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Original Article

Indoor Environmental Factors and Occurrence of Lung Function Decline in Adult Residents in Summer in Southwest China

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Abstract

Background: There is conflicting reports on the respiratory health effects of indoor risk factor exposure. The aim of this study was to assess the association of indoor environmental factors to pulmonary function in an adult population in Zunyi City of Southwest China.

Methods: Between July and Sep 2012, we conducted a cross-sectional survey of people aged ≥18 yr in 11 inner-city areas of Zunyi. Data on asthma and asthma-related symptoms and selected home environmental factors were assessed by questionnaire. Lung function measurements, including FVC, FEV_1, FEV_1/FVC and PEFR, were assessed and compared. Exposure to indoor and outdoor $PM_{2.5}$ was monitored by measurement of $PM_{2.5}$ emission relative concentration.

Results: Cooking oil fumes, environmental tobacco smoke (ETS) and coal fuel use were associated with impaired lung function among adults in summer season ($P<0.05$). Subjects exposed coal fuel combustion, cooking oil fumes, pest in kitchen, mosquito repellent, fluffy blanket, pets, visible mold in bedroom and ETS (active and passive smoking) tended to exhibit greater decreases in FVC, FEV_1 and PEFR values compared with their non-exposed counterparts ($P<0.05$). Median $PM_{2.5}$ relative concentrations in kitchen, sleeping area and outdoor were 486.0cpm, 463.0cpm and 459.0cpm, respectively. $PM_{2.5}$ relative concentration in indoor kitchen and sleeping area were significant higher than outdoor ($P<0.001$).

Conclusion: A negative association between kitchen, sleeping area risk factors and ETS exposure and a reduction in lung function in summer was revealed in Zunyi.

Keywords: Pulmonary function, Indoor air pollution, Adult

Introduction

Concern over the part of indoor air pollution in the damaging of human health has recently increased. People spend more than 80%-90% of their time indoors, especially at home; therefore, a good indoor air quality (IAQ) is crucial. There are conflicting reports on the respiratory health effects of indoor risk factor exposure, including fuel combustion, environmental tobacco smoke and allergen. Some studies reported adverse outcomes of exposure to indoor environment risk factors (1, 2), whereas, few studies reported absence of any association between adverse health effect and the similar exposure (3).

Biological or chemical exposure to biomass smoke, cooking oil fumes, mold, dampness, cockroach, rodent and dust mite allergens, and environmental tobacco smoke (ETS) can have adverse health effects on the adult lung function level. To illustrate, previous studies have linked exposure to mold to worse lung function in asthmatic patients (4). Dampness in the home has been linked to lung function decline (5). Allergic sensitization via cockroach and mouse allergens can be triggering mechanisms for a decrease in lung function among atopic individuals (6). Other potential indoor risk factors include active and passive smoking, positively correlated with a decline in lung function among susceptible populations (7).

Zunyi has rich reservation of coal, with high levels of air pollution. There is a large demand for coal for cooking and baking in households in summer. The combustion of coal and natural gas in poorly ventilated homes exposes children and adults to high levels of particulate matter and other aero contaminants. In addition, Zunyi is one of China's least sunny cities with relative humidity of above 80% in summer season. Its summer has a wet, hot and gloomy climate, predisposed to indoor mold (or fungi) growth. For many people, the risks to respiratory health may be greater due to exposure to excessively high indoor pollutants from poorly ventilated household stoves. A better understanding of seasonal exposure in urban China and the relative contribution of behavioral and household structural factors to personal exposure is important for estimating the global disease burden attributable to indoor air pollution.

This study aimed to investigate the relationship between indoor environmental risk factors and occurrence of lung function decline in adult residents in summer in Zunyi City of Southwest China.

Materials and Methods

Study Design and Location

A cross-sectional investigation was conducted for lung function level among adult residents in Zunyi, the largest city in the north of Guizhou Province, that has 11 inner-city areas, including Laocheng (LC) Road, Wangli (WL) Road, Zhonghua (ZH) Road, Nanmenguan (NMG) Road, Yanan (YA) Road, Zhoushuiqiao (ZSQ) Road, Zhongshan (ZS) Road, Beijing (BJ) Road, Shanghai (SH) Road, Xima (XM) Road, and Dalian (DL) Road, covering an area of approximately 105 km^2, with a population of about 900000.

Eleven communities in 11 inner-city areas in Zunyi were randomly selected and investigated. The first family was selected by simple random sampling of the residential address number in each community. All adult family members present at the residence who met the inclusion criteria were selected. After that, neighbors living in a residence next door who met the inclusion criteria were recruited and interviewed. If no one was at home, the interviewer returned up to three times before moving to another family next door. If the selected family refused to participate or could not be found, neighbors living in the next residence who met the inclusion criteria were recruited. This procedure was repeated for every house among the selected houses until the targeted number of participants was recruited. The residents were asked to complete the consent form and questionnaire at home.

Inclusion criteria for the studied community were no factories/plants within the selected community. Inclusion criteria for eligible residents were 18 and above yr olds for men and women; living more than 3 yr within inner-city area in Zunyi City.

Measurement of pulmonary function

Lung function was examined by measuring forced vital capacity (FVC), forced expiratory volume in 1 s (FEV_1), FEV_1/FVC, and peak expiratory flow rate (PEFR), according to standard guidelines using a portable electronic FGC-A+ spirometer (Anhui Institute of Electronic Science, China). The participants were asked to sit in an upright position with both feet flat on the ground. They were instructed to inhale completely, place the meter in their mouth, and to exhale with maximal force as soon as their lips were sealed around the mouthpiece, while maintaining an upright position. An investigator demonstrated the maneuver. Based on guidelines of the American Thoracic Society, maneuvers were only accepted if they had low back-extrapolated volume (<5% of the FVC and <0.15 L), both the FVC and FEV_1 were within 0.20 L of the best effort FVC and FEV_1, and there was a low volume accumulated at the end of the effort. Each subject was tested on three expiratory maneuvers.

Measurement of pollutants

To measure $PM_{2.5}$ concentrations inside and outside the households, we used a digital dust monitor (LD-3K; Sibata Scientific Technology Inc., Japan), which is a portable monitor based on the light-scattering principle, with a laser diode as the light source. The monitor determines the relative concentration of $PM_{2.5}$ by measuring the intensity of the laser beam scattered by particles. The advantage of measuring $PM_{2.5}$ relative concentration with the LD-3K fine dust monitor was that it allowed an analysis of concentration level (high or low), namely, a relative comparison (screening) and an analysis of variation with time (8). The relative concentration is reported as counts per min (cpm). To determine the cpm, the following equation was used: cpm = counts value/measuring time (in min). Each measurement was maintained for over 1 min, and three readings were taken for each measurement to calculate the mean relative concentration. There was an interval period of 1 min between the 3 measurements of $PM_{2.5}$ in the kitchen, living room, or outdoors, whereas the interval period for measurements between the kitchen, living room, and outdoors was 5 min in each house.

Data analysis

Data analysis was carried out using SPSS Ver. 20.0 (Chicago, IL, USA). After ascertaining whether distributions were normally distributed, we compared continuous variables using Student's two-tailed t-test, ANOVA test, Mann-Whitney U test or Kruskal-Wallis test. A *P*-value of less than 0.05 was considered as level of statistical significance. T-test, ANOVA test, or non-parametric test analysis was used to estimate the difference in pulmonary function (PEFR, FVC, FEV_1 and FEV_1/FVC) among adults who exposed to various indoor exposure factors (kitchen, sleeping area characteristics and ETS) in summer season. Multiple linear regression analysis was used to assess the association of kitchen, sleeping area characteristics, ETS and $PM_{2.5}$ exposure with pulmonary function level (PEFR, FVC, FEV_1 and FEV_1/FVC), controlling for socio-demographic factors. Of these pulmonary function parameters, data analysis was conducted on the largest FVC of the two curves, the largest FEV_1, the ratio of the largest FEV_1 to the largest FVC, and the largest PEFR (9).

Results

Profile of the adult residents

Totally, 610 participants completed the questionnaire and spirometry tests in summer. The indoor and outdoor levels of $PM_{2.5}$ relative concentrations were measured in 20 selected households during the cooking period. Table 1 shows socio-demographic characteristics of the subjects in summer season.

The mean (standard deviation) age of the participants was 45.4 (16.2) yr and 54.4% were female. Only about 19.0% of the adults were over 60 yr old and the percentage of those younger than 39 yr was approximately 42.0%. The marital, educational, BMI and monthly household income status of participants did not change significantly during the two-season period. Chinese ethnic groups (Han) comprised mostly of adult subjects (95.9%), followed by ethnic of minority (4.1%). Around 82.0% subjects were married. About 62.0% had at least a senior high school education. More than half of all subjects (64.6%) had normal weight, compared with those who were underweight (17.5%) and overweight (17.9%). Almost one-third of adult subjects (29.7%) reported familial history of asthma and asthma-related symptoms. Nearly 22% subjects had childhood asthma and asthma-related symptoms. Approximately three-fourth of adults (79.7%) had a total monthly family income of at least 1753 Chinese Yuan. About 20.0% of adult subjects were exposed regularly to dust or gas at work (Table 1).

Effects of personal and environmental risk factors on pulmonary function levels (FVC, FEV1, FEV1/FVC, and PEFR)

Of the 610 subjects who performed spirometry, the adults from coal stove using families showed a significantly lower FVC, FEV_1 and PEFR compared to adults from clean fuel stove and fix fuel stove using families ($P<0.001$).

Table 1: Socio-demographic characteristics of the subjects in summer season

Socio-demographic characteristics	Subjects	
	Number (n=610)	Percentage (%)
Gender		
Male	278	45.6
Female	332	54.4
Age distribution (yr)		
18-39	256	42.0
40-59	239	39.2
≥60	115	18.8
Ethnic group		
Han	585	95.9
Ethnic of minority	25	4.1
Marital status		
Not-married	111	18.2
Married	499	81.8
Education		
Senior high school and above	380	62.3
Below senior high school	230	37.7
BMI (kg/m^2)		
Underweight (BMI < 18.5 kg/m^2)	107	17.5
Normal weight (18.5≤BMI < 23 kg/m^2)	394	64.6
Overweight (BMI≥23 kg/m^2)	109	17.9
Asthma and asthma-related symptoms in childhood		
Yes	132	21.6
No	478	78.4
Familial history of asthma and asthma-related symptoms		
Yes	181	29.7
No	429	70.3
Monthly household income		
Low household income	124	20.3
High household income	486	79.7
Occupational exposure to dust or gas		
Yes	123	20.2
No	487	79.8

When subjects exposed to cooking oil fumes frequently or sometimes were compared with the subjects who seldom exposed or without such exposure, values of FVC (P=0.030), FEV_1/FVC (P=0.042) and PEFR (P=0.029) were significantly lower in subjects who exposed to cooking oil fumes. For pulmonary function test parameters (FVC (P=0.022), FEV_1 (P=0.043) and PEFR (P=0.017)), significant differences were observed among subjects who stated that there was no pest, subjects stated that pest haunted few of the time and subjects stated that pest haunted sometimes in their houses, with median values lowest in those with pest exposure sometimes (Table 2). Median values of FVC (P=0.014), FEV_1 (P=0.014) and PEFR (P=0.017) were significantly lower among adults used mosquitoes killing spray or coil incense to expel mosquito than that among adults used mosquito net or did not use mosquito repellent. In contrast, in adults whose mattress used history more than 5 yr had a significantly higher values of FVC (P=0.023), FEV_1 (P=0.016), and PEFR (P=0.024). FVC (P=0.037) and FEV_1 (P=0.049) were significantly lower in adults who used fluffy blanket as compared with the respective non-users. Compared with the subjects did not keep pets, subjects kept pets showed significant decrease in FVC (P=0.011), FEV_1 (P=0.014) and PEFR (P=0.012). The subjects reported the presence of mould in their bedrooms showed significant deficits in FVC (P=0.001), FEV_1 (P=0.006) and PEFR (P=0.002) as compared with those who reported the absence of mould in their bedrooms (Table 2).

In comparison to non-smokers, both current smokers and ex-smokers were having lower values of FVC (P<0.001), FEV_1 (P<0.001) and PEFR (P<0.001). Compared with the subjects were not exposed to second-hand smoke, subjects who were exposed to second-hand smoke showed similar deficits in FVC (P=0.048), and PEFR (P=0.039) as did the current smokers and ex-smokers (Table 2).

Relationship between indoor and outdoor $PM_{2.5}$ relative concentrations and pulmonary function levels (FVC, FEV_1, FEV_1/FVC, and PEFR)

Table 3 shows that, among the 41 adult participants whose houses were monitored, no significant correlations between indoor kitchen and sleeping area as well as outdoor $PM_{2.5}$ relative concentration and pulmonary function test parameters (FVC, FEV_1, FEV_1/FVC, and PEFR) were observed (P>0.05).

Table 3: Pulmonary function levels (FVC, FEV_1, FEV_1/FVC, and PEFR) in adults and its association with $PM_{2.5}$ exposure level in summer season

$PM_{2.5}$ exposure level	***FVC in L** (n=41)*		***FEV_1 in L** (n=41)*		***FEV_1/FVC in percentage** (n=41)*		***PEFR in Litres/min** (n=41)*	
	r	***P* value**	**r**	***P* value**	**r**	***P* value**	**r**	***P* value**
Indoor kitchen PM2.5 relative concentration	-0.180	0.259	-0.184	0.249	0.287	0.069	-0.182	0.255
Indoor sleeping area PM2.5 relative concentration	-0.219	0.169	-0.222	0.162	0.279	0.078	-0.220	0.167
Outdoor PM2.5 relative concentration	0.061	0.704	0.069	0.699	0.174	0.277	0.064	0.069

r: Correlation coefficient. *significant at P<0.05; **significant at P<0.01; *** significant at P<0.001

Indoor and Outdoor $PM_{2.5}$ Relative Concentrations

Fig. 1 shows that the median (25% and 75% quartile) relative concentrations in $PM_{2.5}$ measured in indoor kitchen, sleeping area and outdoor were 486.0 (468.0-555.5) cpm, 463.0 (440.0-535.0) cpm and 459.0 (420.0-489.0) cpm, respectively. When the indoor kitchen, sleeping area and outdoor concentrations of $PM_{2.5}$ were compared, the PM2.5 relative concentrations were significantly higher in kitchen than in sleeping area (z=-2.343, P=0.019) and outdoor (z=-2.789, P=0.005). Although, the $PM_{2.5}$ relative concentration was higher in sleeping area than outdoor, the difference was not significant (z=-0.858, P=0.391).

Discussion

The major findings of this study are as follows: 1) Subjects exposed coal fuel combustion, cooking oil fumes, pest in kitchen, mosquito repellent, fluffy blanket, pets, visible mold in bedroom and ETS (active and passive smoking) tended to exhibit greater decreases in FVC, FEV_1 and PEFR values compared with their non-exposed counterparts in summer; 2) Median $PM_{2.5}$ relative concentrations in kitchen, sleeping area and outdoor were 486.0cpm, 463.0cpm and 459.0cpm, respectively. $PM_{2.5}$ relative concentration in indoor kitchen and sleeping area were significant higher than outdoor in summer season.

The cross-sectional questionnaire survey of people aged ≥18 yr provides evidence of the effects of indoor environmental factors on occurrence of lung function decline. A negative association between kitchen, sleeping area risk factors and ETS exposure and a reduction in lung function in summer was revealed in Zunyi. To the best of our knowledge, this is the first study to examine potential effect modifiers of indoor environmental exposure on adult lung function level in summer season in China.

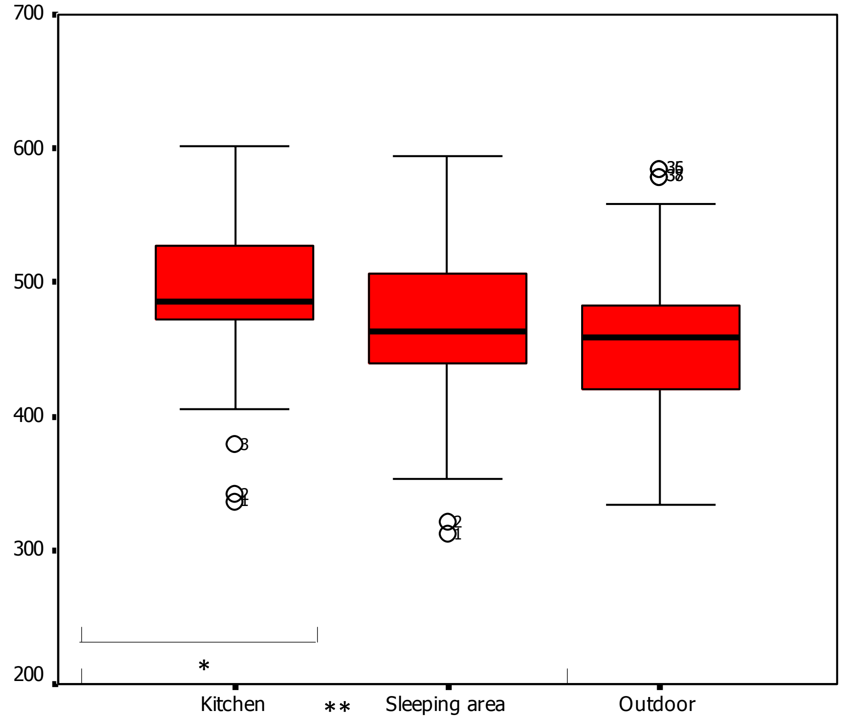

Fig. 1: $PM_{2.5}$ relative concentrations in 20 monitored houses in summer season
Mann-Whitney U test, *significant at *P*<0.05; **significant at *P*<0.01; *** significant at *P*<0.001

Our study documents lower lung function among adults exposed to cooking oil fumes (COF) compared with adults who are never or seldom exposed to COF. This association persists after controlling for the effects of socio-demographic factors, the level of $PM_{2.5}$ concentration, etc. Our findings are in line with previous studies that examined the relationship between COF exposure and lung function. Raj et al. in a study to evaluate the effects of cooking fuel smoke on lung function in asymptomatic women in India demonstrated a reduction in lung function among women who were exposure to COF (10). Mbatchou et al. in a community survey a semi-rural area in Cameroon to assess the effects of COF exposure and lung function, "compared forced respiratory volume between women using wood and women using alternative sources of energy for cooking". In that study, the authors documented a significant airflow obstruction in the wood smoke group (11).

Exposure to household air pollution from coal combustion is recognized as an important cause of impaired lung function. In the present study, we observed impaired lung function among adults from coal using families. Several studies have also reported reduction in lung function in adults chronically exposed to coal fuel smoke. Our recent publication evaluated the exposure to indoor burning coal air pollution as a risk factor for pulmonary function decline in adult participants in Zunyi. Exposure to coal smoke was associated with a 31.7% decrease in FVC, a 42.0% decrease in FEV_1, a 7.46% decrease in the

FEV_1/FVC ratio, and a 23.1% decrease in PEFR in adult residents. "The slope of lung function decrease for Chinese adults is approximately a 2-L decrease in FVC, a 3-L decrease in FEV_1, and an 8 L/s decrease in PEFR per count per minute of $PM_{2.5}$ exposure" (1). Cooking with biomass adversely affects PEFR in nonsmoking rural women (12). Similar reductions in peak flow have been observed 100 Indian women with asthma living in homes that used coal fuel for cooking (13). This deterioration of lung function in coal fuel users has been attributed to the fact that the amount and concentration of particulate matter and other toxic gases (e.g., SO_2) emitted during coal combustion while cooking are more than those emitted during combustion of LPG or cleaner fuel.

Exposure to indoor microbial allergens, together with building dampness, is an important risk factor for the reduction in lung function of the occupants though the underlying mechanisms for exposure-related injury are still being investigated. Numerous studies have analyzed the relationship between cat and dog allergen exposure and effects on respiratory health in adult populations. "Subjects both sensitized and exposed to high levels of sensitizing allergen (dog, cat and dust mite) had significantly lower FEV_1 percent predicted values (mean, 83.7% vs. 89.3%) compared with subjects not sensitized and exposed"(14). Specific immunoresponse to cat was associated with a lower baseline FEV_1 (15). Consistent with earlier reports, in this study, we observed that decreased FVC, FEV_1 and PEFR values among adult residents were inversely related to pet exposure in their bedrooms in summer. Microbial allergens exposure has clear implications for sensitization and lung function decline through the development of bronchial hyper-responsiveness and airway inflammation in sensitized subjects; however, the underlying mechanisms responsible for the observed health effects are not well understood.

Exposure to indoor environmental tobacco smoke (ETS) might increase the risk of lung function decline (16-18). In a Denmark study of 18 to 69-yr olds, adults exposed to environmental tobacco smoke for >5 h/d had a significantly increased risk of decreased lung function (FEV(1)% predicted), compared with those not exposed (19). Eisner et al. noted a dose-dependent effect with 10-yr cumulative ETS exposure on lung function among 1057 older adults. Lifetime cumulative home and work SHS exposure were associated with a greater decline of FEV_1 (-15 mL/s; 95% CI, -29 to -1.3 mL/s and -41 mL/s; 95% CI, -55 to -28 mL/s per 10-yr cumulative exposure, respectively) (20). In this study, a significant proportion of adults reported exposure to ETS, 10.9% of women are exposed to tobacco smoke compared with men (7.5%). Both current smokers and ex-smokers were having lower values of FVC, FEV_1 and PEFR in comparison to non-smokers. Compared with the subjects not exposed to second-hand smoke, subjects exposed to second-hand smoke showed similar deficits in FVC, and PEFR as did the current smokers and ex-smokers. Although, selection bias might be introduced and would mask the relationship, especially, in cross-sectional design, our results showed active smoking was associated with decrements in FEV_1 and PEFR among current smokers and PEFR among adults exposed to others' cigarette smoking which was consistent with other studies from the US (20) and Switzerland (21). Although, China has made progress towards achieving a smoke-free environment, there remains a high degree of exposure to ETS. Collectively, those residing in inner-city areas may be affected by the health burden of tobacco use. Adult residents in Zunyi have less knowledge about ETS and less negative attitudes about ETS, as well as smoke-free home rules are not available (22).

Some limitations in this study include: 1) relatively small sample size; 2) the cross-sectional design, cannot make causal inference; 3) the lack of review about the burning coal smoke exposure time in participants due to not fully recording cooking times in the kitchens of this study; 3) some confounding factors may influence on the association between indoor environmental factors and lung function level, these factors include different location of current residence, ambient air pollution, etc. Notwithstanding the limitations, we still elaborate on the attributable risk of lung function decline due to indoor coal exposure in adult residents in summer in Zunyi.

Conclusion

We identified a number of home environmental factors associated with lung function decline among Chinese adults. Cooking oil fumes, environmental tobacco smoke and coal fuel use were associated with impaired lung function among adults in summer season. Subjects exposed coal fuel combustion, cooking oil fumes, pest in kitchen, mosquito repellent, fluffy blanket, pets, visible mold in bedroom and ETS (active and passive smoking) tended to exhibit greater decreases in FVC, FEV_1 and PEFR values compared with their non-exposed counterparts. Median $PM_{2.5}$ relative concentrations in kitchen, sleeping area and outdoor were 486.0cpm, 463.0cpm and 459.0cpm, respectively. $PM_{2.5}$ relative concentration in indoor kitchen and sleeping area were significant higher than outdoor. The present findings suggest that public health policy for eliminating certain home exposures are needed, which could have large effects not only on public health but also on medical costs in Zunyi.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Table 2: Pulmonary function (FVC, FEV_1, FEV_1/FVC and PEFR) in adults by kitchen risk factors in summer season

Risk Factors (n)	FVC in litres (L)	test	*P* value	FEV1 in litres (L)	test	*P* value	FEV1/FVC in percentage	test	*P* value	PEFR in litres/min	test	*P* value
Stove used for cooking												
Cleaner fuel (371)	3.9 (3.4-4.6)	24.06#	<0.001***	3.5 (3.1-4.1)	21.79#	<0.001***	89.9 (88.5-92.0)	2.05#	0.358	403.2 (377.2-435.8)	23.38#	<0.001***
Fuel mix (190)	3.8 (3.4-4.4)			3.4 (3.1-3.9)			89.8 (88.7-92.5)			399.4 (378.1-426.4)		
Coal (49)	3.2 (2.8-3.9)			3.0 (2.6-3.6)			90.6 (88.8-93.5)			374.7 (350.9-402.6)		
Cooking oil fumes												
Never or seldom (427)	3.8 (3.4-4.6)	-2.17#	0.030*	3.4 (3.0-4.1)	-1.88#	0.060	89.9 (88.8-92.1)	-2.03#	0.042*	399.3 (376.7-438.5)	-2.18#	0.029*
Frequently or sometimes (183)	3.8 (3.0-4.3)			3.4 (2.9-3.9)			89.8 (88.3-92.3)			398.4 (368.7-419.3)		
Kitchen haunted with pest												
None of the time (553)	3.8 (3.4-4.5)	7.65#	0.022*	3.4 (3.0-4.0)	6.31#	0.043*	89.9 (88.6-92.1)	1.31#	0.520	399.8 (376.7-431.0)	8.14#	0.017*
Few of the time (43)	3.5 (2.7-4.1)			3.2 (2.5-3.6)			89.9 (88.1-92.6)			392.7 (342.7-410.5)		
Some of the time (14)	3.5 (2.6-4.3)			3.3 (2.3-3.9)			91.3 (87.4-93.8)			385.1 (322.2-421.9)		
Use of mosquito repellent												
Mosquito net or no method (510)	3.9 (3.4-4.5)	-2.45#	0.014*	3.4 (3.0-4.0)	-2.46#	0.014*	89.9 (88.5-92.1)	-0.73#	0.463	400.0 (376.1-432.3)	-2.41#	0.016*
Mosquitoes killing spray or coil incense (100)	3.5 (3.0-4.1)			3.2 (3.0-3.6)			90.1 (88.7-92.1)			393.3 (370.0-410.7)		
Fluffy blanket												
No (572)	3.9 (3.4-4.5)	-2.09#	0.037*	3.4 (3.0-4.0) 3.1 (2.7-3.9)	-1.97#	0.049*	89.9 (88.6-92.2)	-0.23#	0.818	399.9 (375.7-430.7) 381.4 (358.0-421.9)	-0.20#	0.046
Yes (38)	3.4 (2.9-4.4)						89.8 (88.7-92.2)					
Keep pets												
No (487)	3.9 (3.4-4.5)	-2.54#	0.011*	3.5 (3.0-4.0)	-2.46#	0.014*	89.9 (88.6-92.1)	-0.04#	0.967	400.4 (376.3-433.8)	-2.51#	0.012*
Yes (123)	3.6 (3.2-4.1)			3.3 (3.0-3.7)			89.9 (88.5-92.4)			395.2 (372.1-410.9)		
Mould in bedroom												
No (593)	3.8 (3.4-4.5)	-3.00#	0.001**	3.4 (3.0-4.0)	-2.75#	0.006**	89.9 (88.6-92.1)	-0.07#	0.948	399.6 (376.2-430.6)	-3.04#	0.002**
Yes (17)	3.0 (2.6-4.2)			2.8 (2.3-3.8)			91.0 (86.5-93.6)			350.2 (314.9-419.9)		
Smoking status												
Non-smokers (365)	3.9 (3.4-4.6)	18.07#	<0.001***	3.5 (3.1-4.1)	17.57#	<0.001***	90.0 (88.6-92.2)	2.32#	0.312	404.7 (378.0-442.5)	18.76#	<0.001***
Ex-smokers (85)	3.6 (3.0-4.1)			3.3 (2.8-3.6)			89.8 (88.3-91.9)			393.7 (364.0-410.1)		
Current smokers (160)	3.6 (3.3-4.3)			3.3 (3.0-3.9)			89.9 (88.6-92.7)			394.9 (375.1-419.8)		
Second-hand smoke, exposed to ETS												
No (518)	3.8 (3.4-4.5)	-1.98#	0.048*	3.4 (3.0-4.0)	-1.71#	0.090	89.9 (88.6-92.1)	-1.02#	0.306	399.7 (376.1-431.9)	-2.07#	0.039*
Yes (92)	3.7 (3.1-4.3)			3.4 (3.0-3.8)			89.8 (88.4-92.5)			395.4 (370.0-417.4)		

#Nonparametric test (Mann-Whitney U test or Kruskal-Wallis test), α= 0.05; *significant at $P<0.05$, **significant at $P<0.01$, *** significant at $P<0.001$