RESPIRATORY EFFECTS AMONG NON-SMOKING WOMEN IN RELATION TO HOUSEHOLD COOKING FUEL USES IN TU LIEM SUBURBAN DISTRICT, HANOI, VIETNAM

Nguyen Thi My Hanh, Robert S. Chapman, Piyalamporn Havanond, Naowarat Kanchanakhan*

College of Public Health Sciences, Chulalongkorn University, Bangkok 10330, Thailand

ABSTRACT: This study, conducted in Tu Liem District, Hanoi, Vietnam, evaluated respiratory health in women in relation to cooking fuel use and potentially relevant socio-demographic characteristics and house condition-related. This was a cross-sectional study with the participation of 402 non-smoking women who were sampled equally in 3 groups, which were liquefied petroleum gas (LPG) but not beehive coal use, beehive coal but not LPG use and both LPG and coal use for cooking. Information related to cooking fuel practices, house conditions, socio-demographic factors and six respiratory outcomes including cough for one month or more, phlegm for one month or more, both cough and phlegm for 1 month or more, shortness of breath (SOB) when hurrying on level ground, wheeze with SOB in adulthood, and current COPD were collected by interview structured questionnaire, a modified version of the American Thoracic Society Questionnaire (adult version). In descriptive findings, there were 16.2%, 12.2% and 11.9% respondents having cough, phlegm and both cough and phlegm for one month and more respectively. SOB when hurrying on level ground, wheeze with SOB and current Chronic Obstructive Pulmonary Disease (COPD) was observed in 60.2%, 24.4% and 19.9% non-smoking women in study sample. In bivariate analysis findings, respiratory outcomes were positively associated with current of fuel use; and had strongly positive relationship with number of years using beehive coal and biomass ($p<0.001$), dampness and mould in house ($p<0.001$); and several socio-demographic factors. Meanwhile, respiratory outcomes negatively associated with distance of house location to main road and farmland ($p<0.01$) and cooking time per day with LPG. Exposure to LPG or fumes in workplace, quantity of beehive coal briquettes used per month and cooking time with beehive coal had positive association with the prevalence of several respiratory symptoms and illness. Clearly, current beehive coal use for cooking and history of beehive coal and biomass use significantly contributed to the risk of respiratory symptoms and illness. Appropriate interventions to reduce solid fuel smoke exposure, and improve respiratory health should be considered.

Keywords: Respiratory symptoms, Beehive coal, Liquefied petroleum gas, Vietnam

INTRODUCTION

Indoor air pollution due to cooking fuel was not only significantly ascribed to global disease burden, especially in developing countries; but also second leading cause of respiratory diseases, following the causality of smoking [1]. The global risk assessment investigated that the women those exposed with coal combustion products day by day was likely to get triple risk of COPD for instance of asthma, chronic bronchitis or emphysema and twice times higher risk of lung cancer compared with those using LPG, electricity and even higher than biomass [2, 3]. The Western Pacific region, which

* *Correspondence to: Naowarat Kanchanakhan*
E-mail: naowarat.k@chula.ac.th

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was classified by WHO, was reported with 1.2 billion people, 71% of this population predominantly used coal or biomass fuel for cooking. Additionally, cooking fuel combustion products were responsible for 426,000 COPD deaths and 15,000 lung cancer deaths [4]. In Vietnam, the prevalence of respiratory infections was 28.4%, which was in top three major burden of diseases [5]. Besides, among 12 Asian countries, Vietnam had highest prevalence of COPD with 6.7% [6].

According to WHO country health statistics 2004 regarding environmental disease burden for selected risk factors, indoor air pollution in Vietnam is attributable to 2.8 DALYs/1000 cap/year and the highest mortality rate of 23,800 deaths/year in which 88.6% from chronic obstructive pulmonary disease (COPD), 8.6% due to acute respiratory infections (ARI) and 2.8% caused by lung cancer [7]. More than two million people in Vietnam still use beehive coal as daily cooking fuel. Beehive coal briquette is popularly used in Vietnam and principally made from bituminous coal & Lignite Surface Mining (also called coal dust and peat-coal), which is coal-mining residue, and mixed with clay for the brick shape and sawdust for flammable. Red Delta region has 3 times higher rate of beehive coal use than that of national average rate. In addition, due to the rapid increase of LPG price in Vietnam in 2012, a number of households using LPG only tend to turn back to beehive coal use or parallel use with LPG to reduce the expenditure [8]. Vietnamese women is considered as the most vulnerable group to effects of cooking fuel emission exposure when more than 80% Vietnamese women spend 2.6 hours average per day on cooking [8]. To the best knowledge, data on health effects owing to cooking fuel emission in Vietnam are limited. This study aimed to assess the burden of coal use to health effects by comparing with that of LPG use and both LPG and coal use among non-smoking women in Tu Liem suburban, Hanoi, where has the highest percentage of beehive coal use in Hanoi [9].

METHODOLOGY

The cross-sectional design was used in this study. The study was conducted in Tu Liem suburban district, Hanoi, Vietnam in February of 2013. The inclusion criteria of study participants are the above 21 year-old non-smoking women who were mainly responsible for cooking in households using LPG only, beehive coal only and both LPG and beehive coal. In the study area, beehive coal is the only form of coal used for household cooking. The women who had either disability such as deafness or mental health problems were excluded from the sample. There were 402 subjects in the study, based on the sampling formula of Cochran [10]. Subjects were equally divided into 3 groups based on current beehive coal and LPG use, namely use LPG but not beehive coal, use beehive coal but not LPG, and use both LPG and beehive coal. Multi-stage sampling technique was used to randomly select 402 women from two chosen communes by chance among 15 communes of Tu Liem suburban district, Hanoi, Vietnam (The Central Town was excluded from sampling due to significantly different socio-demographic characteristics compared to 15 communes in Tu Liem district. In Vietnam, The Central Town is considered one administrative unit as commune). Structured interview administered questionnaire were adapted according to American Thoracic Society Questionnaire for adult in order to collect information regarding to cooking fuel practices, house environments, socio-demographic factors and six respiratory symptoms; namely cough for one month or more, phlegm for one month or more, both cough and phlegm for 1 month or more, shortness of breath (SOB) when hurrying on level ground, wheeze with SOB in adult, current COPD status. This questionnaire was pre-tested on 30 women in neighboring communes, which is Dan Phuong district; those have the same inclusion criteria as the study participants to check the validity and reliability of the study instrument before applying for data collection.

Data analysis

The licensed SPSS version 17.0 was applied for analysis. In descriptive analysis, percentage, frequency, interquantile range (IQR) were used for categorical variables to describe socio-demographic characteristics, cooking fuel use status, housing conditions, and the prevalence of respiratory symptoms; and mean, stardard deviation (SD) were applied for continuos variables such as age, distance of house location to industrial section and road, cooking time, quantity of cooking fuel used per month, number of years used solid fuel and cooking time per day. In a bivariate analysis, associations between respiratory effects and cooking fuel practices, house conditions, socio-demographic factors were assessed. Binary logistic regression was used for the bivariate analysis.

Ethical consideration

The study was reviewed and approved by Hanoi School of Public Health Ethical Review Board in Vietnam according to decision No. 03/2013/YTCC-HD3, issued on 24th January 2013.

Table 1 Frequency and percentage distribution of socio-demographic factors, cooking fuel practices and house conditions

Characteristics	Frequency	Percentage
Socio-demographic factors		
Age (n=402)	Median = 43, IQR= 31-54	
Education (n=402)		
No formal education	7	1.8
Primary school	56	13.9
Secondary school	190	47.3
High school	87	21.6
College/University/Graduate school	62	15.4
Occupation (n=402)		
Government Officer	37	9.2
Worker	12	3
Office staff in private sectors	11	2.8
Trader	165	41
Farmer or Agricultural worker	84	20.9
Housewife	74	18.4
Working in dusty job for a year and more (n=402)	45	11.2
LPG or chemical fumes exposure in workplace (n=402)	100	24.9
Cooking fuel use		
Classification of households by current cooking fuel use (n=402)		
LPG use only	136	33.8
Beehive coal use	132	32.8
Both use	134	33.4
Quantity of cooking fuel per month in house hold (n=402)		
Beehive coal only (briquettes)	Median=225, IQR=0-90	
LPG only (kg)	Median=6, IQR=0-4	
Beehive coal in household using both cooking fuels (briquettes)	Median=60, IQR=0-21	
LPG in household using both cooking fuels (kg)	Median=5, IQR=0-4	
Cooking time per day (n=402)		
Beehive coal use only (hr.)	Median=5, IQR =0-3	
LPG use only (hr.)	Median=1, IQR =0-1	
With beehive coal in household using both cooking fuels (hr.)	Median=3, IQR =0-2	
With LPG in household using both cooking fuels (hr.)	Median=2, IQR=0-1	
History of solid fuel use for cooking (n=402)		
Have ever used beehive coal (n=402)	322	80.1
Number of year used beehive coal (n=314)	Median=13, IQR=2-20	
Have ever used biomass (n=402)	176	43.8
Number of year used biomass (n=176)	Median=20, IQR=0-15	
Cooking fuel emission exposure from neighboring households	116	28.9
House conditions		
Dampness and mould status (n=402)	141	35.1
Distance from house location to main road (m) (n=402)	Median=600, IQR=400-752.5	
Distance from house location to farmland (m) (n=402)	Median=900, IQR=500-1200	
Distance from house location to industrial area (m) (n=402)	Median=7000, IQR=3925-11000	
Indoor smoking status (n=402)	202	50.2

IQR: Interquantile Range

All study participants will be provided adequate study information and informed consent form for their signature before decision of participation in the study.

RESULTS

The participants of this study were selected from three groups with equal sample size and on the basis of their use of fuel for cooking which were households using LPG only, beehive coal only and both LPG and beehive coal. Among 134 households using both LPG and beehive coal, there was a majority of household use beehive coal as the main cooking fuel with 67.9%. The average number of beehive coal briquettes expended per month in family utilizing beehive coal only was 2 times more than in households using both coal and LPG; meanwhile this number of LPG expended per month in household using LPG only and both LPG and coal was similar. Cooking time in households using beehive coal only was higher than that of those using both beehive coal and LPG. However, cooking time with LPG in households using LPG only was same as in households using both beehive coal and LPG. As for history of solid fuel use, most study participants have ever used beehive coal

Table 2 Frequency and prevalence (percent) of respiratory symptoms and illness (n=402)

Respiratory effects	Frequency	Prevalence (%)
Respiratory symptoms		
Cough with or without cold (*)	65	16.2
Phlegm with or without cold (*)	49	12.2
Cough and phlegm with or without cold (*)	48	11.9
Shortness of breath when going upstairs	242	60.2
Wheeze with shortness of breath in adult	98	24.4
Respiratory illness		
Current COPD status (†)	80	19.9

(*) The respiratory symptoms for duration of 1 month or more per year
(†) Indirectly estimated by either having doctor-diagnosed chronic bronchitis or emphysema

before with 80.1%; and nearly a half of sample size has ever used biomass. The descriptive findings also found that 35.1% respondents reported they got dampness and mould in house. The median of distance from house location to main road was 600 m (IQR=400-752.5), to farmland was 900 m (IQR=500-1200) and to industrial area was 7000 m (IQR=3925-11000). A half of sample size got at least one family member who usually smokes in house. The median of participant age was 43 years old (IQR=31-54). The majority had finished secondary school (47.3%). The common jobs were farmer and trader with 20.9% and 41% respectively. There were 11.2% respondents have ever worked under dusty environment and the double higher percentage was 24.9% of participants who have ever exposed to LPG or chemical fumes in workplace (Table 1). According to Table 2, there were 16.2%, 12.2% and 11.9% respondents got cough, phlegm and both cough and phlegm for one month and more respectively. SOB when hurrying on level ground, wheeze with SOB and current COPD status was observed in 60.2%, 24.4% and 19.9% non-smoking women in study sample (Table 2).

The bivariate analysis findings revealed that the current cooking fuel use significantly associated with four respiratory effects only including cough for one month and more, SOB when hurrying on level ground, wheeze with SOB in adult and current COPD status with $p<0.05$. However, history of beehive coal and biomass use had positively strong relationship with all six respiratory episodes, particularly cough for one month and more (OR=6.97 and 5; *p-value*<0.001); phlegm for one month and more (OR=7.56 and 4.7; *p-value*≤0.001); both cough and phlegm for one month and more (OR=7.38 and 5.2; *p-value*≤0.002); SOB when hurrying on level ground (OR=7.02 and 7.8; $p<0.001$); wheeze with SOB in adult (OR=5.66 and 4.98; *p-value*<0.001) and current COPD status (OR=6.7 and 5.32; *p-value*<0.001). Similarly, the study investigated the strongly positive association between all six respiratory effects and dampness and mould status and age ($p<0.001$). In contrast, the negative relationships were figured out between all six respiratory symptoms and illness and quantity of LPG in households using both LPG and beehive coal. The study findings also pointed out that the longer distance from house location to main road and farmland were; the less risk of respiratory symptoms and illness was (OR=0.99, $p<0.01$). Women who have higher education (upper secondary school) got the less risk of respiratory impairment than lower educated women with OR=0.35-0.46, *p-value*<0.005. In addition, gas or chemical fumes exposure in workplace, occupation, exposure to cooking emission from next-door households, cooking time per day, quantity of beehive coal or LPG just found a smaller number of associations with some of respiratory symptom and illness (Table 3, 4).

DISCUSSION

The prevalence of cough with or without cold for one month and more in the current study, which was 16.2%; was higher than the results of other study with 4.6% [11]. However, another study had consistent result with 17.7% women in 21-45 age groups and 19.3% women in the age of 46-70 from BaVi, Hanoi who got longstanding cough [12]. Regarding phlegm with or without cold for one month and more, the current study showed 12.2% women participated in research had this symptom. This number was the same as the study of Lam and her co-workers with 13.9% and 15.7% in women in 21-45 and 46-70 age groups respectively [12]. However, the prevalence of SOB when hurrying on level ground, wheeze with SOB in adult and current COPD status were remarkable higher than the previous studies [12, 13]. This higher statistic can be explained by different tools used, the age of sample size, the diverse socio-demographic factors of study

Table 3 Association between cooking fuel practice, house conditions and socio-demographic factors; and cough, phlegm and both cough and phlegm symptoms

Independent variables	Cough[a]		Phlegm[a]		Cough and phlegm[a]	
	Crude OR	***P-value***	**Crude OR**	***P-value***	**Crude OR**	***P-value***
Socio-demographic factors						
Age (years old)	1.066	<0.001	1.066	<0.001	1.065	<0.001
Education						
Below secondary school	1		1		1	
Upper secondary school	0.45	0.011	0.45	0.024	0.46	0.034
Occupation						
Officer	1		1		1	
Trader	0.59	0.548	1.03	0.971	1.03	0.971
Worker	2.40	0.085	3.06	0.076	3.06	0.076
Farmer	1.57	0.418	2.02	0.302	1.80	0.396
Housewife	1.19	0.768	1.32	0.702	1.32	0.702
Chemical fumes exposure in workplace						
No	1		1		1	
Yes	1.69	0.070	1.92	0.04	1.99	0.031
Cooking fuel practice						
Current cooking fuel use						
LPG use only	1		1		1	
Beehive coal use only	2.39	0.025	2.22	0.061	2.08	0.089
Both use	3.42	0.001	2.77	0.014	2.77	0.014
Cooking time per day						
LPG only (hr.)	0.59	0.016	0.65	0.071	0.66	0.083
Beehive coal only (hr.)	1.06	0.145	1.05	0.290	1.04	0.314
With beehive coal in households using both (hr.)	1.13	0.052	1.14	0.060	1.15	0.047
With LPG in household using both (hr.)	1.07	0.342	1.08	0.323	1.09	0.292
Quantity of cooking fuel per month						
Beehive coal in household using beehive coal only (briquettes)	1.00	0.920	1.00	0.819	1.00	0.798
LPG in household using LPG only (kg)	0.92	0.485	0.89	0.258	0.93	0.217
Beehive coal in household using both (briquettes)	1.06	0.517	1.00	0.931	1.00	0.980
LPG in household using both (kg)	0.86	0.008	0.86	0.026	0.87	0.031
Ever used beehive coal						
No	1		1		1	
Yes	6.97	<0.001	7.56	0.001	7.38	0.002
Number of years used beehive coal (years)	1.075	<0.001	1.08	<0.001	1.079	<0.001
Ever used biomass						
No	1		1		1	
Yes	5	<0.001	4.7	<0.001	5.2	<0.001
Number of years used biomass (years)	1.073	<0.001	1.074	<0.001	1.076	<0.001
Cooking fuel emission exposure from neighboring households						
No	1		1		1	
Yes	1.83	0.003	1.51	0.196	1.56	0.161
House conditions						
Dampness and mould status						
No	1		1		1	
Yes	2.54	0.001	3.44	<0.001	3.29	<0.001
Distance from house to main road (m)	0.999	0.01	0.998	0.002	0.998	0.002
Distance from house to farmland (m)	0.999	<0.001	0.999	<0.001	0.999	<0.001
Distance from house to industrial section (m)	1.00	0.431	1.00	0.067	1.00	0.060
Indoor smoking status						
No	1		1		1	
Yes	0.95	0.858	1.24	0.469	1.19	0.563

[a] *These respiratory symptoms for duration of one month or more per year*

Table 4 Association between cooking fuel practice, house conditions and socio-demographic factors; and SOB when hurrying on level ground, wheeze and current COPD status

Independent variables	SOB when hurrying on level ground		Wheeze with SOB in adult		Current COPD	
	Crude OR	***P-value***	**Crude OR**	***P-value***	**Crude OR**	***P-value***
Socio-demographic factors						
Age (yrs)	1.058	<0.001	1.058	<0.001	1.068	<0.001
Education						
Below secondary school	1		1		1	
Upper secondary school	0.436	<0.001	0.40	0.001	0.355	<0.001
Occupation						
Officer	1		1		1	
Trader	1.26	0.616	1.70	0.367	1.27	0.735
Worker	2.88	0.002	2.54	0.356	3.03	0.284
Farmer	1.65	0.167	1.83	0.210	1.87	0.257
Housewife	1.24	0.552	1.36	0.536	1.83	0.282
Chemical fumes exposure in workplace						
No	1		1		1	
Yes	2.78	<0.001	1.47	0.132	1.61	0.080
Cooking fuel practice						
Current cooking fuel use						
LPG use only	1		1		1	
Beehive coal use only	4.2	<0.001	3.39	<0.001	4.49	<0.001
Both use	6.5	<0.001	2.32	0.009	2.73	0.007
Cooking time per day						
LPG only (hr.)	0.41	<0.001	0.54	0.001	0.47	0.001
Beehive coal only (hr.)	1.06	0.065	1.11	0.004	1.12	0.002
With beehive coal in households using both coal and LPG (hr.)	1.31	<0.001	1.07	0.209	1.01	0.816
With LPG in household using both beehive coal and LPG (hr.)	1.06	0.087	1.03	0.673	0.96	0.698
Quantity of cooking fuel						
Beehive coal only (briquettes)	1.001	0.041	1.002	0.008	1.001	0.047
LPG only (kg)	0.83	<0.001	0.87	0.002	0.8	<0.001
Beehive coal in household using both (briquettes)	1.003	0.013	1.001	0.331	1.00	0.762
LPG in household using both (kg)	0.96	0.243	1.009	0.813	0.99	0.861
Have ever used beehive coal						
No	1		1		1	
Yes	7.02	<0.001	5.66	<0.001	6.7	<0.001
Number of year used beehive coal (years)	1.13	<0.001	1.07	<0.001	1.08	<0.001
Have ever used biomass						
No	1		1		1	
Yes	7.8	<0.001	4.98	<0.001	5.32	<0.001
Number of year used biomass (years)	1.14	<0.001	1.08	<0.001	1.08	<0.001
Cooking fuel emission exposure from neighboring households						
No	1		1		1	
Yes	1.70	0.02	1.52	0.086	1.43	0.177
House conditions						
Dampness and mould status						
No	1		1		1	
Yes	3.27	<0.001	3.06	<0.001	3.95	<0.001
Distance from house to main road (m)	0.99	<0.001	0.997	<0.001	0.997	<0.001
Distance from house to farmland (m)	0.99	<0.001	0.999	<0.001	0.99	<0.001
Distance from house to industrial section (m)	1.00	0.238	1.00	0.783	1.00	0.659
Indoor smoking status						
No	1		1		1	
Yes	1.36	0.132	1.36	0.182	1.98	0.960

population in each study. Furthermore, the higher prevalence of SOB when hurrying on level ground can be explained that study participants possibly did not distinguish between SOB when hurrying on level ground due to respiratory impairment and heavy physical activity.

The study findings investigated that there were associations between respiratory effects and current cooking fuel use and history of solid fuel use. However, the association of history of solid fuel use with all six respiratory symptoms and illness was significantly stronger than that of current fuel use. Obviously, if a woman, who currently uses LPG only as cooking fuel, had used beehive coal or biomass for long time in the past; she enables to get as high risk of respiratory effects as a woman who currently use beehive coal and have the same exposure duration because that woman has already had long-term exposure to beehive coal emissions. The study which was conducted in China also figured out that the largest total amount of average lifetime exposed with solid fuel significantly associated with decreases of pulmonary function [14]. This author also had another research in 2012 and showed the consistent results that those who had the highest tertile of solid fuel use duration had greater odds of health effect [15]. It can be said that history of solid fuel use was more principal determinants to the occurrence of health effects than current cooking fuel use.

The cooking time with cooking fuel use per day just showed the significant association with a few respiratory impairments. This feature can be elucidated by the difference of quantity of fuel consumed per day in women who have the same cooking time. Spending the same time on cooking per day does not mean having equivalent quantity of fuel used per day. For instance, women who simultaneously use 3 or 4 even 5 beehive coal briquettes with big stove spend the same time as those burn one beehive coal briquette only. However, the present study just collect the data of quantity of cooking fuel per month instead of daily.

Dampness and mould in house; distance of house location to main road and farmland also contributed to occurrence of respiratory impairments in this study with $p<0.001$. The same results was also found in the European Community Respiratory Health Survey which was conducted in 2002 and pointed out that mould exposure had strong relationship with asthma symptoms and bronchial responsiveness [16]. Outdoor air pollution owing to pesticide effects from farmland and pollutants from main road was also pointed out in Vietnam. Poverty-Environment Report figured out that the pesticide use in Vietnam is increasing more and more and the substances in pesticide composition were very adverse to respiratory health and environment [17]. Meanwhile, effects from main road was reported in Vietnam National State of Environment report in 2007 with the statement that road transport was greatest source of outdoor air pollution in Vietnam, attributed 70% of total pollution [18].

In this study, the relationship between passive smoking and the presence of respiratory effects could not be confirmed. Meanwhile, other studies in the world clearly pointed out this relationship [19], [20]. The inconsistency can be explained by the fact that the study just assessed study participants have family member who usually smoke in house but not directly assessed whether women exposed to cigarette or cigar smoke from their family members or not. In cases that even participants have indoor smoker but they usually keep stay away when those smoke, these cases could not take into account to be secondhand smoking.

CONCLUSION

The women who those currently utilizes beehive coal and both LPG and beehive coal significantly have higher risk of almost respiratory effects with different magnitudes except phlegm, both cough and phlegm lasting 1 month or more per year than those use LPG only. The positive relationships of respiratory effects with current cooking fuel use are not as strong as history of solid fuel use in the study. The study findings provided more evidences for hypothesis that the longer exposure to solid fuel emissions is; the greater risk of respiratory effects are. Intervention activities should be taken place to change awareness and behavior of the community on choice of the safer cooking fuels toward the better health.

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