD, asthma patients were more frequently sensitised to mites (26.8% vs. 46.8%) and to at least one airborne allergen (49.7% vs. 69.4%). The prevalence of allergen sensitisation was significantly lower among patients with $\geqslant 10$ packs-years of cumulative smoking and compared to smokers, never-smokers were more frequently sensitised to mites or food (Table 3).

Living in rented accommodation or in households with a shared kitchen was a risk factor for food sensitisation. Cooking with wood, burning incense and exposure to pets were protective against mite sensitisation (Table 4). As wood cooking and rural living were possible confounding factors, we evaluated patients from rural areas ($n = 271$) and found a significant negative association between mite sensitisation and exposure to wood fumes (34/124 exposed patients compared with 59/147 patients naïve to wood cooking, χ^2 $P = 0.027$).

Risks factors for allergen sensitisation on multivariate analysis

We developed a multivariate model for sex, age and diagnosis, which was applied to each parameter significant on bivariate analysis (Table 5). The risk of mite sensitisation was significantly higher among younger individuals native to and/or living in urban areas with a high level of education and low cumulative prevalence of smoking. The risk of airborne allergen sensitisation was higher among younger individuals with an active profession and low cumulative prevalence of smoking. The risk of food sensitisation was higher among females, younger people and non-smokers.

DISCUSSION

The most frequent allergen sensitisers among CRD patients in southern Viet Nam were mites and cockroach droppings. Rural living was a protective factor, but was no longer effective in the case of migration to urban areas. The risk of allergen sensitisation was negatively related to age. A high level of education and active occupations (with the exception of farming) were risk factors for sensitisation, while exposure to pets and wood cooking were protective. Smokers were less frequently sensitised but had more severe obstructive disease.

Although the prevalence of atopy among CRD patients cannot be extrapolated to healthy subjects, and there was a disequilibrium in the sex distribution, our data are consistent with results for the general population from northern Viet Nam (*B. tropicalis* 23%, DPT 13%, and cockroach droppings 13%).[17]

Nearly 50% of asthma patients in our study were sensitised to mites and 70% were sensitised to at least one airborne allergen. This observation is in line with findings from a study conducted in four regions of China which reported that >50% of asthma patients were sensitised to aeroallergens, such as mites and that sensitisation was negatively related to age.[18] Sensitisation to mites was the main risk factor for the increased prevalence of wheeze from 2002 to 2010 among schoolchildren in Guangzhou City, China.[19]

Compared with outdoor sensitisers, the prevalence of indoor and food sensitisers was higher. One explanation could be poor ventilation in the home (such as in the 'tube houses', the apartment buildings in Viet Nam's large cities) leading to the accumulation of pollutants and allergens. Moreover, the selection of outdoor allergens common in Western countries may have led to an underestimation of the prevalence of pollen or mould sensitisation. Food sensitisation was uncommon and mainly due to vegetables (soya, hazelnut, peanut). Of note, few people were sensitised to shellfish despite high consumption. Early introduction to the diet, which is associated with the protective effect conferred by parasitosis, may have been protective against this type of sensitisation.[20] Our data are consistent with findings from rural Chinese populations reported to be sensitised to mites (30.6%) and cockroach droppings (25.2%), but less frequently to shellfish (16.7%) or peanuts (12.3%).[21] In Indonesia, sensitisation to house dust mites and cockroach droppings is less common in rural areas than in semi-urban areas (13.5 and 23.8%, respectively), and this protective effect is associated with more hookworm infection.[22]

More than 80% of the CRD patients affected were males; among these, 340 (56%) had COPD, including 270 smokers and 70 non-smokers. More than 99% of smokers with COPD were males. However, >90% of females with COPD were non-smokers, as yet reported in low-income countries, where exposure to fumes from biomass fuels and at the workplace remains common.[23] Also, genetic susceptibility in females may have reinforced lung injury.[24]

We observed a negative relationship between the prevalence of sensitisation and age. In a review by

Table 4 Type of accommodation of study patients

	n (%)	HDM+ *n* (%)	OR (95%CI)	*P* value	Airborne allergen+ *n* (%)	OR (95%CI)	*P* value	*n* (%)	Food allergen+ *n* (%)	OR (95%CI)	*P* value
Total	610							519			
Type of house											
Rural	271 (44.4)	86 (31.7)	1	NS	163 (60.1)	1	NS	260 (50.1)	77 (29.6)	1	0.022*
Tube (high-rise building)	258 (42.3)	94 (36.4)	1.23 (0.86–1.77)		147 (57.0)	0.88 (0.62–1.24)		196 (37.8)	55 (28.1)	0.93 (0.62–1.40)	
Rented	81 (13.3)	37 (45.7)	1.81 (1.09–3.00)		51 (63.0)	1.13 (0.67–1.88)		63 (12.1)	29 (46.0)	2.03 (1.16–3.56)*	
Site of kitchen											
Outside the house	180 (29.5)	58 (32.2)	1	NS	107 (59.4)	1	NS	174 (33.5)	51 (29.3)	1	NS
Inside the house	430 (70.5)	159 (37.0)	1.23 (0.85–1.79)		254 (59.1)	0.99 (0.69–1.40)		345 (66.5)	110 (31.9)	1.13 (0.76–1.68)	
Separate room	384 (89.3)	137 (35.7)	1	NS	225 (58.6)	1	NS	313 (90.7)	93 (29.7)	1*	0.007*
Shared room	46 (10.7)	22 (47.8)	1.65 (0.89–3.06)		29 (63.0)	1.21 (0.64–2.27)		32 (9.3)	17 (53.1)	2.68 (1.29–5.59)	
Incense burning at home											
No	108 (17.7)	48 (44.4)	1*	0.034*	69 (63.9)	1	NS	87 (16.8)	33 (37.9)	1	NS
Yes	502 (82.3)	169 (33.7)	0.63 (0.42–0.97)		292 (58.2)	0.79 (0.51–1.21)		432 (83.2)	128 (29.6)	0.69 (0.43–1.11)	
Cooking with wood fuel											
No	482 (79.0)	183 (38.0)	1*	0.017*	289 (60.0)	1	NS	393 (75.7)	119 (30.3)	1	NS
Yes	128 (21.0)	34 (26.6)	0.59 (0.38–0.91)		72 (56.3)	0.86 (0.58–1.27)		126 (24.3)	42 (33.3)	1.15 (0.75–1.77)	
Pet at home											
No	330 (54.1)	131 (39.7)	1*	0.021*	194 (58.8)	1	NS	275 (53.4)	80 (29.1)	1	NS
Yes	280 (45.9)	86 (30.7)	0.67 (0.48–0.94)		167 (59.6)	1.04 (0.75–1.43)		244 (46.6)	81 (33.2)	1.21 (0.84–1.76)	
Dog at home											
No	370 (60.7)	145 (39.2)	1*	0.021*	219 (59.2)	1	NS	303 (58.4)	90 (29.7)	1	NS
Yes	240 (39.3)	72 (30.0)	0.67 (0.47–0.94)		142 (59.2)	0.99 (0.72–1.39)		216 (41.6)	71 (32.9)	1.16 (0.80–1.69)	

* Significance at the 5% level.
HDM = house dust mite; OR = odds ratio; CI = confidence interval; NS = not significant.

Table 5 Adjusted multivariate analysis for sex, age and diagnosis of each factor found to be significant on bivariate analysis. Only significant adjusted factors are shown below.

	Adjusted OR (95%CI)	*P* value
Multivariate model for dust mite sensitivity		
Age, years		
20–43	1	0.000*
44–52	0.48 (0.29–0.80)*	
53–59	0.40 (0.24–0.69)*	
60–64	0.42 (0.24–0.76)*	
65–90	0.27 (0.15–0.48)*	
Diagnosis		
COPD	1	0.018*
Asthma	1.73 (1.15–2.60)*	
Other	1.68 (0.99–2.84)	
Place of birth, place of residence		
Rural, rural	1	0.013*
Rural, urban	1.33 (0.84–2.10)	
Urban, urban	1.88 (1.23–2.86)*	
Place of birth		
Rural	1	0.007*
Urban	1.65 (1.15–2.39)	
Level of education		
Primary	1	0.03*
Secondary	1.32 (0.81–2.16)	
High school	1.03 (0.61–1.71)	
Post-secondary	2.04 (1.20–3.49)*	
Pack-years $\geqslant$10		
No	1	0.000*
Yes	0.40 (0.25–0.64)	
Multivariate model for airborne sensitivity		
Age, years		
20–43	1	0.017*
44–52	0.67 (0.38–1.16)	
53–59	0.67 (0.38–1.18)	
60–64	0.44 (0.25–0.80)*	
65–90	0.41 (0.23–0.72)*	
Active profession		
No	1	0.033*
Yes	1.53 (1.03–2.26)	
Diagnosis		
COPD	1	0.001*
Asthma	1.81 (1.21–2.73)*	
Other	2.37 (1.6–4.15)*	
Pack-years $\geqslant$10		
No	1	0.035*
Yes	0.60 (0.37–0.96)	
Multivariate model for food sensitivity		
Sex		
Female	1	0.011*
Male	0.54 (0.34–0.87)	
Age, years		
20–43	1	0.036*
44–52	0.78 (0.43–1.39)	
53–59	0.62 (0.34–1.12)	
60–64	0.95 (0.49–1.79	
65–90	0.41 (0.22–0.77)*	
Smoking status		
Never smoker	1	0.05*
Ex-smoker	0.53 (0.26–1.08)	
Current smoker	0.41 (0.20–0.84) *	

* Significance at the 5% level.
OR = odds ratio; CI = confidence interval; COPD = chronic obstructive pulmonary disease.

Scichilone et al.[25] of 13 (among 15) cross-sectional studies, the authors also reported a reduction in allergen sensitisation with age in healthy controls and asthma patients.[17] A recent large longitudinal Swedish study reported a reduction in atopy due to both the rare incidence and frequent remission of allergen sensitisation with age.[26]

Younger age and urban living were also risk factors for sensitisation in a longitudinal study carried out in Sweden.[27] A longitudinal cohort of European adults showed a decrease in sensitisation to mites and cat dander related to age, in particular among those aged >40 years.[28] According to the US National Health and Nutrition Examination Survey 2005–2006, sensitisation to one or more allergens (44%) was also associated with younger age.[29] This phenomenon may be due to immunosenescence, as B and T cell functions are affected by ageing.[30] In our population, age-related risk of sensitisation may also reflect the change in lifestyle that occurred in the last 50 years in Viet Nam. Birth and residence in rural areas were protective against sensitisation to mites and airborne allergens. Conversely, rapid migration of rural populations to urban areas could be a risk factor for allergen sensitisation among the youngest. This finding is in line with another study which reported that >80% of the Chinese inhabitants and migrants from non-tropical countries in Singapore were sensitised to mites and developed intense sensitivity to mites.[31]

As expected, heavy smoking was associated with more severe lung obstruction but with less allergen sensitisation, regardless of age, diagnosis (COPD/asthma) or sex. This observation is in accordance with a study conducted by Hancox and colleagues in a cohort of 1037 individuals born in New Zealand, which reported that parental smoking during childhood and cigarette smoking in teenage and early adult life were associated with a lower risk of allergen sensitisation in those with a family history of atopy.[32] Among schoolchildren in central Viet Nam, smoking in the household was associated with less sensitisation to mites or cockroach droppings.[33] In a US study, serum cotinine levels were negatively associated with the risk of the release of secretory immunoglobulin E among healthy children/adults[30] and adults only.[34]

Exposure to fumes at home could be a protective factor among rural populations. This surprising effect is nevertheless consistent with the 'hygiene hypothesis', as higher airborne endotoxin concentrations have been reported in households that use biomass fuel,[35] and endotoxins are protective against sensitisation.[8] We hypothesised that, due to migration to the city, urban patients had less contact with animals, a lower risk of parasitosis and less exposure to wood-based cooking. Due to the cross-sectional design of our study, causality in case of significant associations cannot be established. However, we feel that the migrating population can be considered as time-related controls, when comparing sedentary and migrating rural populations.

In conclusion, mites and cockroach droppings were the most frequent sensitisers among CRD patients in southern Viet Nam. Compared with urban populations, native rural populations were less frequently sensitised. Migration from rural to urban areas suppressed this protective effect.

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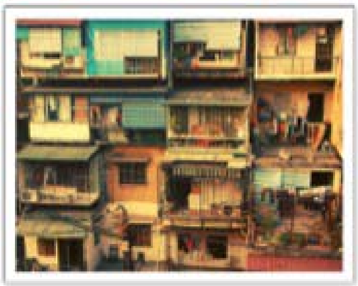
APPENDIX



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PATIENT QUESTIONNAIRE

I. *Socio-economic status/demographics*

1.1. Sex

1. Male ❐ 2. Female ❐

1.2. Age (years): ____________________

1.3. Profession (more than one answer accepted). For each answer, please indicate the longest period you worked in this profession (in years)

1. Not professionally active/housewife ❐
2. Farmer ❐
   Livestock Yes ❐ No ❐
   Details: ____________________

3. Employed (please specify): Yes ❐ No ❐
   If yes → details → years) :
   ____
   ____

4. Factory worker:
   - Coal, hard rock miner ❐
   - Cotton factory ❐
   - Brick factory ❐
   - Construction ❐
   - Iron, steel factory ❐
   - Rubber factory ❐
   - Plastic factory ❐
   - Wood factory, furniture, carpentry ❐
   - Automobile repair ❐
   - Chemical factory ❐
5. Driver
   - Truck ❐
   - Bus ❐
   - Taxi ❐
   - Motorbike ❐
6. Beauty care (hairdresser, nail salon) ❐
7. Other (→ details → years): ____________________

1.4. Education: What is the highest degree you have?

1. None ❐
2. Primary school ❐
3. Secondary school (first degree) ❐
4. High school (second degree) ❐
5. Post-secondary education ❐

1.5. Geographical origin: Place of birth
A. Rural
1. Do you still live there? Yes ❒ No ❒
2. Do you live in a city at present?
Yes, moved to this city in (year): ____________________
B. City: Still live in a city Yes ❒ No ❒

II. *Smoking habits*
Do you currently smoke? (yes = ⩾1 cigarette/day) Yes ❒ No ❒
a. If no, did you ever smoke? Yes ❒ No ❒
(If no, jump to next Section III)
b. If yes, on average for how long (total number of)? Years _______
If <1 year, months: ________
c. If yes, on average, how many cigarettes/day? __________________
d. If yes, when did you stop? Years: _______ If less <1, months: ________

III. *Type of dwelling and indoor pollution*
3.1. Since when have you lived in this house/apartment?
(years; if <1 year, note 0):____
3.2. Not pertinent, was born in this place ❒

If you have lived in this house/apartment <1 year, please refer to the previous house/apartment:
3.3. What type of accommodation do you live in?
a. Villa: detached ___ semi-detached ___ in a terrace ___
b. Apartment/studio: What floor? __
3.4. Humidity
1. During the last 6 months have you noticed any stains or leaks or felt that the walls were wet? Yes ❒ No ❒
2. Has your house been flooded during the last 6 months due to heavy rain? Yes ❒ No ❒

3.5. Cooking habits:

Fuel sources:	Lighting	Cooking	Cooling	Heating water
Electricity				
Gas				
Kerosene				
Wood				
Straw				
Rice husk (chaff)				
Oil				
Coal				
Charcoal				
Animal dung				
Other: ________				
No				

3.6. Kitchen type

1. What type of cooking stove do you use at home?
   - Open fire/stove without chimney/hood — Yes ❒ No ❒
   - Open fire/stove with chimney/hood — Yes ❒ No ❒
   - Closed stove with chimney — Yes ❒ No ❒

2. Where is the cooking usually done (main cooking fuel)?
   - In a room used for living/sleeping — Yes ❒ No ❒
   - In a separate room used as a kitchen — Yes ❒ No ❒
   - In a separate building used as a kitchen — Yes ❒ No ❒
   - Outdoors — Yes ❒ No ❒

3. Is there an air extractor in your house? Yes ❒ No ❒
   If yes, how often is it used?
   - ⩾1/day ❒
   - Every day ❒
   - >1/week, but not everyday ❒
   - From time to time ❒
   - Never/doesn't work anymore ❒

4. Dust, fumes, particles
   How often do you use incense in the house (on average): Never ❒

	>1 a day	Once a day	>1/week, not everyday	Occasionally/rarely or never
Living room				
Bedrooms				
Worship room				

How often do you use anti-mosquito incense in the house (on average)
Never ❒

	>1 a day	Once a day	>1/week, not everyday	Occasionally/rarely or never
Living room				
Bedrooms				
Other rooms				

5. How often do you use an air cooler in the house (on average) Never ❒

	>1 a day	Once a day	>1/week, not everyday	Occasionally/rarely or never
Living room				
Bedrooms				
Other rooms				

6. Presence of pets in the house (number): None ❐
   - Dog ❐
   - Cat ❐
   - Birds ❐
   - Hamster ❐
   - Other (Details → Number): ______________

7. Presence in the house/apartment of:
   - Rats, mice Yes ❐ No ❐
   - Cockroaches Yes ❐ No ❐

IV. *Outdoor pollution*

4.1. How would you describe the surroundings of your home?
1. Rural ❐
2. Industrial ❐
3. Residential (rich, upper class area, green) ❐
4. Urban (high density of building, lots of traffic, lots of shops) ❐
5. Mixed area (mix between at least two types of the categories described above) ❐

4.2. How would you describe the traffic around your residence?
1. No traffic ❐
2. No blocked traffic, although there are cars and motorbikes in my surroundings ❐
3. During rush hours, the traffic is blocked ❐
4. The traffic is almost permanently blocked ❐

4.3. How would you rate the pollution levels due to traffic (air pollution) in your surroundings?
1. Extremely high ❐
2. High ❐
3. Average ❐
4. Fairly low ❐
5. Low ❐

V. *Clinical evaluation*

5.1. Have you had wheezing or whistling in your chest at any time in the last <u>12 months?</u> Yes ❐ No ❐
1. Have you been breathless at all when the wheezing noise was present? Yes ❐ No ❐
2. Have you had this wheezing or whistling when you did <u>not</u> have a cold? Yes ❐ No ❐
3. Have you woken up with a feeling of tightness in your chest at any time in the last <u>12 months</u>? Yes ❐ No ❐
4. Have you been woken up by an attack of shortness of breath at any time in the last <u>12 months</u>? Yes ❐ No ❐
5. Have you been woken up by an attack of coughing at any time in the last <u>12 months</u>? Yes ❐ No ❐

6. Have you had an attack or exacerbation in the last 12 months?
Yes ❐ No ❐

5.2. Quality of life: restriction of activity
Because of those respiratory problems during the last 12 months, did you:
1. Have to stop working >1 week? Yes ❐ No ❐
2. If yes, for how long (how many weeks in 12 months)? ______________

5.3. How does this health problem affect:	Very significant impact	Significant impact	Moderate impact	Mild impact	No impact	Not relevant
1. Household duties (cleaning, fixing, etc.)						
2. Taking care of children						
3. Visiting family, friends						
4. Leisure activities						

5.4. CRD and comorbidities: ____________________________________

5.5. Medication against parasites Yes ❐ No ❐

VI. *Access to finance for health care:*
6.1. During the last 12 months how many times (on average) did you have to (more than one answer is possible)?

	Private doctor/consultation	Primary care service	Hospital
Postpone medical examinations because of a lack of money			

6.2. Have you postponed buying drugs/medicines due to a lack of money?
Yes ❐ No ❐

RÉSUMÉ

OBJECTIF : Evaluer la prévalence et les facteurs de risque de sensibilisation à des allergènes chez les personnes atteintes de maladie respiratoire chronique (CRD) au Sud du Vietnam.

SCHÉMA : Un questionnaire relatif à l'environnement et des tests cutanés aux allergènes aériens et alimentaires a été obtenu chez des patients porteurs de CRD, définies par des symptômes respiratoires et un déficit de la fonction pulmonaire.

RÉSULTATS : Sur 610 CRD, il y a eu 56% de bronchopneumopathie pulmonaire chronique obstructive et 31% d'asthme ; 80% des patients ont été des hommes. Les sensibilisants les plus fréquents ont été les acariens (*Dermatophagoides farinae*, 22% ; *Blomia*, 19% ; *Dermatophagoides pteronyssinus*, 18%) et les cafards (13%). Parmi les patients, 37% étaient nés en zone rurale et 36%, en ville, tandis que 27% avaient migré d'une zone rurale vers une zone urbaine. Etre né en ville, par opposition à être né à la campagne, a été un facteur de risque de sensibilisation aux acariens (OR 1,56 ; IC95% 1,11–2,20 ; $P < 0,02$). En analyse multivariable, le lieu de naissance est resté un facteur de risque de sensibilisation aux acariens. Par rapport aux patients nés en ville, le risque de sensibilisation aux acariens n'a pas été significativement différent chez les patients nés à la campagne et ayant migré en zone urbaine.

CONCLUSION : Les acariens et les cafards ont été les allergènes les plus fréquents parmi les CRD dans le Sud du Vietnam. Par rapport aux citadins, le fait d'être né à la campagne a été un facteur de protection vis-à-vis de la sensibilisation aux acariens, mais cet effet n'a plus été significatif après migration de la campagne vers la ville.

RESUMEN

OBJETIVO: Evaluar la prevalencia y los factores de riesgo de sensibilización a alérgenos en las enfermedades pulmonares crónicas (CRD) en el sur de Vietnam.

MÉTODO: Se obtuvo un cuestionario ambiental y pruebas de punción intraepidérmica para alérgenos respiratorios y alimentarios en pacientes con diagnóstico de CRD, definida por los síntomas y el deterioro de la función respiratoria.

RESULTADOS: De las 610 personas con CRD, un 56% presentaba enfermedad pulmonar obstructiva crónica y un 31% asma; el 80% era de sexo masculino. Los elementos sensibilizantes más frecuentes fueron los ácaros del polvo (*Dermatophagoides farinae*, 22%; *Blomia*, 19%; *Dermatophagoides pteronyssinus*, 18%) y la cucaracha (13%). De los participantes, el 37% había nacido en un entorno rural, el 36% en una ciudad y el 27% había migrado de una zona rural a una zona urbana. En comparación con el nacimiento en medio rural, el hecho de haber nacido en zona urbana fue un factor de riesgo de sensibilización a los ácaros (OR 1,56; IC95% 1,11–2,20; $P < 0,02$). En un análisis multivariante, se confirmó el lugar de nacimiento como un factor de riesgo de sensibilización a los ácaros. El riesgo de este tipo de sensibilización no fue significativamente diferente en los pacientes nacidos en medio rural y los que migraban a un entorno urbano, al compararlos con las personas nacidas en medio urbano.

CONCLUSIÓN: Los ácaros del polvo y las cucarachas fueron los alérgenos detectados con mayor frecuencia en las personas con CRD en el sur de Vietnam. En comparación con el hecho de haber nacido en un medio urbano, el ser nativo de un medio rural constituyó un factor de protección frente a la sensibilización a los ácaros del polvo, pero este efecto perdía su significación estadística después de la migración a zonas urbanas.

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