RESPIRATORY SYMPTOMS IN RELATION TO HOUSEHOLD AIR POLLUTION SOURCES IN RURAL AND URBAN AREAS OF VIENTIANE CAPITAL, LAO PDR

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ABSTRACT: The objective of this cross-sectional study was to investigate whether household air pollution source from house characteristic, practices and personal factors associated with risk of respiratory symptoms among people living in rural and urban area of Vientiane Capital, Lao PDR, and also to compare the prevalence of respiratory symptom and practices between two areas. A total of 422 households were studied; one male and one female per household with age of 15 - 59 years were interviewed. Total respondents were 770, missing for those who were absent or declined to participate. Data were collected in February and March 2012, by using structured interviewer-administered questionnaires. Bivariate analysis was performed to find associations between factors in household as air pollution sources and respiratory symptoms. The descriptive findings found that people in rural area were quite more vulnerable than people in urban according to the percentage of each respiratory symptom and many other related conditions. The respiratory symptoms studied were cough without colds, phlegm without colds, wheeze and shortness of breath. In analytical findings, associations were found in some factors of socio-demographic, household characteristic, household practices, and some of personal practices and health with each respiratory symptom. Inside, when compared between two areas, urban was found to have more associated factors than rural.

Keywords: Air Pollution, Respiratory Symptoms, Rural, Urban, Lao PDR

INTRODUCTION

Household air pollution causes respiratory and other diseases [1]. Respiratory disease is one dominant health concern as one leading cause of worldwide morbidity and mortality [2]. Clean air is considered to be a basic requirement of human health. However, air pollution continues to pose a significant threat to global health [3]. It can be said that to avoid respiratory disease and symptoms, air pollution is needed to be reduced [4]. In Asia, the prevalence of exposure to household air pollution is high, especially among people living with poverty [5]. In Laos, 2001, approximately 81.60% of the population used biomass fuels for cooking or heating [6]. Further information is that households air pollution in the country attributed to 2,600 deaths/year and 11 DALYs/1000cap/year [7]. In Laos, household air pollution is also one of environmental issues and while the country has been accountable to the harming of respiratory diseases, promoted by poor air quality, that comprise the top causes of morbidity and mortality [3]; while strong trend of people moving from rural to cities has been found, Vientiane Capital therefore has the highest proportion of urban area, about 82% [8]. Energy use in country is dominated by household activity. In Vientiane capital, air pollutant level has been found to be quite high; with poor ventilation, pollution is therefore trapped in the areas where they are generated [3]. A previous study found positive associations between indoor air pollutants and respiratory symptoms among women and children [9]; however, further study is also essential to show a comparison between people who lived in rural area and urban area. Both male and female are also interested to be included in study, as they all involve in home scale activity. Due to a crowded living condition and the in-migration of people from every part of the country, it is therefore very important and interesting to know about the prevalence of each respiratory symptom among people living in rural and urban area of Vientiane capital, and the difference in each prevalence between two areas. Also, it is very important to find out how the exposure to household air pollution sources, such as household characteristics and practices of people, associate

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Table 1 Associations of independent variables with prevalence of cough and phlegm with and without colds

Independent Variables	Cough without Cold		Phlegm without Cold	
	OR(95% CI)	*P-value*	OR(95% CI)	*P-value*
Socio-Demographic				
Area: Rural vs. Urban	1.8 (1.2-2.8)	0.003		
Main Job (5 levels)		0.074*		
Years of family living: > 20 years vs. ≤ 20 years	1.9 (1.2-2.8)	0.002	1.7 (1.1-2.7)	0.020
Household Income: ≤ 2,000,000k vs. > 2,000,000k			0.5 (0.3-0.8)	0.005
House member: > 5 vs. ≤ 5			1.8 (1.1-2.9)	0.008
Household Characteristic				
House location: By major road vs. In street	1.6 (1.1-2.4)	0.016	2.2 (1.4-3.4)	0.001
House nearby factory:	1.5 (1.02-2.3)	0.039	1.4 (0.8-2.2)	0.146
Type of House (4 levels)		0.087*		
Kitchen in house vs. Outside			2.4 (1.2-4.9)	0.013
Kitchen with windows	0.6 (0.4–1.1)	0.096	1.9 (0.8-4.2)	0.111
House Floor (3 levels)				
House windows: >10 vs. ≤10	1.5 (1.01-2.2)	0.042	1.7 (1.1-2.7)	0.016
Rooms in house: ≤ 4 vs. > 4			0.6 (0.3-0.9)	0.030
House with exhaust fan	0.5 (0.3-0.7)	0.001		
Household Practice				
Main fuel for cooking: Biomass vs. Non-biomass			0.7 (0.4-1.1)	0.154
Mosquito coil use	1.5 (0.9–2.2)	0.056	1.5 (0.9-2.4)	0.054
Smoker(s) in the house				
Lightening fire for body warming during cool season	2.2 (1.4–3.3)	< 0.001	1.4 (0.8-2.3)	0.186
Waste Burning	2.8 (1.9-4.2)	< 0.001		
Knowledge				
Heard about Household Air Pollution	0.5 (0.3–0.7)	< 0.001	0.7 (0.4-1.1)	0.131
Personal Practice and Health				
Spend time most in house			0.6 (0.4-1.0)	0.052
Minutes spent in the kitchen/day (3 levels)		0.021*		0.068*
Current smoker vs. never & past smoker	2.3 (1.4-3.6)	< 0.001	2.1 (1.2-3.5)	0.006
Number of cigarettes/day (3 levels)		0.003*		0.018*
Years of Smoking (3 levels)		0.002*		0.002*
Having chronic disease(s)**	2.0 (1.3–3.1)	0.001	1.9 (1.2-3.2)	0.007

* *P-value* for independent variable as a factor, not for individual levels of the variable.

** Chronic disease(s): including hypertension, diabetes, COPD, etc. that a respondent is having as underlying disease.

with each respiratory symptom among those people.

METHODS

A cross-sectional study was conducted in Vientiane Capital, Lao PDR. The data collection started from mid-February to March. The study population was the households which had been residing in the study area for at least 6 months, both private and collective households. Totally 422 households were divided into 281 urban households and 141 rural households. Multi-stage sampling was used including purposive, cluster and simple random sampling. Vientiane capital, purposively sampled, consists of 9 districts (4 districts in rural and 5 districts in urban). For rural area, Pakngeum District was randomly selected from four districts of rural area in Vientiane capital; then Natharm Village was randomly selected from 53 villages in Pakngeum District. For urban area, Chanthabouly District was randomly selected from five districts of urban area in Vientiane capital; then Thongsangnang Village was randomly selected from 30 villages in Pakngeum District. Two people per one household were subjected as male and female, age range 15 - 59 years and truly being a member of that household. Total respondents were 770, missing 74 subjects for those who were absent or declined to participate. Structured questionnaire, reviewed by three experts of Environmental and Occupational Health, was used to ask about household characteristics, practices and other personal related information, based on extensive review, American Thoracic Society [10] and this study's specific purposes. The study was approved by Ethical Consideration Committee for Research in Human Subjects, Chulalongkorn University, Thailand and the Research Ethical Committee of University of Health Sciences, Laos.

The software SPSS v.17 was used for descriptive and inferential data analysis. In a bivariate analysis,

Table 2 Associations of independent variables with prevalence of wheezing and SOB

Independent Variables	Wheezing with or without cold		SOB with or without cold	
	OR (95% CI)	***P-Value***	**OR (95% CI)**	***P-Value***
Socio-Demographic				
Area: Rural vs. Urban	3.7 (2.2-6.3)	< 0.001	7.3 (4.8-11.1)	< 0.001
Age group: > 36 vs. ≤ 36			1.5 (1.03-2.2)	0.035
Home town: Original vs. Moved in	1.6 (0.9-2.7)	0.060	2.3 (1.5-3.4)	< 0.001
Job (5 levels)		< 0.001*		<0.001*
Educational level (3levels)		0.001*		<0.001*
Marital Status (3 levels)				0.014*
House Income/month: ≤ 2,000,000k vs. > 2,000,000k	2.4 (1.4-4.2)	0.002	3.2 (2.1-4.9)	<0.001
Duration of living: > 20 years vs. ≤ 20 years			1.6 (1.1-2.4)	0.014
Household Characteristic				
House location: By road vs. In small street	0.6 (0.3-1.1)	0.149	0.7 (0.4-1.06)	0.097
House nearby factory	1.6 (0.9-2.8)	0.084		
Kitchen in house vs. Outside	0.6 (0.3-1.0)	0.057		
Type of House (3levels)		0.002*		<0.001*
House with exhaust fan	0.6 (0.4-1.1)	0.087	0.4 (0.3-0.6)	<0.001
Kitchen with window			0.5 (0.3-0.9)	0.019
House windows: > 10 vs. ≤ 10	0.6 (0.3-1.1)	0.124	0.6 (0.4-1.01)	0.064
Rooms in house: ≤ 4 vs. > 4	2.7 (1.4-5.3)	0.002	2.5 (1.6-4.1)	<0.001
Dust in House: Very dusty vs. Little dusty	0.6 (0.3-1.0)	0.061	0.4 (0.3-0.6)	<0.001
Household Practice				
Main fuel for cooking: Biomass vs. Non-biomass	2.1 (1.1-3.9)	0.018	2.7 (1.7-4.4)	<0.001
Waste Burning	2.2 (1.3-3.8)	0.002	4.02 (2.7-5.9)	<0.001
Smoker(s) in the house	2.2 (1.3-3.7)	0.003	2.2 (1.5-3.2)	<0.001
Lightening fire for body warming during cool season	3.9 (2.3-6.6)	<0.001	3.8 (2.5-5.7)	<0.001
Incense stick burning				
Observed Smoke from fire flows into the house	0.6 (0.3-1.1)	0.101	0.7 (0.4-1.1)	0.104
Knowledge				
Heard about Household Air Pollution	0.4 (0.2-0.7)	0.001	0.5 (0.3-0.7)	<0.001
Personal Practice and Health				
Spend time most in house	2.6 (1.4-4.7)	0.001	1.9 (1.3-2.8)	0.002
Cook for family	1.5 (0.9-2.6)	0.124	1.5 (1.06-2.3)	0.025
Minutes spent in the kitchen/day (3levels)		0.017*		0.001*
Minutes spent by fire/day: > 30 min vs. ≤ 30 min	3.2 (1.8-5.6)	<0.001	2.7 (1.8-4.1)	<0.001
Current smoker vs. non and past smoker			1.5 (0.9-2.5)	0.061
Number of cigarettes/day (3 levels)				0.104*
Years of Smoking (3 levels)				0.082*
Having chronic disease(s)**	2.9 (1.7-4.9)	< 0.001	1.6 (1.06-2.5)	0.025

* *P-value* for independent variable as a factor, not for individual levels of the variable.

Symptom with/without cold means that symptom with cold and without cold in the same respondent are combined as one, because all or nearly all of respondents have ever had the symptom both with and without cold.

** Chronic disease(s): including hypertension, diabetes, COPD, etc. that a respondent is having as underlying disease.

in which dependent variables were examined separately, chi-square and binary logistic regression were used to find out the association between each independent variable and each respiratory symptom: cough, phlegm, wheeze and shortness of breath. A total of 35 independent variables was examined. Results for any of these for which p<0.15 are shown in Tables 1, 2, 3 and 4. Among totally 35 independent variables, any of them with p < 0.15 from chi-square and binary logistic regression are shown (Table 1 - 4).

RESULTS

Table 1, 2, 3 and 4 show inferential findings and Table 5, 6 and 7 show descriptive findings. By using median as the cut point of household income, most rural households had percentage of lower income (83.7%) much more than urban households (37.7%). However, urban household had higher prevalence of very dusty house environment than rural household. Activity in the household, 67.5% of all households used biomass fuel for cooking and heating purpose; especially in rural, 98.6% used

Table 3 Associations of independent variables with prevalence of cough and phlegm without cold in rural and urban

Independent Variables	Cough without cold				Phlegm without cold			
	Rural		Urban		Rural		Urban	
	OR(95% CI)	*P-value*	OR(95% CI)	*P-value*	OR(95% CI)	*P-value*	OR(95% CI)	*P-value*
Socio-Demographic								
Educational level (3 levels)		0.035*						
Years of family living: > 20 years vs. ≤ 20 years			2.1 (1.2-2.5)	0.004			1.9 (1.1-3.2)	0.021
Household Income: ≤ 2,000,000k vs. > 2,000,000k	0.4 (0.2-1.0)	0.051	0.6 (0.3-1.1)	0.108			0.3 (0.1-0.5)	<0.001
House member: > 5 vs. ≤ 5							2.1 (1.2-3.7)	0.006
Household Characteristic								
House location: By major road vs. In street	2.3 (1.2-4.8)	0.012	1.5 (0.9-2.5)	0.094			2.9 (1.6-5.0)	<0.001
House nearby factory:			1.5 (0.9-2.5)	0.100				
Type of House (4 levels)								0.055*
Kitchen in house vs. Outside			1.7 (0.8-3.6)	0.123			2.8 (1.1-7.3)	0.022
Kitchen with windows					2.2 (0.8-7.2)	0.114		
House Floor (3 levels)				0.028				
Dust in house: Very dusty vs. Little dusty	1.8 (0.9 – 3.7)	0.077					1.7 (0.9-3.3)	0.088
House windows: >10 vs. ≤10			1.9 (1.1-3.3)	0.010			2.3 (1.3-4.2)	0.003
Rooms in house: ≤ 4 vs. > 4			0.5 (0.3-0.8)	0.008			0.4 (0.2-0.8)	0.009
House with exhaust fan			0.5 (0.3-0.9)	0.023				
Household Practice								
Main fuel for cooking: Biomass vs. Non-biomass							0.6 (0.3-1.0)	0.101
Mosquito coil use			1.5 (0.9–2.5)	0.098	2.3 (0.9–5.5)	0.050		
Smoker(s) in the house	0.4 (0.2–0.9)	0.023	1.5 (0.9-2.6)	0.092	0.4 (0.1-0.8)	0.021	2.1 (1.2-3.7)	0.005
Lightening fire for body warming during cool season	2.6 (1.1-6.7)	0.031			2.7 (0.7-9.4)	0.103		
Waste Burning			4.8 (2.4-9.4)	< 0.001				
Observed Smoke from fire flows into the house			2.2 (0.9-5.0)	0.047			3.4 (1.2-9.7)	0.013
Knowledge								
Heard about Household Air Pollution	0.4 (0.2-1.0)	0.048	0.5 (0.3–1.0)	0.054				
Personal Practice and Health								
Spend time most in house							0.5 (0.3-0.9)	0.021
Cook for family					2.6 (0.9-7.2)	0.057	0.4 (0.2-0.8)	0.007
Minutes spent in the kitchen/day (3 levels)						0.012*		0.037*
Current smoker vs. never & past smoker			2.8 (1.5-5.2)	< 0.001			3.3 (1.7-6.3)	<0.001
Number of cigarettes/day (3 levels)				0.001*				<0.001*
Years of Smoking (3 levels)				0.002*				0.002*
Having chronic disease(s)**	1.9 (0.9–3.9)	0.052	2.0 (1.1–3.4)	0.013			2.2 (1.2-4.0)	0.006

* P-value for independent variable as a factor, not for individual levels of the variable.

** Chronic disease(s): including hypertension, diabetes, COPD, etc. that a respondent is having as underlying disease.

Table 4 Associations of independent variables with prevalence of wheezing and SOB in rural and urban

Independent Variables	Wheezing with or without cold				SOB with or without cold			
	Rural		Urban		Rural		Urban	
	OR(95% CI)	*P-value*	OR(95% CI)	*P-value*	OR(95% CI)	*P-value*	OR(95% CI)	*P-value*
Socio-Demographic								
Age group: > 36 vs. ≤ 36							2.1 (1.1-4.1)	0.016
Job (5 levels)						0.047*		
Educational level (3levels)				0.047*				
Household Characteristic								
House location: By road vs. In small street			0.4 (0.1-1.0)	0.061				
House nearby factory	1.9 (0.8-4.1)	0.096						
Kitchen in house vs. Outside			0.4 (0.2-1.0)	0.068				
Type of House (3levels)								0.095*
House with exhaust fan	2.4 (1.1-5.3)	0.015	0.2 (0.1-0.6)	0.001			0.4 (0.2-0.8)	0.010
Household Practice								
Waste Burning							2.0 (0.8-5.0)	0.139
Smoker(s) in the house			2.1 (0.9-4.6)	0.053			1.6 (0.8-3.1)	0.119
Lightening fire for body warming during cool season	2.2 (0.8-6.1)	0.100						
Knowledge								
Heard about Household Air Pollution			0.4 (0.1-0.9)	0.033			0.5 (0.2-1.0)	0.072
Personal Practice and Health								
Spend time most in house			5.4 (1.8-15.8)	0.001			2.7 (1.3-5.5)	0.004
Cook for family					1.6 (0.9-2.9)	0.084		
Minutes spent in the kitchen/day (3levels)				0.084*		0.024*		
Minutes spent by fire/day: > 30 min vs. ≤ 30 min	2.3 (0.8-6.0)	0.080	2.3 (1.1-5.0)	0.029			1.8 (0.9-3.4)	0.064
Current smoker vs. non and past smoker			2.0 (0.8-5.3)	0.125			2.2 (1.6-3.8)	0.030
Number of cigarettes/day (3 levels)								0.008*
Years of Smoking (3 levels)				0.007*				0.064*
Having chronic disease(s)	4.0 (1.8-8.5)	<0.001						

* *P-value* for independent variable as a factor, not for individual levels of the variable.

Symptom with/without cold means that symptom with cold and without cold in the same respondent are combined as one, because all or nearly all of respondents have ever had the symptom both with and without cold.

Table 5 Household characteristics and household practices in rural and urban areas

Independent variables		Rural n = 141 Freq. (%)	Urban n = 281 Freq. (%)
Household characteristics			
Location:	By major road	37 (26.2)	110 (39.1)
House member:	> 5 persons	59 (41.8)	127 (45.2)
Years of family living:	> 20 years	125 (57.6)	250 (45.2)
House income/month: (1USD=8,000 kip)	≤ 2,000,000 kip	118 (83.7)	106 (37.7)
House type:	Wood	19 (13.5)	14 (5.0)
	Concrete	34 (24.1)	183 (65.1)
	Wood-Concrete	88 (62.4)	84 (29.9)
House floors:	> 1 floor	84 (59.6)	120 (42.7)
Windows in house:	> 10 windows	35 (24.8)	142 (50.5)
Rooms/house:	> 4 rooms	10 (7.1)	130 (46.3)
House nearby factory		76 (53.9)	146 (52.0)
Dust observed in house environment:	Very dusty	39 (27.7)	190 (67.6)
Kitchen Inside the house		105 (74.5)	226 (80.4)
Kitchen without window		45 (31.9)	18 (6.4)
House with exhaust fan		69 (48.9)	225 (80.1)
Household practices			
Biomass as main fuel for Cooking		139 (98.6)	146 (52.0)
Waste Burning		109 (77.3)	22 (7.8)
Mosquito coil burn		68 (48.2)	106 (37.7)
Incense stick burning		72 (51.1)	181 (64.4)
House with cigarette smoker:		96 (68.1)	87 (30.9)
	1 smoker	78 (55.3)	67 (23.8)
	> 1 smoker	18 (12.8)	20 (7.1)
Lighting fire for body warming during cool season		104 (73.7)	7 (2.5)

Table 6 Personal characteristics of rural and urban participants

Variables		Rural n=217 Freq. (%)	Urban n = 553 Freq. (%)
Age:	37 - 59 years	118 (54.4)	250 (45.2)
	15 – 36 years	99 (45.6)	303 (54.8)
Sex:	Male	93 (42.9)	268 (48.4)
	Female	124 (57.1)	285 (51.6)
Marital status:	Single	6 (2.8)	149 (26.9)
	Married	207 (95.4)	391 (70.7)
	Divorced/Widow(er)	4 (1.8)	13 (2.3)
Hometown:	Original villager	164 (75.6)	195(35.2)
Education:	Tertiary	5 (2.3)	299 (54.1)
	Secondary	80 (36.9)	208 (37.6)
	Primary	132 (60.8)	46 (8.3)
Main Job:	Office staff	3 (1.4)	243 (43.9)
	Farmer	172 (79.3)	2 (0.4)
	Labor	10 (4.6)	36 (6.5)
	Unemployed	21 (9.7)	121 (21.9)
	Business Owner	11 (5.1)	151 (27.3)
Current Smoker:		52 (23.5)	70 (12.7)
	Light smoker (1-8 cigarettes/day)	12 (5.5)	52 (9.4)
	Heavy smoker (> 8 cigarettes/day)	20 (9.2)	38 (6.9)
Past smoker		4 (1.8)	25 (4.5)
Duration of smoking:	1 - 15 years	20 (9.2)	46 (8.3)
	> 15 years	32 (14.7)	24 (4.3)
Spending time in a day mostly inside the house		140 (64.5)	294 (53.2)
Cook for family		136 (62.7)	289 (52.3)
Time spent in kitchen/day:	1 - 60 min	75 (34.6)	196 (35.4)
	> 60 min	63 (29.0)	91 (16.5)
Time spent by fire/day:	1 - 30 min	61 (34.9)	390 (70.5)
	> 30 min	114 (65.1)	163 (29.5)
Chronic disease		56 (25.8)	112 (20.3)

Table 7 Respiratory symptom prevalences in participants

Dependent variables	Rural n= 217 Freq. (%)	Urban n=553 Freq. (%)	Total n=770 Freq. (%)
Cough without cold	46 (21.2)	70 (12.6)	116 (15.1)
Phlegm without cold	25 (11.5)	59 (10.7)	84 (10.9)
Wheezing with or without cold	35 (16.1)	27 (4.9)	62 (8.1)
Shortness of Breath(SOB) with or without cold	83 (38.2)	43 (7.8)	126 (16.4)

biomass fuel for cooking and much higher than in urban. Also prevalence of waste burning and lighting fire for body warming during cool season were much higher in rural (Table 5).

Rural area had higher prevalence of lower education level than urban area. The main occupation of rural residents was farmer, while that of urban residents was office staff. Prevalence of current smoker was 15% of all respondents were current smokers. The percentage of current smoker and people having chronic disease in rural were also higher than in urban (Table 6).

Prevalence in each respiratory symptom in rural respondents was higher than prevalence in urban respondents. The highest symptom prevalence found in this study was cough (Table 7).

***Cough without cold*:** Socio-demographically, positive associations were found in rural area, original villager and older family (> 20 years). In household characteristics, house located by road, nearby factory and having greater number of windows were found positively associated. In household practice, mosquito coil use, lightning fire for warming and waste burning were found to be risks. Higher knowledge regarding household air pollution was associated with lower prevalence. Personal practice and health background, positive associations was found in current smokers and having chronic disease. Also time spending in kitchen, number of cigarettes smoked/day and years of smoking were found statistically significant (Table 1).

Phlegm without cold: In socio-demographic factors, positive associations were found in older family and greater number of house member. People who lived in lower income household were less likely to have this symptom. In household characteristics, house located by road, nearby factory, kitchen inside the house and having greater number of windows were found positively associated. In household practice, mosquito coil use and house heating were also found to be risks. Personal practice and health background, positive association was found in having chronic disease. Smoking status, number of cigarette smoked/day and years of smoking were also statistically significant (Table 1).

Wheezing with or without cold: In socio-demographic factors, positive associations were found in rural area, lower income household, and original villagers. In household characteristics, lesser number of rooms in house and house nearby factory were found positively associated. In household practice, biomass fuel use, waste burning, smoker in house and house heating were statistically significant. Knowledge on household air pollution was found to be protective for this symptom. In personal practice and health, positive associations were found in spending time most inside house, time spent by fire > 30 minutes, and having chronic disease (Table 2).

SOB with or without cold: In socio-demographic factors, strongly positive association was found in rural area (OR=7.3, p<0.001), while other factors also showed risky role such as older age group, original villagers, lower income and older family. Jobs, education and marital status were also found significant. In household characteristics, lesser number of rooms in house was found positively associated. House with exhaust fan and greater number of windows showed protective role for this symptom. In household practice, biomass fuel use (OR=2.7), waste burning (OR=4.02), smoker in house (OR=2.2) and staying near fire for body warming (OR=3.9) were all statistically significant. Knowledge on household air pollution was found to be protective for this symptom (OR=0.5, p < 0.001) (Table 2).

Inferential analysis separated by area: Again, only variables with p< 0.15 were shown up. Some variables from previous tables 4 and 5 might be dropped out. More variables were found significant and nearly significant in association with both cough and phlegm in urban area than in rural area. Variables that seemed to act on cough without cold in both rural and urban were household income, house location, smoker(s) in house, knowledge, and chronic disease (Table 3). For phlegm without cold, only three variables that seemed to act on in both areas were smoker(s) in house, regularly cooking for family, and time duration spent in kitchen/day. Similarly, more variables were found significant

and nearly significant in association with wheeze and SOB with or without in urban area than in rural area. Variables that seemed to act on wheeze with or without cold in both rural and urban were house with exhaust fan and time spent by fire/day. For SOB with or without cold, variables associated with the symptom in both areas were not similar at all (Table 4).

DISCUSSION

In descriptive findings, it was found that percentage of biomass fuel use in this study (67.5%) was less than the percentage in previous records, e.g., in 2001, approximately 81.6% of the population in general used biomass fuels for cooking or heating [6]; this might be due to the distribution of urban-rural was different between proportion of urban-rural in Vientiane capital and proportion of urban-rural in country which is considerably reverse, as the use of biomass fuel seems to follow geographical patterns [11], e.g. forest cover; as well as economic status, or people may tend to use more in non-biomass fuel, e.g. electricity and gas, for cooking as being urbanized. However, the prevalence of biomass fuel use is still high in rural (98.6%). There was also a study in China which found that the rural population had higher indoor air pollution exposure than the urban population [12]. Average number of household member and proportion of male and female in the present study were similar to the data of the country, e.g.Total population of Lao PDR is 5.62 million, 50.2% were females and 49.8%were males [8]. The average household size is 5.9 people/ household [6]. The prevalence of each symptom is quite different to the prevalence in previous study in Burmese community in Thailand [13]. These differences might reflect differences of socio-demographic and other conditions.

In analytical findings, this study found some sources of household air pollution with had positive association with respiratory symptoms and might be able to support the findings in previous study that almost of household pollutants, such as CO, PM_{10} and NO_2, had positive association with most of respiratory symptoms of women and children [9], consistency to another research that focused on mosquito coil, as household air pollution source and respiratory symptoms, positive association significantly was found, for instant with cough with/without cold in respondents (OR=1.84, 95% CI=1.02 to 3.33, p=0.045) [13]. Biomass fuel as the main fuels use in household were found to be positively associated with cough, phlegm, wheeze and shortness of breath that has also shown consistencies to other previous studies in other countries, e.g. a case-control study in Turkey women with obstructive airway disease [14], a study on exposure to biomass fuel smoke in rural and urban of Africa [15], a meta-analysis study in 2002 [16], a study in China about urban and rural exposure to indoor air pollution from domestic biomass and coal burning [12], a cohort study in China [17]. While many studies focused on women's respiratory health regarding household air pollution exposure and found positive association [9, 12-15, 18, 19], this study found no association between gender and respiratory symptoms in respondents. This might be possible that there are not only women who cook for family or expose to household air pollution, but also men nowadays, or the population in this study were not specifically exposed to household combustion smoke daily like in specific ethnics, or might be due to the high percentage of smoking in men that could bring respiratory symptom even not exposed to household air pollution. Adverse association in very dusty house might be due to a wrong observation, as the tool for detecting particulate matter or ventilation was not used, and did not know for certain whether a house was cleaned prior to the coming of data collector; further study may be needed to add this point. Another study found that arsenic from fertilizer in drinking water was statistically associated with respiratory symptoms [20]; however, this study did not include questions about using of fertilizer.

Years of family living, house location, number of windows in house, house with exhaust fan, lightening fire for body warming during cool season, waste burning, and knowledge on household air pollution were statistically associated with cough without cold; while biomass fuel, household with smoker, observed Smoke from fire flows into the house, and spending time most in house were not statistically associated with cough without cold. Also in phlegm without cold, area, house with smoker, observed Smoke from fire flows into the house, and cook for family were not statistically associated with phlegm without cold; while household income, number of house member, and having chronic disease were statistically associated with phlegm without cold (Table 1) This could suggest that different symptom can either have same associated factors and different associated factors. Most of all respiratory symptoms were strongly co-associated with having chronic disease, socio-demographic of rural and urban area, household characteristic of rooms in house, house practices (lightening fire for body warming and

waste burning), knowledge and personal practice of spend time in kitchen.

Results of associations separated by area shows that urban area had many more variables than rural area that were found to be associated with each respiratory symptom, while the descriptive result shows each respiratory symptom prevalence in rural higher than in urban. It might be because of the differences in household characteristics and practices, personal practices and household pollutant levels which were not covered in this study. The overall, our finding demonstrated that respiratory symptoms in urban area were mostly co-associated with personal practices (spending time in house, current smoking, number of cigarette smoking per day and duration time of smoking) and household character of house with exhaust fan. But in rural area, most different variables were associated with each respiratory symptom. Cough and phlegm symptoms were co-associated with smoking in house while cough and wheezing symptoms were co-associated with having chronic disease.

CONCLUSION

Prevalence of respiratory symptoms was higher in rural than in urban. But the household air pollution sources variable which associated with each respiratory symptom in urban were more than in rural area. It should be because of more potential or intensity of the household air pollution sources variable in rural area. However, we suggested that knowledge on household air pollution was interesting factor for planning of decreasing those respiratory symptoms.

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REFERENCES

1. World Health Organization [WHO]. Public health and environment: air pollution; 2011 [cited 2011september 12]. Available from: http://www.who.int/topics/air_pollution/en/
2. World Health Organization [WHO]. Global burden of disease: 2004 update. Geneva: WHO; 2008 [cited 2011 September 15]. Available from: http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf
3. World Health Organization [WHO]. Lao People's Democratic Republic: Environmental Health Country Profile; May 19, 2005 [cited 2011 August 1]. Available from: http://www.environmenthealth.asia/fileupload/laopdr_ehcp_19May05.pdf
4. World Health Organization [WHO]. Air quality and health (Factsheet No. 313); 2011 [cited 2011 September 16]. Available from: http://www.who.int/mediacentre/factsheets/fs313/en/
5. HEI International Scientific Oversight Committee. Outdoor air pollution and health in the developing countries of Asia: a comprehensive review: Executive Summary (Special report 18); 2010 [cited 2011 October 14]. Available from: http://pubs.healtheffects.org/view.php?id=349
6. National Statistic Center, Lao PDR. Population census: chapter 1&2; 2005 [cited 2011 September 2]. Available from: http://www.nsc.gov.la/Products/PopulationCensus2005_ chapter2.htm
7. World Health Organization [WHO]. Country profile of environmental burden of disease of Laos; 2009 [cited 2011 August 30]. Available from: http://www.who.int/quantifying_ehimpacts/national/countryprofile/laopeodemrep.pdf
8. National Statistic Center, Lao PDR. Population census. chapter 3: household characteristics; 2005 [cited 2011 September 25]. Available from: http://www.nsc.gov.la/Products/Populationcensus2005/PopulationCensus2005_chapter3.htm
9. Mengersen K, Morawska L, Wang H, Murphy N, Tayphasavanh F, Darasavong K, et al. Association between indoor air pollution measurements and respiratory health in women and children in Lao PDR. Indoor Air. 2011 Feb; 21(1): 25-35.
10. American Thoracic Standard Questionnaire: Adult questionnaire; 1978 [cited 2011 November 1]. Available from: http://www.cdc.gov/niosh/atswww.txt
11. Bryan S, Gatti E, Lopes P. Non-renewable biomass assessment in Laos. [S.l.]: Nexus-Carbon for Development; 2012.
12. Mestl HE, Aunan K, Seip HM, Wang S, Zhao Y, Zhang D. Urban and rural exposure to indoor air pollution from domestic biomass and coal burning across China. Sci Total Environ. 2007 May 1; 377(1): 12-26.
13. Tharaphy. The effect of household air pollution due to burning of mosquito coils on respiratory problems in Myanmar migrant workers in Mae Sot district, Tak province, Thailand [Master's thesis]. Bangkok: College of Public Health Sciences, Chulalongkorn University; 2009.
14. Ekici A, Ekici M, Kurtipek E, Akin A, Arslan M, Kara T, et al. Obstructive airway diseases in women exposed to biomass smoke. Environ Res. 2005 Sep; 99(1): 93-8.
15. Fullerton DG, Semple S, Kalambo F, Suseno A, Malamba R, Henderson G, et al. Biomass fuel use and indoor air pollution in homes in Malawi. Occup

Environ Med. 2009 Nov; 66(11): 777-83.
16. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJL. Selected major risk factors and global and regional burden of disease. The Lancet. 2002; 360(9343): 1347-60.
17. Lan Q, Chapman RS, Schreinemachers DM, Tian L, He X. Household stove improvement and risk of lung cancer in Xuanwei, China. J Natl Cancer Inst. 2002; 94(11): 826-35.
18. Fullerton DG, Bruce N, Gordon SB. Indoor air pollution from biomass fuel smoke is a major health concern in the developing world. Trans R Soc Trop Med Hyg. 2008; 102(9): 843-51.
19. Parikh J. Hardships and health impacts on women due to traditional cooking fuels: A case study of Himachal Pradesh, India. Energy Policy. 2011; 39(12): 7587-94.
20. Mazumder DN, Haque R, Ghosh N, De BK, Santra A, Chakraborti D, et al. Arsenic in drinking water and the prevalence of respiratory effects in West Bengal, India. Int J Epidemiol. 2000; 29(6): 1047-52.