RESPIRATORY EFFECTS AMONG NON-SMOKING WOMEN IN RELATION TO HOUSEHOLD COOKING FUEL USES: LIQUEFIED PETROLEUM GAS ONLY, COAL ONLY AND BOTH LIQUEFIED PETROLEUM GAS AND COAL IN TU LIEM SUBURBAN DISTRICT HANOI VIETNAM

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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Public Health Program in Public Health
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การศึกษาผลกระทบต่อระบบทางเดินหายใจในผู้หญิงที่ไม่สูบบุหรี่ซึ่งปรุงอาหาร
โดยใช้เชื้อเพลิงประเภทก๊าซหุงต้ม ถ่าน และทั้งสองประเภท
ในตำบล ทู เลียน เมืองฮานอย ประเทศเวียดนาม

นางสาวเหงียน ทิ มาย ฮาน

วิทยานิพนธ์ฉบับนี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรมหาบัณฑิต

สาขาวิชาสาธารณสุขศาสตร์

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Thesis Title	RESPIRATORY EFFECTS AMONG NON-SMOKING WOMEN IN RELATION TO HOUSEHOLD COOKING FUEL USES: LIQUEFIED PETROLEUM GAS ONLY, COAL ONLY AND BOTH LIQUEFIED PETROLEUM GAS AND COAL IN TU LIEM SUBURBAN DISTRICT HANOI VIETNAM
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เหงียน ทิ มาย ฮาน: การศึกษาผลกระทบต่อระบบทางเดินหายใจในผู้หญิงที่ไม่สูบบุหรี่ซึ่งปรุงอาหารโดยใช้เชื้อเพลิงประเภทก๊าซหุงต้ม ถ่านและทั้งสองประเภทในตำบล ทู เลียม เมืองฮานอย ประเทศเวียดนาม (RESPIRATORY EFFECTS AMONG NON SMOKING WOMEN IN RELATION TO HOUSEHOLD COOKING FUEL USES: LIQUEFIED PETROLEUM GAS ONLY, COAL ONLY AND BOTH LIQUEFIED PETROLEUM GAS AND COAL IN TU LIEM SUBURBAN DISTRICT HANOI VIETNAM) อ. ที่ปรึกษาวิทยานิพนธ์: ผศ. ดร. เนาวรัตน์ กาญจนาคาร: 107 หน้า.

ภูมิหลัง: มลภาวะทางอากาศที่เกิดจากการใช้เชื้อเพลิงหุงต้มเป็นตัวการสำคัญที่ก่อให้เกิดโรคภัยต่างๆโดยเฉพาะในประเทศที่กำลังพัฒนา ประชากรกว่า 2 ล้านคนในประเทศเวียตนามยังคงใช้ถ่านลิกไนท์ในการหุงต้มทุกวัน แต่ข้อมูลที่บ่งชี้ถึงผลกระทบต่อสุขภาพยังมีจำกัด การศึกษานี้เปรียบเทียบถึงผลกระทบของมลพิษที่ถูกปลดปล่อยจากเชื้อเพลิงหุงต้มต่อกลุ่มอาการในระบบทางเดินหายใจในผู้หญิงที่ไม่สูบบุหรี่ซึ่งปรุงอาหารโดยใช้เชื้อเพลิงประเภทก๊าซหุงต้ม ถ่าน และใช้ทั้งสองประเภทในตำบล ทู เลียมและวิเคราะห์หาความสัมพันธ์กับปัจจัยที่เกี่ยวข้องอื่นๆด้วย

วิธีการศึกษา: การวิจัยเชิงสำรวจภาคตัดขวาง กลุ่มตัวอย่างเป็นผู้หญิงที่ไม่สูบบุหรี่จำนวน 402 คนแบ่งออกเป็น 3 กลุ่มคือ กลุ่มที่ใช้ก๊าซในการหุงต้ม กลุ่มที่ใช้ถ่านและกลุ่มที่ใช้ทั้งสองประเภทโดยการสุ่มตัวอย่างแบบหลายขั้นตอน ใช้แบบสอบถามในการสำรวจข้อมูลเกี่ยวกับประเภทเชื้อเพลิงหุงต้ม สภาพแวดล้อมของบ้านพัก ปัจจัยทางสังคม และอาการของระบบทางเดินหายใจ 6 อาการ ได้แก่ อาการไอ อาการมีเสมหะ อาการไอและมีเสมหะโดยมีไข้หวัดร่วมด้วยหรือไม่มีไข้หวัดร่วมด้วยซึ่งเป็นมานาน 1 เดือนหรือนานกว่านั้น อาการหายใจถี่ อาการหายใจถี่แบบมีเสียงหวีดในผู้ใหญ่ อาการของโรคหอบหืด แล้ววิเคราะห์หาความสัมพันธ์ทางสถิติด้วยวิธีไบวาเรียน ยูนิวาเรียนไบนารีโลจิสติครีเกรสชัน และมัลติวาเรียนไบนารีโลจิสติครีเกรสชันที่ระดับความสำคัญน้อยกว่าหรือเท่ากับ 0.15

ผลการศึกษา: จากการวิเคราะห์ด้วยสถิติแบบไบวาเรียนพบว่าอาการทางระบบทางเดินหายใจทั้ง 6 อาการมีความสัมพันธ์กับประเภทของเชื้อเพลิงหุงต้มที่ใช้ จำนวนปีทีใช้ถ่านลิกไนท์และถ่านชีวมวล ความชื้นและเชื้อราที่พบในบ้าน ระยะห่างระหว่างบ้านกับถนนหรือบ้านกับฟาร์มเกษตรและปัจจัยทางสังคม แต่อย่างไรก็ตามเมื่อวิเคราะห์ด้วยมัลติวาเรียนไบนารีโลจิสติครีเกรสชันและปรับด้วยตัวแปรปัจจัยทางสังคม ความชื้นและเชื้อราที่พบในบ้านพบว่าอาการทางระบบทางเดินหายใจทั้ง 6 อาการมีความสัมพันธ์อย่างมีนัยสำคัญทางสถิติกับจำนวนปีที่ใช้ถ่านลิกไนท์และถ่านชีวมวล สำหรับปัจจัยอื่นๆ เช่น ความชื้นและเชื้อราที่พบในบ้าน การได้รับมลพิษจากเชื้อเพลิงหุงต้มของเพื่อนบ้าน การได้รับสารเคมีและก๊าซจากที่ทำงานพบว่ามีความสัมพันธ์กับบางกลุ่มอาการเท่านั้น นอกจากนี้ยังพบว่าระยะห่างระหว่างบ้านกับถนนและระยะห่างระหว่างบ้านกับฟาร์มเกษตรมีความสัมพันธ์แบบผกผันโดยมีค่าOR=0.999 และ 0.998, 95%CI=0.998-1 และ 0.997-0.999 ตามลำดับ

สรุป: จำนวนปีที่เพิ่มขึ้นของการใช้ถ่านลิกไนท์และถ่านชีวมวลในการหุงต้มจะเพิ่มความเสี่ยงต่อการเกิดความเจ็บป่วยในระบบทางเดินหายใจในกลุ่มตัวอย่างที่ทำการศึกษา ควรมีการจัดโปรแกรมส่งเสริมความรู้เรื่องการเลือกใช้เชื้อเพลิงหุงต้มให้เหมาะสมและปลอดภัยแก่ชุมชนอย่างทั่วถึง

สาขาวิชา สาธารณสุขศาสตร์ ลายมือชื่อนิสิต ____________

ปีการศึกษา 2555 ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก ____________

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KEYWORDS: RESPIRATORY SYMPTOMS/ BEEHIVE COAL/ LIQUEFIED PETROLEUM GAS/ TU LIEM SUBURBAN DISTRICT/ HANOI/ VIETNAM

NGUYEN THI MY HANH: RESPIRATORY EFFECTS AMONG NON-SMOKING WOMEN IN RELATION TO HOUSEHOLD COOKING FUEL USES: LIQUEFIED PETROLEUM GAS ONLY, COAL ONLY AND BOTH LIQUEFIED PETROLEUM GAS AND COAL IN TU LIEM SUBURBAN DISTRICT HANOI VIETNAM. ADVISOR: ASST. PROF. NAOWARAT KANCHANKHAN, Ph.D., 107 pp.

Background: Indoor air pollution due to cooking fuel was significantly ascribed to global disease burden, especially in developing countries. More than 2 million people in Vietnam use beehive coal as daily cooking fuel. To the best knowledge, data on health effects owing to cooking fuel emission in Vietnam are limited. The study endeavour to compare burden of coal use for cooking with that of gas and both gas and coal use in relation to respiratory effects among women in Tu Liem district as well as determines other factors that associate with respiratory effects.

Method: This is a cross-sectional study with the participation of 402 non-smoking women who divided into 3 groups, which are gas use only, coal use only and both coal and gas use for cooking. These women were selected by multi-stage sampling technique. Data on cooking fuel practices, house environments, socio-demographic factors and six respiratory symptoms including cough, phlegm, both cough and phlegm with or without cold for 1 month or more, shortness of breath (SOB) when hurrying on level ground, wheeze with SOB in adulthood, current Chronic Obstructive Pulmonary Disease (COPD) were collected by interview structured questionnaire. Data were analyzed by bivariate analysis with univariable logistic regression; and multivariable logistic regression with p-value ≤ 0.15.

Results: In the bivariate analysis findings, six respiratory effects were found the association with kind of fuel use, number of years used beehive coal and biomass, dampness and mould status, distance of house location to main road and farmland, socio-demographic factors. However, in the multivariable logistic regression models after the adjustment with socio-demographic factors, house conditions; only number of years used beehive coal and biomass positively associated with all six respiratory effects. Meanwhile, other factors including dampness and mould status, exposure to cooking emissions from neighboring households, exposure to gas or chemical fumes in workplace just positively associated with some of respiratory effects. There were two factors showed negative relationships with several respiratory symptoms and illness, which were distance from house location to farmland and main road with OR=0.999 and 0.998, 95%CI=0.998-1 and 0.997-0.999 respectively.

Conclusion: The longer exposure to beehive coal and biomass emissions is; the higher risk of respiratory impairments is. The intervention or action should be taken to improve the awareness of community about the choice of safer cooking fuel.

Field of study	Public Health	Student's Signature	
Academic Year	2012	Advisor's Signature	

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LIST OF ABBREVIATIONS OR ACRONYMS

ADP	Accenture Development Partnerships
ALRI	Acute lower respiratory infections
ARI	Acute respiratory infection
CI	Confidence interval
CO	Carbon monoxide
COPD	Chronic obstructive pulmonary disease
DALYs	Disability-Adjusted Life Years
HHs	Households
LPG	Liquefied petroleum gas
LRI	Lower respiratory infection
MPH	Master of Public Health
NCBI	National Center for Biotechnology Information
OR	Odds ratio
PAHs	Polycyclic aromatic hydrocarbons
PM_{10}	Particulate Matter less than 10 µm in diameter
RR	Relative Risk
SD	Standard deviation
SOB	Shortness of breath
US EPA	United States Environmental Protection Agency
VOCs	Volatile organic-compounds
WHO	World Health Organization
WPR	Western Pacific Region

CHAPTER I

INTRODUCTION

1.1. Background and Rational

Nowadays, environmental health is considered as one of the most concerned issues all over the world because of its severe consequences. According to The World Health Report in 2006, 85 out of the 102 categories of diseases and injuries related to environmental causality (WHO, 2006). WHO stated that one quarter of deaths and disease burdens in worldwide children under the age of five are attributable to environmental factors; and nearly 30% of deaths and diseases due to environmental issues in developing countries. Among five major environmental risks that were made list in WHO Global Health Risk Report in 2009 including indoor air pollution; unsafe water, sanitation, hygiene; urban outdoor air pollution; global climate change and lead exposure; indoor air pollution contributed the most severe effects on human health with the highest mortality rate of 3.3% in the world and 3.9% in developing countries (WHO, 2009).

Compared with outdoor air pollution, indoor air pollution was significantly ascribed to global disease burden more than outdoor air pollution because human spends a great part of the life inside home, office and building with more than 8 hours of average working time and around 15 hours at home everyday (Brasche & Bischof, 2005; Manins, 2001). Besides, indoor air contains a plenty of talent hazardous pollutants released from not only interior furniture such as chest, desk, dining table, sofa, cartain, cupboard, carpet or electricity appliances for instance of refrigerator, electric heater, desktop personal computer, liquid crystal display television and audio (Tanaka-Kagawa, Furuta, Shibatsuji, Jinno, & Nishimura, 2011; Tanaka-Kagawa, Jinno, Furukawa, & Nishimura, 2010); but also routine household activities consisting of cooking, smoking and heating (McCormack et al., 2008) in which the exhaust emissions from cooking fuels were considered as the most common indoor pollution source (WHO, 2006).

As defined by the WHO, there are two major kinds of cooking fuels including solid fuels with coal and biomass and non-solid fuels with electricity, gas, kerosene.

Coal is considered is one of cooking fuel types producing the highest levels of health-damaging pollutants. Based on using expense, it can be seen clearly that coal is inevitably found at most of households in very low or low income countries. In 2006, WHO reported that over three billion people in the world along with solid fuel use including coal do not know that they are being exposed by a plenty of hazardous pollutants from solid fuels day by day (WHO, 2006). According statement of WHO, a great level of air pollutants is emitted through coal combustion process. 24-hour-PM_{10} level of burned solid fuels ranges from 300 to 3,000 $\mu g/m^3$ and peak level can release around 10,000 $\mu g/m^3$ that is exceedingly higher than the annual PM_{10} allowed benchmark from the US EPA, which is 50 $\mu g/m^3$. Meanwhile, 8-hour-carbon monoxide level is released from coal combustion process is 20 ppm that surpass the standard level, which identified by the US EPA is 9 ppm (Bruce, Perez-Padilla, & Albalak, 2000). The comprehensive panorama of environmental risk in term of cooking fuels is just completed by combining hazardous pollutant concentrations with exposure time. The more time people expose to hazardous pollutants, the more adverse health effects people get. It goes without saying that women are the most common victim because of 3-7 hours per day spending on cooking activity day by day (WHO, 2006).

Among leading causes of disease burden in the world, respiratory infections are predicted to become the third principal cause of death by 2030. Worldwide, 235 million people are suffered from respiratory diseases, in particular of asthma and chronic obstructive pulmonary disease (COPD) in which 3 million people died and 90% deaths in low, middle income countries. In Vietnam, the rate of respiratory infections is 28.4% which is in top three major causes of disease burden (WHO, 2002a). Besides, among 12 Asian countries, Vietnam has highest prevalence of COPD with 6.7%. According to research findings from Hanoi Medical University in 2011, the asthma rate among adults in Hanoi is 5.6% with no gender difference although the prevalence of smoking in male adults is 10 times higher than in female (Lam et al., 2011).

WHO also pointed out that indoor air pollution owing to cooking fuel is second leading cause of respiratory diseases follow the causality of smoking. Additionally, the association between respiratory effects and indoor air pollution caused by coal emissions was affirmed through a considerable amount of published studies. In recent time, the global risk assessment investigated that the women those exposed with coal combustion products day by day is 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 gas, electricity and even higher than biomass (Desai MA, 2004; Smith, Samet, Romieu, & Bruce, 2000). For instance, the Western Pacific region of WHO (WPRO) is reported with 1.2 billion people, equivalence of 71% population predominately using coal and biomass for cooking. Consequently, cooking fuel combustion products are responsible for 426,000 COPD deaths and 15,000 lung cancer deaths (WHO, 2002b).

Vietnam, which is a developing country in WPRO, is also facing the burden caused by indoor air pollution due to emissions from cooking fuel. Indoor air pollution is the leading risk in term of environmental health burden in Vietnam compared to other causes such as water pollution, sanitation and hygiene; outdoor air pollution and vector-borne diseases. According to WHO country health statistics 2004 regarding environmental disease burden for selected risk factors, indoor air pollution from cooking smoke 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 (WHO, 2004).

There is a plenty of cooking fuels in Vietnam including electricity, liquefied petroleum gas (LPG), kerosene, coal and biomass. In 2003, WHO reported 70% Vietnamese population using solid fuels consisting of coal and biomass for cooking, nevertheless, this number was reduced in 2010 to 56% (WHO, 2010). Cooking fuel use in Vietnam is significantly differentiated by regional characteristics. In rural areas, biomass is the predominant cooking fuel type with 54.9% population using; meanwhile, urban or suburban areas have the lowest rate of biomass use (11%) and the highest rate of gas and coal use. In Vietnam, Red Delta region has 3 times higher rate of coal use than the coal use national average rate, in which 650,000 people in Hanoi are using coal, accounting for 10% of the population (Vietnam General Statistics Office, 2011).

Tu Liem, an outer district of Hanoi, is considered the area which has the highest rate of coal use in Hanoi with 34.4% (Chien, 2007), people in this area has lower income and living standard than in Hanoi inner districts as well as not mainly relies on agriculture. Therefore, two main cooking fuel types are used in this area; which are coal and gas with estimation of 20% households using coal only, 25% using both coal and gas, 40% using gas only and 15% using other cooking fuels. Furthermore, the gas price in Vietnam is higher and higher, an increase of 35% in March and April of 2012 compared to the first two months of 2012 in accordance with the Vietnam Economic Report for the first 6 months of 2012 (Finance, 2012). As the result, a number of households using gas only tend to turn back coal use or parallel use with gas to reduce the expenditure (ADP, 2012). Apart from these, Accenture Development Partnership (ADP) also stated that Vietnamese women play key role in household cooking activity as well as the most vulnerable group to consequences of cooking fuel emission exposure when more than 80% Vietnamese women spend 2.6 hours average per day on cooking.

Although indoor air pollution from cooking fuel emissions in Vietnam is one of the most severe issues as mentioned above, there are a number of studies on air pollution, but not concentrated on household indoor air pollution. More specifically, Medisch Comite Nederland-Vietnam conducted the desk study and found that almost studies related to indoor air pollution in Vietnam about industrial indoor air pollution, not households' air pollution (SNV, 2010). To the best of my knowledge, this study on "***Respiratory effects among non-smoking women in relation to household cooking fuel uses: liquefied petroleum gas only, coal only and both liquefied petroleum gas and coal in Tu Liem suburban district, Hanoi, Vietnam***" is the first study which assess the burden of coal use to health effects, compared with gas, to contribute by far to the picture in term of indoor air pollution burden due to cooking fuel as well as close the gap in Vietnamese available database regarding to indoor air pollution. Besides, the findings of the study will provide scientific evidences for Vietnamese policy makers and stakeholders to pay more attention to the reduction of health burdens from coal emissions. Furthermore, the study results hopefully will be useful for communication activities to change awareness and behavior of people on choice of the safer cooking fuels toward the better health.

1.2. Research Objectives

1.2.1. General objective

To compare burden of coal use for cooking with that of gas use and both gas and coal use in relation to respiratory effects among women in Tu Liem district and determines the association between respiratory effects and cooking fuel use, house conditions and socio-demographic factors.

1.2.2. Specific objectives

1. To investigate the relationship between respiratory effects among women in Tu Liem district with cooking fuel uses.
2. To explore the association of respiratory effects among women in Tu Liem district with house conditions.
3. To examine that respiratory effects among women in Tu Liem district associated with socio-demographic factors.

1.3. Research questions

1. Is there the association between respiratory effects among women and cooking fuel uses in Tu Liem district?
2. Is there the relationship between respiratory effects among women and house conditions in Tu Liem district?
3. Is there the relationship between respiratory effects among women and socio-demographic factors in Tu Liem district?

1.4. Study Hypotheses

1. Respiratory effects among women have association with cooking fuel uses in Tu Liem district.
2. There is the association between respiratory effects among women and house conditions in Tu Liem district.
3. There is the association between respiratory effects among women and socio-demographic factors in Tu Liem district.

1.5. Conceptual framework

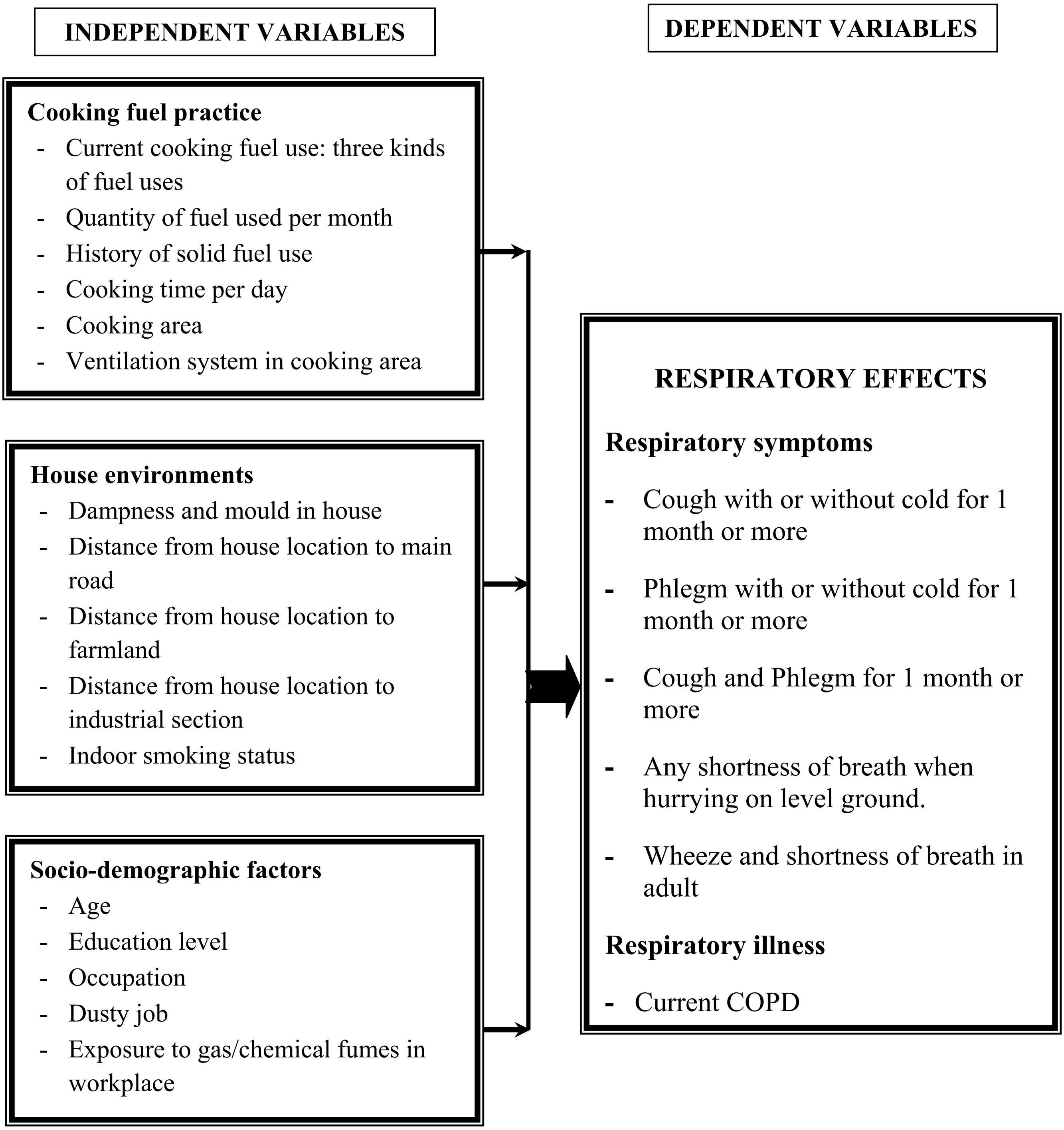


Figure 1 Conceptual Framework

1.6. Operational Definitions

- **Respiratory effects:** referred five respiratory symptoms and current COPD.
- **Respiratory symptoms:** Within the scope of this study, five respiratory symptoms are cough with or without for one month or more per year, phlegm with or without cold for one month or more per year, cough and phlegm with or without cold for one month or more per year, shortness of breath when hurrying on level ground and wheeze with shortness of breath in adulthood.
- **Cough for one month or more per year:** prolonged and regular cough with or without cold such as fever, soar throat, headache and runny nose, lasting one month per year or more.
- **Phlegm for one month or more per year:** Fluid secrections is produced from respiratory tract when cough without or with cold such as fever, soar throat, headache and runny nose, lasting one month per year or more.
- **Cough and Phlegm for one month or more per year:** Having both cough and phlegm symptoms lasting one month per year or more.
- **Wheeze with shortness of breath in adulthood:** feel air release through narrowed breathing tubes along with whistling sound and forced breathing along with shortness of breath in adulthood without or with cold such as fever, soar throat, headache and runny nose (excluding those women who get wheeze with or without cold when they were a child).
- **Shortness of breath (SOB) when hurrying on level ground:** referred that the difficult feeling of respiration which has ever gotten when hurrying on level ground or walking up a small hill.
- **Chronic obstructive pulmonary disease (COPD):** is a lung disease characterized by chronic obstruction of lung airflow that interferes with normal breathing and is not fully reversible including chronic bronchitis and emphysema (WHO).
- **Respiratory illness:** the study concerned about current COPD which was presently diagnosed either chronic bronchitis or emphysema by doctor.

- **Beehive coal:** concerned in this study that is beehive coal briquette to use for cooking purpose as shown in Figure 2. Beehive coal briquette is 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

Figure 2 Beehive coal briquettes

- **Gas:** concerned in the study that is liquefied petroleum gas (LPG) using for cooking.
- **Beehive coal use only:** referred to the households use beehive coal only for cooking with above 80% cooking time.
- **Gas use only:** definded the households use gas only with above 80% cooking time.
- **Both beehive coal and gas use:** means concurrent utilization both coal and gas for cooking in which either of these fuels is used more than or equal to 20% and less than or equal to 80% cooking time.
- **Place to cook:** the location of stove is daily used for cooking the meal. Classification of place consists of outside, inside with separate section and inside without separate section.
- **Ventilation system in cooking place:** The systems to air exhaust emissions from cooking outside including open windows/doors, chimneys and ventilators (fans).

- **History of solid fuel use:** is defined that have ever used beehive coal or biomass before and the number of year using beehive coal and biomass for cooking.
- **Dampness and mould in home:** Evident dampness or mold in buildings such as visible dampness, visible water damage, visible mold, or mold odor.
- **House location to main road, farmland and industrial section:** the nearest distance from main windows/doors of household to the nearest highway or main road, farmland and industrial section.
- **Indoor Smoking Behavior:** family members living with study subjects daily smokes tobacco or cigarret, cigar inside the house.
- **Dusty job:** means the employer must expose to dust during most of the working hours

CHAPTER II

LITERATURE REVIEW

2.1. Characteristic of coal and gas using in Vietnam

In Vietnam, there are two major types of cooking fuel as WHO's classification, which are solid (46.5%) and non-solid fuels (53.1%). Solid fuels consist of biomass, coal; meanwhile, non-solid fuels include kerosense, LPG, electricity, biogas. However, biomass, coal and LPG are still the most favourite cooking fuels in Vietnamese households. LPG is considered the major cooking fuel in urban areas (80.7%); biomass is the choice of 54.9% households in rural regions. Nowadays, coal is no longer widely used in Vietnam (approximately 5%); however, concentrated in certain areas, especially in the Red River Delta area. According to the MICS report (Figure 3), 10% of the populations in the Red River Delta region are suffered by coal use as cooking fuel (corresponding to 1,883,560 people), which mainly focuses on the suburban area of Hanoi because Hanoi accounts for 36% population of Red River Delta region.

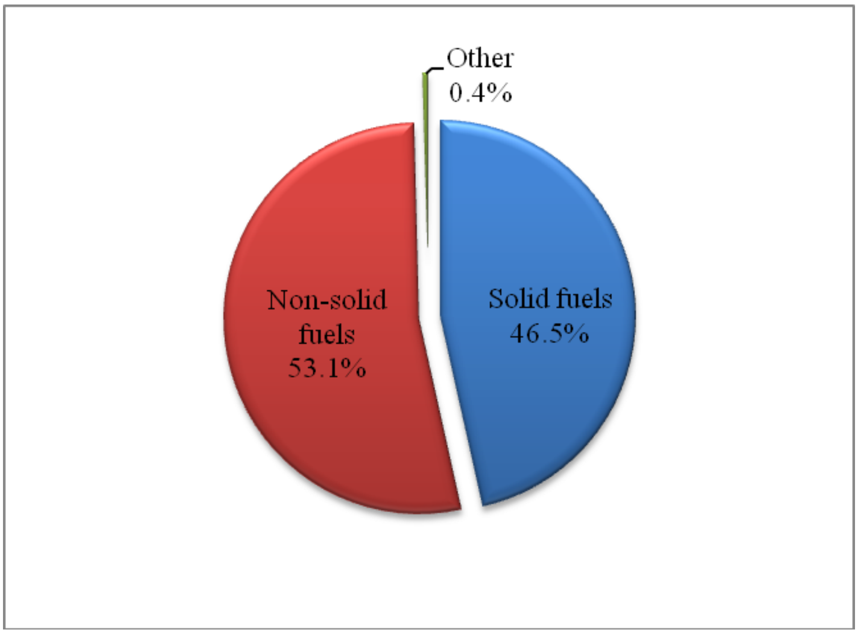


Figure 3 Cooking fuel use in Vietnam

(Source: Viet Nam Multiple Indicator Cluster Survey, 2011)

It can be easily explained by the regional characteristics when rural or mountainous areas are mostly available in wood or agricultural tailing; therefore, they naturally take advantage these raw materials as cooking fuel without any expense. In contrast, people in urban areas have higher income and living standard, and they are enable to pay for the cooking fuel use cost; thus, gas becomes the favourite fuel type in urban area. Similarly, coal is the best choice of people living in the suburban area by the intersection between the two characteristics mentioned above.

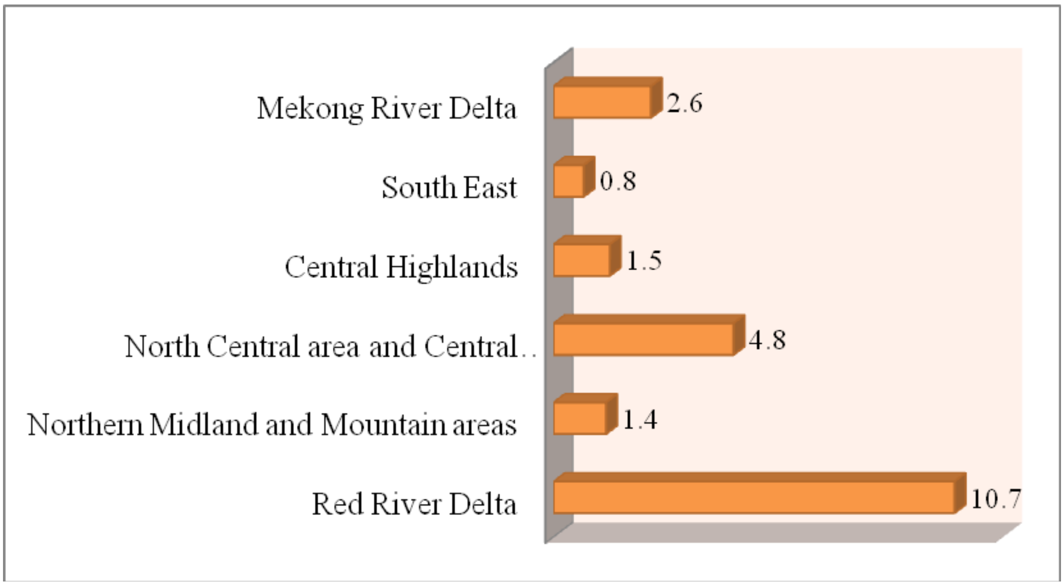


Figure 4 Percentage of coal use by region

(Source: Viet Nam Multiple Indicator Cluster Survey, 2011)

Coal

Beehive coal briquette is the predominant type of coal which used in Hanoi. This coal briquette is named "beehive" because after mixing with components, coal brick is perforated holes with the same distance in order to circulate the air flow during comburstion; thus, the font side of a finished production is looked like a beehive. Beehive coal briquette is principally made from bituminous coal and mixed with other components such as clay and sawdust for flammable. One beehive coal briquette can radiate heat for 3-4 hours.

Beehive coal stove normally made from clay or cement mortar, nevertheless, many people nowadays use glasswool (Fibre glass) stove with numerous advantages: very high utility and ultra high tolerance of heat. Especially, glasswool kitchen has the advantage of being lightweight and super deodorant. Producers only warrants a thin layer of hard cement mortar to the original shape, the middle layer of the stove body is inserted with glasswool (ceramic glass or asbestos), in the same class as ordinary mortar. Because of removable characteristic, households usually use beehive coal stove outside the house. In accordance with MICS 3 report in 2006, the percentage of open stove or fire with no chimney or any ventilation system account for 77.5; meanwhile, only 2.8% households have closed stove with chimney and 19.2% open stove with chimney used in household. As can be seen clearly, the majority of household is not protected from the adverse consequences of solid fuels. (Vietnam General Statistics Office, 2011).

Figure 5 Production process of beehive coal briquette

Gas

Main type of gas which is used in household for cooking is LPG. LPG, stands for Liquefied Petroleum Gas, is a mixture of light hydrocarbons in the gas phase. Main components of LPG are propane (C_3H_8) and butane (C_4H_{10}), a colorless, odorless, tasteless and non-toxic. LPG which is ultilized in household for cooking is stored in pressurised containers with total weight of 12 kg; and per kg gas supply about 12,000 kcal of energy. LPG cost based on a range of 400-500,000 VND per 12kg tank, used for 45-60 days with 2 meals per day (ADP, 2012).

As reported by Vietnam Multiple Indicator Cluster Survey 2011, cooking fuel use in Vietnam is influenced by household living standards and education status. These can be the contributors to create this difference because 76.3% uneducated population use solid fuels, meanwhile, solid fuels were used by only 13.2% population under at least tertiary education. Besides, the percentage of using non-solid fuels in poor households (2.6%) is higher by far than in wealthy households (97.4%). (Vietnam General Statistics Office, 2011).

2.2. Cooking fuel is one of the major indoor air pollution sources

There is a large volume of published studies pointed out that cooking fuel burning emit remarkable high level of a wide range of hazardous air pollutants such as $PM_{2.5}$, PM_{10}, CO, SO_2, PAHs, NO_2, VOCs and others due to incomplete cooking fuel combustion. Therefore, cooking fuel becomes to the most important contributor to indoor air pollution situation in the world (WHO, 2006).

Beehive coal briquette is predominantly made from bituminous coal which has characteristics of lower fixed carbon and elevated volatile matter compared to anthracite. The significant differences of bituminous coal are its relative volatile matter and sulfur content as well as its slagging and agglomerating distinctiveness. The main emissions of bituminous coal combustion are particulate matter (PM), sulfur oxides (SOx), and nitrogen oxides (NOx). Some incompleted combustibles consisting of CO and numerous organic compounds are generally released even under proper boiler operating conditions (The US EPA).

As stated by the US EPA, SOx from coal combustion are principally SO_2, with a lower amount of SO_3 and gaseous sulfates by far. Such compounds as the organic and pyritic sulfur in the coal are incompletely oxidized in the combustion procedure. On average, about 95 percent of the sulfur present in bituminous coal will be emitted as gaseous SO_2. In 1995, the study on household indoor air pollution in China investigated that the concentration of SO_2 from coal emissions in Chinese homes is 0.01 – 23 mg/m^3 (Sinton JE, 1995). Another study, carried out in winter on in Santiago urban households in Chile, found a elevated average concentration of SO2 was 295 ppb in the kitchen (Cáceres D, 2001).

Cacbon monoxide (CO) is mostly well-known as the production of incomplete combustion of fossil fuels such as coal (International Programme on Chemical Safety, 1999). In developed regions, the most significant indoor exposure source of carbon monoxide is release from poorly ventilated or unvented cooking appliances combusting fossil fuels (Leaf & Kleinman, 1996). The main adverse impact of CO on health is hypoxic consequences. CO goes inside the body through inhalation route after that disminishs oxygen distribution to tissue via myoglobin by structure of carboxymyoglobin which is the result of the reaction between CO and haemoglobin (Hauck & Neuberger, 1984). The binding of CO and haemoglobin occurs as quickly and easily as the reaction between oxygen and haemoglobin, even though, the bond of CO is just over 200 times higher than that of oxygen (Joumard, Chiron, Vidon, Maurin, & Rouzioux, 1981).

Raiyani conducted the study on “Assessment of indoor exposure to polycyclic aromatic hydrocarbons (PAHs)” in 1993 and investigated that a considerable amount of particulate PAH compound concentration was found in cooking process when fossible fuels (coal) were incompletely burned. Increase of concentration of PAHs due to cooking fuel is dependent on the kind of fuel in the ascending order of LPG, kerosene and biomass respectively. Beside, the study also figured out that PAHs produced by burning cooking fuel is 2 – 10 times higher than outdoor air pollution sources (Raiyani et al., 1993).

According to a wide range of worldwide researches, a remarkable level of nitrogen dioxide was found in exhaust emissions from fuel-burning stoves in which the most is gas appliances (Levy, Lee, Spengler, & Yanagisawa, 1998), (Hagenbjork-Gustafsson et al., 1996), (Kodama et al., 2002) and (Baxter, Clougherty, Laden, & Levy, 2007). For instance, a study which is conducted in United States demonstrated nitrogen dioxide average concentration in house with gas use as cooking fuel (33.1 ppb corresponding to 63.3 μg/m3) is higher than in those without a gas oven (16.8 ppb corresponding to 32.1 μg/m3) (Hansel et al., 2008). Committee on the Medical Effects of Air Pollutants in London also stated the same result with the concentrations of nitrogen dioxide in houses using gas stoves from 25 to 70 $\mu g/m^3$ and 13 to 40 $\mu g/m^3$ in houses not use (CMEAP, 2004).

Cooking fuel use such as coal, gas, kerosene or liquid petroleum gas (LPG) contributes higher concentrations of volatile organic-compounds (VOCs) indoors (Brown, 2002), (Srivastava, Pandit, Sharma, & Mohan Rao, 2000). The study in five

European cities figured out that VOCs concentrations produced from cooking are two to three orders of magnitude greater than the sources from outdoor (Ilacqua, Hanninen, Kuenzli, & Jantunen, 2007).

Besides, WHO demonstrated that the solid fuel combusting releases enormously elevated level of particulate matter including PM_{10} and $PM_{2.5}$, especially in developing countries in Asia, Latin America and Africa with 24-hour levels of PM_{10} exceeding by far the benchmark level of the US EPA and the standard level of the European Union (WHO, 2006).

2.3. Respiratory symptoms and illness in relation to cooking fuel use

Most of available researches on health effects of cooking fuel productions showed strong evidences related to association between cooking fuel use and respiratory diseases. In 2009, "Global Health Risks: mortality and burden of disease attributable to selected major risks" publication of WHO mentioned that indoor air pollution regarding the exhaust emissions from cooking is attributable to nearly 3% of worldwide environmental burden of diseases including 39 million DALYs and more than 1.6 million deaths in which approximately 900,000 annual deaths due to pneumonia and other acute lower respiratory infections; nearly 700,000 worldwide deaths caused by COPD; and 1.5% of worldwide deaths due to lung cancer. In developing countries, health consequences attributed to indoor smoke are more severe with account of 3.7% of total burden of disease because of a numerous of household utilizing solid cooking fuels (WHO, 2009).

In 2006, Baker also found that low respiratory infection (LRI) in Czech children from households using coal for cooking occurred more regularly than from those using other energy sources with RR=1.45 and 95% CI = 1.07 – 1.97; meanwhile, there is no association between LRI and using other cooking fuels including electricity, LPG (Baker et al., 2006).

A research in China on the relationship between respiratory symptoms and coal burning has the same statement that people in households burning coal for cooking have 1.57 (95% CI 1.07-2.29) times higher risk of wheeze with cold and 1.44 (95% CI=1.05-1.97) times without cold. This study also showed the strong evidence that burning coal associates with cough (OR=1.74, 95% CI=1.17-2.60) and phlegm (OR=2.25, 95% CI=1.36-3.72) with and without cold (Salo et al., 2004).

One more study was conducted in China to measure risk of the most adverse respiratory disease which is lung cancer on the subject of various kinds of coal use in household for cooking and heating. Retrospective cohort study design was applied from 1976 to 1996 with 27310 people using smoky coal and 9962 people using smokeless coal. Lung cancer deaths in smoky coal users are significantly higher than smokeless coal users. There are 18% men and 20% women using smoky coal died before the age of 70; meanwhile, this number in men and women using smokeless coal is only 0.5%. Lung cancer is attributable to 40% of mortality before the age of 60 in smoky coal users. There is a significant relationship between an increased risk of lung cancer death and smoky coal use in China with HR=36 (95% CI=20-65) for male and HR=99 (95% CI=37-266) for female (Barone-Adesi et al., 2012).

Another study in 4 Chinese cities found out exposure time to residential coal use consisting of four exposure levels: non-exposure (control group), light, moderate and heavy exposure in relation to respiratory symptoms and illness including wheeze, phlegm, cough with phlegm, bronchitis, asthma and others. The results of this study provided more evidences regarding the association between respiratory impairments and coal use in the means of the higher ORs for cough, wheeze, and asthma in the exposure groups than in the non-exposure group (Qian, Zhang, Korn, Wei, & Chapman, 2004).

Dutt, an Indian researcher, studied the effects on the respiratory system of 105 women using biofuels, 105 those using kerosene and 105 those using LPG for cooking in the urban slum of Pondicherry. The research used 3 indexes to measure the lung function including FVC, FEV1 and PEFR along with checking up the presence of respiratory symptoms. It was found that women who use biofuel have significantly lower pulmonary function and higher prevalence of respiratory symptoms with 23% than those using kerosene (13%) and LPG (8%). FVC, FEV1 and PEFR in LPG users are clearly higher than kerosene users with $p\text{-value} < 0.01$. According to the predicted model regarding lung function and cooking fuel use, biofuel is considered to reduce FVC, FEV1 and PEFR more than kerosene and LPG use.

However, in 1996, Ellegard with the research on cooking fuel emissions and respiratory symptom among women in low-income areas in Maputo cannot point out such clear association. In the study, 1200 women who are selected use different kinds of cooking fuels such as wood, charcoal, electricity and LPG. Then, person-carried equipment and peak expiratory flow test were applied to measure the concentration of pollutants as well as the pulmonary function and respiratory symptoms. The study identified the particulate concentration from wood use is nearly 2 times higher than charcoal use (540 µg/m3) and 3 times higher than morden fuels use (200-380 µg/m3). Nevertheless, only wood users significantly cough more than other users and cough symptoms is not different among women using charcoal and other fuels. Besides, no association between dyspnea, wheezing, shorness of breath with wood use was found in this study (Ellegard, 1996).

Apart from respiratory impairments, cooking fuel is one of the factors which are attributable to cardiovascular disease. A study in Shanghai, China on the association between cardiovascular disease and in-home solid fuel use investigated that solid fuel usage in home was significantly associated with an increased risk for hypertension (OR 1.70, 95% CI 1.40 to 2.07), CHD (OR 2.58, 95% CI 1.53 to 4.32). Compared with individuals in the lowest tertile of the duration of solid fuel exposure, those in the highest tertile of the duration of solid fuel exposure had increased odds of hypertension (OR 1.73, 95% CI 1.45 to 2.06), stroke (OR 1.87, 95% CI 1.03 to 3.38) (Lee et al., 2012). This point also was demonstrated in the study on hypertension with elevated levels of oxidized low-density lipoprotein and anticardiolipin antibody in the circulation of premenopausal Indian women chronically exposed to smoke during cooking. The study findings showed that high risk of developing cardiovascular diseases (CVD) among poor, underprivileged women in their reproductive ages using solid fuel for cooking (Dutta, Mukherjee, Das, Banerjee, & Ray, 2011).

2.4. Other risk factors influencing on respitatory symptoms

Socio-demographic factors

Socio-demographic factors including gender, age, occupation, income were shown to have the clear relationship with respiratory problems in a number of studies. Supporting for this point of view, Ferre and his coworkers conducted the study on

"Chronic bronchitis in the general population: influence of age, gender and socio-economic conditions" in 2012 with 9050 above 45 year old Frenches as study population to explore chronic bronchitis burden and the association with socio-economic conditions. Multivariable analysis is applied to show this association. Sex, active smoking, lower income and occupational category are factors which significantly influence on the prevalence of symptoms and diagnostic of chronic bronchitis. Labor-intensive and self-employed occupation categories are people who get the highest prevalence of chronic bronchitis. Apart from these, male and people who belong to higher socio-economic condition group recorded to have greater proportion of under-dianosis of chronic bronchitis (Ferre et al., 2012).

A researcher group from India implemented the study on 202 children in which 101 acute lower respiratory tract infection cases and 101 children without disease participated in the research. Among 101 children have acute lower respiratory tract infection cases including 24.8% got pneumonia, 45.5% got serious pneumonia and 29.7% had extremely severe respiratory disease, almost of them are from household which have poor socio-economic status. With logistic regression analysis of multiple risk factors, the association between socio-economic conditions and acute lower respiratory tract infection was significantly demonstrated (Ramesh Bhat, Manjunath, Sanjay, & Dhanya, 2012).

In the study on asthma length of stay in hospitals and influential factors in London, 2001-2006, socio-demographic factors were indicated to be one of significant determinants of asthma hospitalization. Study subjects are out-patients in London from January of 2001 to December of 2006. The study applied negative binomial regression to set up the model between socio-demographic factors and the other relevant factors on the hospitalization length. Age and gender were considered main predictor for the model of the severity of asthma and the length of stay. The younger were more probably to be admitted than the elderly ($p<0.001$). The study concluded that asthma hospitalization can be predicted by socio-demographic factors and other factors (Soyiri, Reidpath, & Sarran, 2011).

Rupa and his coworkers affirmed once again the association between socio-demographic conditions and respiratory impairments through the findings of the study on "Risk factors for upper respiratory infection in the first year of life in a birth cohort". Upper respiratory infection is positively increased corresponding to the increment of age, which shown by the peak on 72% in the 9th month. Parental occupation is significant risk factor which influence on the prevalence of upper respiratory in the first year old children with OR=1.37 and 95% CI = 1.1 - 1.8. Besides, sex of the child, parents' education, type of house, birth weight, number of family members, passive smoking and use of firewood for cooking have association with increased risk of upper respiratory infection episodes (Rupa, Isaac, Manoharan, Jalagandeeswaran, & Thenmozhi, 2012).

Housing conditions

In the world, there is a wide range of evidences to show the bond between housing condition and respiratory episodes. The research on "Housing characteristics, home environmental factors and respiratory health in 14,729 Chinese children" concentrated on housing conditions including distance of the house to traffic and outdoor pollution source, dampness and mould in house, home adornments and exposure to indoor tobacco smoking and explored that all these factors were significantly in relation to doctor-diagnosed asthma and asthma symptoms in both genders. However, the magnitude of morbidity due to housing conditions is different in gender. Respriratory risks in particular of persistent phlegm is higher in girls more than boys (OR = 1.68; 95% CI=1.48 - 1.96) (Dong et al., 2008).

"Do housing conditions associate with respiratory symptoms?" This is also the research question in the study on "A measure for quantifying the impact of housing quality on respiratory health: a cross-sectional study". 891 New Zealand households participated in the research and Respiratory Hazard Index (RHI) and multivariale logistic regression were used to measure level of influencing factors on respiratory symptoms in relation to housing conditions. The study found that the odds of at least one wheezing/whistling symptoms and asthma attack increase by 11% when Respiratory Hazard Index increase one unit in the past 12 months (OR=1.11, 95% CI = 1.04% – 1.2% and OR=1.11, 95% CI = 1.01% – 1.22%, respectively). Among households have lower house conditions, the number of people who get respiratory symptoms would be decreased by 33% if they improve their house quality (RR=0.67, 95% CI = 0.53-0.85). Aside from above statement, the study showed the strong relationship between dampness and mould in house and the increased odds of respiratory health (Keall et al., 2012). Two recent comprehensive review articles, by the World Health Organization and by Mendell et al., have summarized current knowledge on health effects of damp and moldy in homes which is based on the overall scientific literatures and concluded that dampness itself is not considered to directly cause health effects. It seems likely that mold or bacteria growth in damp materials is involved in causing the above health effects (Mendell et al., 2011; World Health Organization, 2009).

In “Effects of indoor environmental factors on respiratory health of children in a subtropical climate” study of Yang and his coworkers from Taiwan, China with the objective to examine whether respiratory illness is influented by indoor environmental characteristics, datas regarding respiratory symptoms and housing conditions are collected from parents of 4164 primary school children. The researcher group used multivariable logistic regression model to determine the association between respiratory symptoms including wheezing, cough, bronchitis, allergic rhinitis and asthma and housing conditions. Aside from dampness in house show the relationship with all respiratory symptoms in the scope of the study and incense burning and mosquito repeller burning associated with cough episodes, there is no other association was significant. The study concluded that dampness in house significantly influence on respiratory impairments in subtropical areas (Yang, Chiu, Cheng, & Lin, 1997).

Smoking behavior

There is no denying the fact of relationship between smoking and chronic respiratory diseases because there is a great deal of studies on this topic. Smoking is ascribed to one fourth of cancer mortality in developed countries (Peto, 2005). 25-40% of smokers are predicted to die between 40 and 70 years of age (Vollset, Tverdal, & Gjessing, 2006). A study in UK pointed out that 15-24 cigarette per day smokers had 26 times higher of COPD than non-smokers; meanwhile, people smoking less than 15 cigarettes per day had 8 times higher risk to get COPD (Doll & Hill, 1950). This researcher group also conducted the study in 1978 and stated that a person who had smoke for 45 years had 100 times higher risk of the lung cancer than those had smoke for 15 years (Doll & Peto, 1978).

CHAPTER III

RESEARCH METHODOLOGY

3.1. Study design

A cross – sectional study design was used in this study with descriptive analysis to describe cooking fuel uses, house conditions, socio-demographic factors and the prevalence of respiratory effects among non-smoking women in study area and inferential analysis to determine the associations of respiratory effects with cooking fuel uses, house conditions and socio-demographic factors.

3.2. Study area and population

3.2.1. Study area

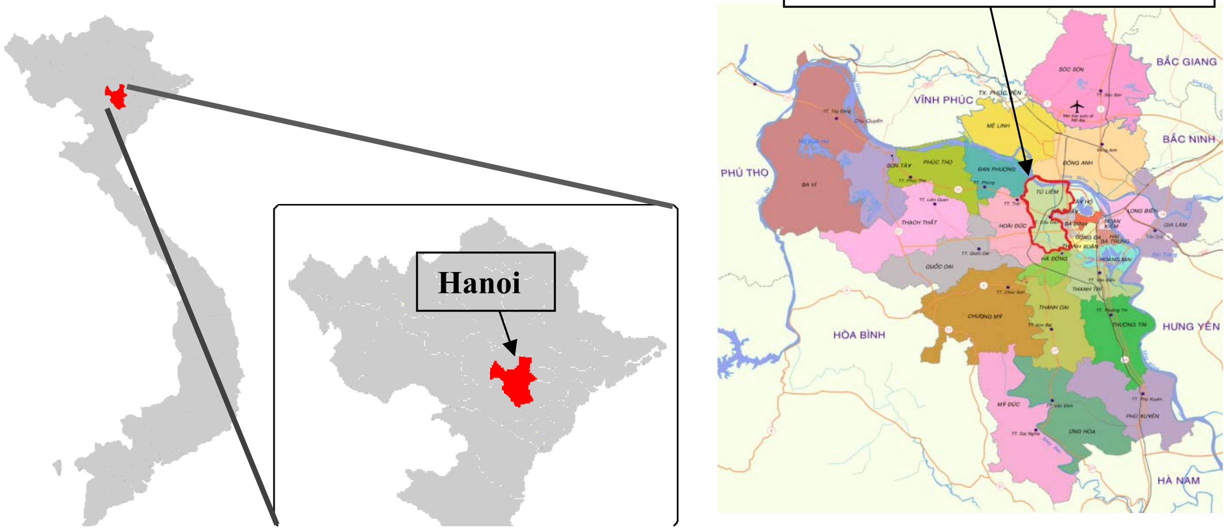


Figure 6 Study area mapping

Tu Liem, which is one out of 18 outer districts of Hanoi, has 16 administrative units consisting of 1 town (Cau Dien) and 15 communes. This district located in the west and 30 km far away from the central of Hanoi. The area of the district is 75.32 km^2 with a total population in 2010 was 550,000 (GSO, 2010). Total of household in this area was 124,141.

3.2.2. Study population

Inclusion criteria:

Participants were included in the study need the prerequisites as follows:

- Women are above 21 years old and never smoke, who are mainly responsible for cooking in households.
- Women, who live in Tu Liem district
- Belonging to households with the conditions as below:
    - Using gas as cooking fuel with over 80% cooking time. Other cooking fuels such as wood, charcoal and electricity is accepted with cooking time not over 20%.
    - Using beehive coal as cooking fuel with over 80% cooking time. Other cooking fuels such as wood, charcoal and electricity is accepted with cooking time not over 20%.
    - Using both gas and beehive coal, in which either of these fuels is used more than or equal to 20% and less than or equal to 80% cooking time. Other cooking fuels such as wood, charcoal and electricity is accepted with cooking time not over 20%.
- Agree to participate in the study with informed consent.

Exclusion criteria:

Participants who satisfied the inclusion criteria but cannot respond the study questionnaire because of:

- Disability such as dump or deaf women
- Mental health problems
- Conflict language, not understand the questionnaire in Vietnamese or English

3.3. Sample size

Applying the formula of Cochran sample size calculation: (Cochran, 1977)

$$n = \frac{z^2 \times p \times (1-p)}{d^2}$$

$$n = \frac{1.96^2 \times 0.5 \times (1-0.5)}{0.05^2} = 384$$

n: Sample size

z: Value from normal distribution associated with 95% confidence interval 1.96

p: The expected proportion of respiratory symptoms of women in Tu Liem district to gain maximum sample size is 50% (or 0.5)

d: Error allowance (degree of accuracy desired) 5%

This study used 5% non completion of questionnaire.

Total number of sample size can be calculated by this formula, n=384+18=402 persons. Total sample size was equally divided into 3 groups:

- Number of women using gas: 134
- Number of women using both of coal and gas: 134
- Number of women using coal: 134

3.4. Sampling technique

Multiple stage sampling was used in the study with 4 stages:

In 1st stage, purposive sampling technique was used to select the study area, which is Tu Liem district, Hanoi, Vietnam. Tu Liem is the place where have the highest percentage of population using beehive coal briquette in Hanoi.

The 2nd stage was implemented to ramdomly select 2 communes out of 15 communes of Tu Liem district by simple random sampling technique. The town of Tu Liem district was excluded because this is the center town as well as the most devoloped section in the district. Therefore, the socio-demographic characteristics of household in this area is significantly different from other communes. In order to avoid the confounding factors, the study sampling did not take this town into account. 15 communes were numbered in alphabetical order before using computer generated random numbers at http://www.random.org/ to select 2 communes corresponding to 2 numbers which were results of programme, which were Lien Mac (4 villages) and Me Tri commune (3 villages).

The 3rd stage was to choose 2 villages among 7 villages of 2 selected communes which have nearly equal distribution of using coal, gas and both for cooking. Dai Cat and Me Tri Thuong village was appropriate to this criterion with nearly equal percentage of household using 3 kinds of cooking fuel.

In 4th stage, 402 samples were identified by random sampling technique with the steps as follows:

- 402 of total sample size were equally divided for 2 villages. It means 201 samples for each village with 67 samples using coal, 67 samples using gas and 67 samples using both gas and coal.
- Sampling frame for each village which was set up by numbering in household lists which sliped by categories of cooking fuel use including coal, gas and both coal and gas.
- Simple random sampling technique by using computer generated random numbers at http://www.random.org/ was used to select 67 households from 2 choosen villages following in each household list which categorized by 3 types of cooking fuel use.

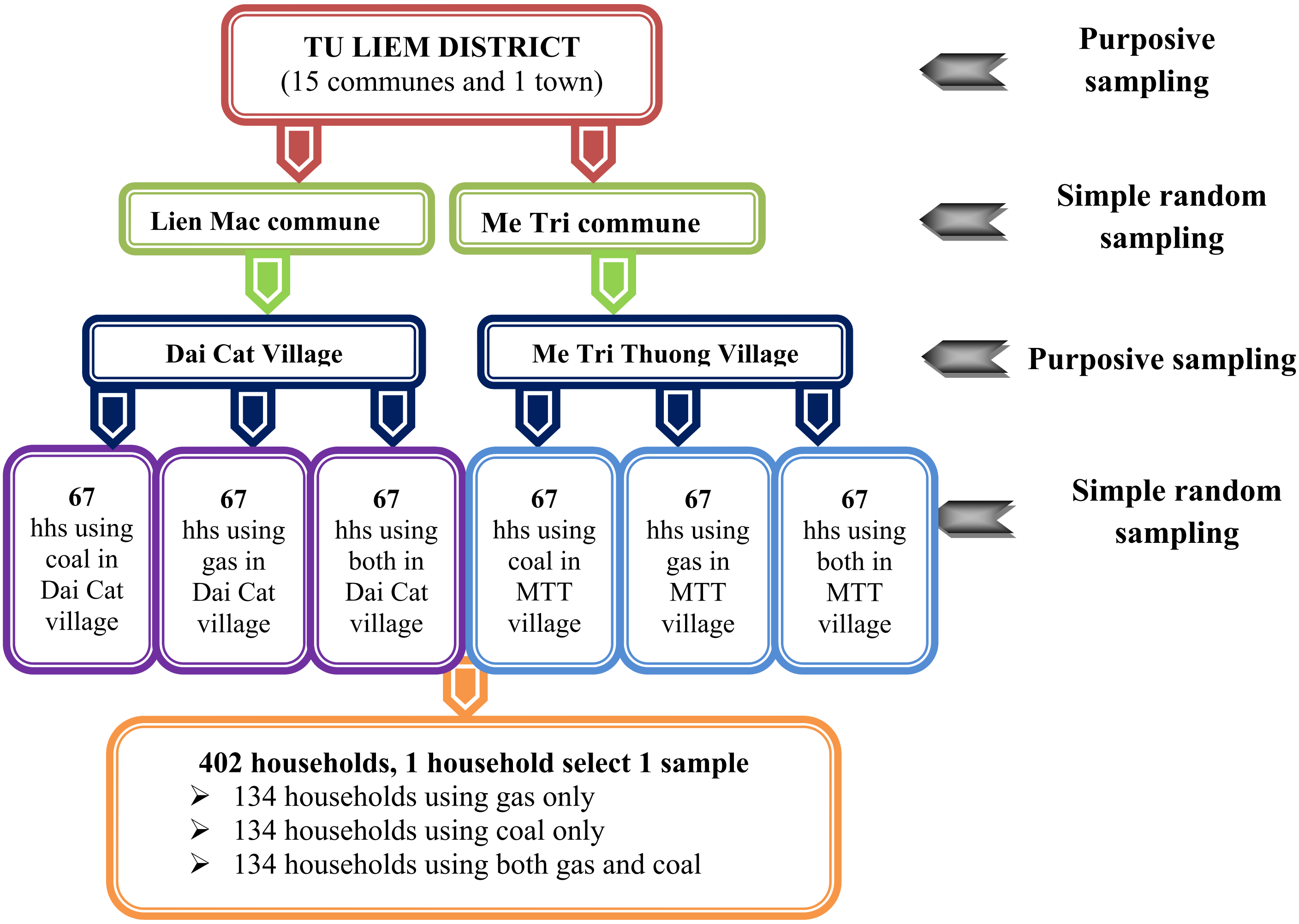


Figure 7 Sampling process

3.5. Measurement Tools

- **Method:**
  - Face to face interview with administered questionnaire
- **Tool: Structured interview administered questionnaire**

Questionnaire was developed according to the questionnaires that were designed by BMRC, the American Thoracic Society Children's and Adults' Respiratory Questionnairs, the St. George's Respiratory Questionnaire, (Tun, 2011) and (Vongxay, 2011). The questionnaire was taken pretest in order to guarantee that it was appropriate to the study, straightforward to follow for participants. The questionnaire was divided into 5 parts:

1) *Demographic Information*
2) *Cooking fuel practice*
3) *House conditions*
4) *Respiratory effects*

Translation of Questionnaire

Questionnaire and informed consent were translated into Vietnamese by experts. This questionnaire was translated back from Vietnamese into English by a second translator.

Validity of questionnaire

Three experts in College of Public Health Sciences, Chulalongkorn University reviewed content and construct validity of the questionnaire before use.

Pre-test

The pre-test was organized before one week of the first day of data collection. The sample of the pretest was 15 women using gas and 15 women using beehive coal that have similar inclusion criteria as the study sample in Dan Phuong district, Hanoi; which is neighboring district of study area. The objective of the pre-test was to determine the response of participants to the questionnaire, validity and clearance of the translation of the study instrument and the appropriateness for the flow of the questions.

The questionnaire was revised following results of the content validity and pre-test; the responses and suggestions from test takers.

3.6. Data collection

- Data collectors were trained about this study including objectives, methods, details of the study processes and study questionnaire. Besides, interviewers were required household observation to cross check the information which was provided by respondents such as kind of cooking fuel, place to cook, ventilation system in kitchen in order to reduce biases.

- Researcher was introduced by representative of local authority explain the study to responders.
- Those who decide to participate in study signed on informed consent form

3.7. Data analysis

- The licensed SPSS software version 17.0 was used for analysis and clearance. The missing information was recollected for completion.
- All data collected was entered by using the Epi Data 3.5 software.
- Descriptive statistics:
  - ➢ Percentage and frequency to describe socio-demographic characteristics, cooking fuel use status, housing conditions, and the prevalence of respiratory symptoms.
  - ➢ Mean, standard deviation to measure central tendency, variation and distribution of continuous 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.
- Statistical analysis:
  - ➢ Bivariate analysis was used with Univariable Logistic Regression in order to explore the association in pair between each independent variable with each dependent variables including cough with or without cold for one month or more per year, phlegm with or without cold for 1 month, cough and phlegm with or without cold for one month or more per year, shortness of breath, wheeze with shortness of breath in adulthood and current COPD.
  - ➢ Multivariable Logistic Regression include two steps:
    - The first step was applied multivariable logistic regession for all six dependent variables including cough with or withour cold for one month or more per year, phlegm with or without cold for 1 month,

cough and phlegm with or without cold for one month or more per year, shortness of breath when hurrying on level ground, wheeze with shortness of breath in adulthood and current COPD with independent variables which had p-value ≤ 0.15 in bivariate analysis.

- The second step was also redone multivariable logistic regression to determine the final multiple relationship models of all six dependent variables with independent variables which had p-value ≤ 0.15 in the first step.

3.8. Ethical consideration

- The research proposal including measurement tools were 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.
- All study participants were provided adequate study information before decision of participation in the study. They could discontinue from the study whenever they want.
- Each participant had informed consent form to sign prior to their participation in the study.
- All data collected from each individual were kept private and confidential.

3.9. Limitation

- The assessment of prevalence of respiratory symptoms through questionnaire without physical examination was inevitably limited by recall biases; besides, respiratory impairement can be under or overestimated.
- Lacking of information regarding to duration of gas use.
- The study concerns about non-smoking women only; therefore, personal smoking behavior factor was not considered within the scope of this study.
- The study cannot estimate the prevalence of cooking fuel use in study area because study sample was selected equally to 3 groups of cooking fuel use: gas only, coal only and both gas and coal.

3.10. Strategies to solve the problems

- To overcome by training investigators carefully before proceeding with data collection in the field, to unify the research objectives, interview, record forms and statistical methods. The research team checked answer sheets each day before handing over them. The information which was incompletely collected was required to complete by investigators.
- To conduct compliance sampling technique with inclusion and exclusion criterias.
- To integrated observation during interview to cross check information. Besides, if applicable cases, interviewer checked personal health records of participants when they collected information about respiratory effects.

3.11. Expected Benefits

The study endeavours to explore the overview of indoor air pollution sources as well as assess health effects due to them. This will be the contribution to reduction strategy of adverse consequences owing to indoor air pollution in particular of coal usage as cooking fuel. Expectantly, the study findings will be used for promotion health policy makers to design the intervention programmes in order to increase awareness of people on safer cooking fuel use. Besides, the study will be a suggestion for other scientists to research more deeply in this field.

CHAPTER IV

RESULTS

The study used cross-sectional study design with face to face interview method in company with structured questionnaire which were modified version of the American Thoracic Society Questionnaire (adultversion). 402 randomly selected non-smoking women from two villages in Tu Liem suburban district, Hanoi, Vietnam provided study data. In this chapter, the findings of the study have been divided into two main components which were descriptive and inferential parts following order below:

Part 1: Descriptive analysis

1) Socio-demographic characteristics
2) Cooking fuel practices
3) House conditions
4) Respiratory effects

Part 2: Inferential analysis

1) Bivariate analysis
2) Multivariable analysis

In descriptive part, the frequencies and percentages of all categorical independent variables and dependent variables were presented in the tables, meanwhile, descriptive statistic data of continuous independent variables were shown with mean and standard deviation (SD).

Inferential analysis was started by bivariate analysis results to point out the one by one relationship between independent and dependent variables with crude OR and 95% Confidence Interval (95%CI). Multivariable analysis part presented the results of multivariabe logistic regression models of all six outcomes through adjusted OR and 95% CI.

4.1. Descriptive Analysis

4.1.1. Socio-demographic characteristics

The average age of participants was 42.6 years old. 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 gas or chemical fumes in workplace.

Table 1 Socio-demographic characteristics

Characteristics	Frequency	Percentage
Age (n=402)	Median=43, Mean = 42.6, SD = 12.61	
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	60	14.9
Graduate school	2	0.5
Occupation (n=402)		
Government Officer	37	9.2
Industrial Worker	12	3
Office staff in private sectors	11	2.8
Daily paid worker	19	4.7
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
Gas or chemical fumes exposure in workplace (n=402)	100	24.9

4.1.2. Cooking fuel practices

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 gas only, beehive coal only and both gas and beehive coal. However, in this scheme, other cooking fuel can be accepted with less than 20% of total current cooking time. Statistics in table 2 has shown the percentage of alternate uses of other fuel use including wood, charcoal and electricity (15.2%, 5% and 3.2% respectively) with minor cooking time. Among 134 households using both gas and beehive coal, there were 20.2% households which have equally used both gas and beehive coal, 67.9% households using beehive coal more than gas and 11.9% households using gas in excess of beehive coal (See Table 1).

Table 2 Cooking fuel use

Cooking fuel use	**Frequency**	**Percentage**
Cooking fuel used (n=402)		
Wood	61	15.2
Charcoal	20	5.0
Beehive coal briquette	268	66.7
Gas	268	66.7
Electricity	13	3.2
Classification of households by current cooking fuel use (n=402)		
Gas use only	136	33.8
Both gas and beehive coal use	134	33.3
Beehive coal use	132	32.8
The main kind of cooking fuel in household using more than one fuel (n=134)		
No main fuel	27	20.2
Beehive coal briquette	91	67.9
Gas	16	11.9

Table 2 has presented the cooking place characteristics in household. For cooking place of gas stove in households using both beehive coal and gas as cooking fuel, the majority of households used gas stove inside the house without separate section (37.3%); the minority was setting gas stove inside the house with separate section (12.7%). Occupying nearly same percentage belonged to households placing gas stove outside the house and in kitchen outside the house. Meanwhile, the most beehive coal stoves were placed outside the house (61.9%). Only 6.7% and 2.2% families kept beehive coal stove inside the house either separate section or not. The others had beehive coal stoves which were located in kitchen outside the house with

29.1%. For households using beehive coal or gas only, there were 33.5% respondents had stove inside the house without separate section. Outside house and kitchen outside the house were cooking place of 26.4% and 27.5% households respectively. The percentage of households setting the stove inside the house with separate section was 12.6% only (See Table 2).

Table 3 Cooking place

Cooking place	Frequency	Percentage
Cooking place in households using both beehive coal and gas (n=134)		
Gas stove (n=134)		
Outside the house	32	23.9
Inside the house without separate section	50	37.3
Inside the house with separate section	17	12.7
In kitchen outside the house	35	26.1
Beehive coal stove (n=134)		
Outside the house	83	61.9
Inside the house without separate section	9	6.7
Inside the house with separate section	3	2.2
In kitchen outside the house	39	29.1
Cooking place in households using beehive coal or gas only (n=268)		
Outside the house	71	26.4
Inside the house without separate section	89	33.5
Inside the house with separate section	34	12.6
In kitchen outside the house	74	27.5

In which of 134 households using both beehive coal and gas that had ventilation system in cooking place, 116 out of 134 had ventilators for gas stove including chimney, ventilator fan and opening windows or doors (17%, 16.2% and 65.8% respectively) and 75 out of 134 had chimney (13.2%), ventilator (6.6%) and opening windows or doors to ventilate exhaust emission from beehive coal stove. Number of households using both gas and beehive coal which had ventilation system for their stoves was 249, in which 24.9% of chimney, 69.1% of opening windows or doors and 6% of ventilator fan. The average number of beehive coal briquettes expended per month in family utilizing beehive coal only was nearly 256 briquettes, which was higher than that of households using both gas and beehive coal with 143 briquettes. Likewise, the average kilogram of gas spent per month for cooking in women using gas only was more than in those using both gas and beehive coal with 6.25 and 5.6 kg respectively (See Table 3).

Table 4 Ventilation system in cooking place and quantity of used cooking fuel

Ventilation system in cooking place and quantity of used cooking fuel	**Frequency**	**Percentage**
Ventilation system in household using both beehive coal and gas (n=134)		
Gas stove (n=116)	116	86.6
Chimney	20	17.0
Ventilator fan	19	16.2
Opening windows and/or doors	77	65.8
Beehive coal stove (n=75)	75	56.0
Chimney	10	13.2
Ventilator fan	5	6.5
Opening windows and/or doors	60	80.3
Ventilation system in household using beehive coal or gas only (n=249)	249	92.6
Chimney	62	24.9
Ventilator fan	15	6.0
Opening windows and/or doors	172	69.1
Quantity of cooking fuel per month (n=402)		
Quantity of beehive coal in household using beehive coal only (briquettes)	Median=225, Mean=255.8, SD=191.2	
Quantity of gas in household using gas only (kg)	Median=6, Mean=6.25, SD=3.7	
Quantity of beehive coal in household using both beehive coal and gas to be cooking fuel (briquettes)	Median=60, Mean=142.6, SD=163	
Quantity of gas in household using both beehive coal and gas to be cooking fuel (kg)	Median=5, Mean=5.6, SD=2.58	

Number of hours to cook with beehive coal of respondents in household using beehive coal only was 1.5 times more than in household using both gas and beehive coal, which were 5.42 and 3.25 hours in that order. Whereas, 1.53 and 1.93 hours were cooking time with gas use in households using gas only and both beehive coal and gas. As for the history of solid fuel use, 80.1% women have ever used beehive coal before. Meanwhile, nearly a half of sample size have ever used biomass. For women who have ever consumed beehive coal in their life, the average duration of exposure to emissions was 15 years and that of those who have ever used biomass was 18.3 years. The study results also pointed out 28.9% of respondents that exposed to cooking fuel emission from next-door households (See table 4).

Table 5 Cooking time and history of solid fuel use

Cooking time and history of solid fuel use	Frequency	Percentage
Cooking time per day (n=402)		
Cooking time with beehive coal in household using beehive coal only (hours)	Median=5, Mean=5.42, SD=2.7	
Cooking time with gas in household using gas only (hours)	Median=1, Mean=1.52, SD=0.8	
Cooking time with beehive coal in household using both beehive coal and gas (hours)	Median=3, Mean=3.25, SD=1.7	
Cooking time with gas in household using both beehive coal and gas (hours)	Median=2, Mean=1.93, SD=1.8	
History of solid fuel use for cooking (n=402)		
Have ever used beehive coal (n=402)	322	80.1
Number of years used beehive coal (n=314)	Median=13, Mean=15, SD=9.9	
Have ever used biomass (n=402)	176	43.8
Number of years used biomass (n=176)	Median=20, Mean=18.3, SD=11.9	
Cooking fuel emission exposure from neighboring households	116	28.9

4.1.3. House conditions

There were 35.1% respondents reported they got dampness and mould in house. The average distance from house location to main road was 566 m, to farmland was 939.4 m and to industrial area was 7317.9 m. According to table 5, the statistics has shown that 50.2% respondents had at least one family member who smokes inside the house. 158 out of 202 smokers were respondents' husband corresponding to 78.2%. Most of smokers consumed less than 5 cigarettes/cigars per day with 38.6%. The percentage of people smoked 5-9 cigarettes/cigars in house per day was nearly similar to smoking 10-19 cigarettes/cigar, which were 25.7 and 24.8% in that order (See Table 5).

Table 6 House characteristics

House characteristics	Frequency	Percentage
Dampness and mould status (n=402)	141	35.1
Distance from house location to main road (m) (n=402)	Median=600, Mean=566, SD=289.5	
Distance from house location to farmland (m) (n=402)	Median=900, Mean=939.4, SD=663.5	
Distance from house location to industrial area (m) (n=402)	Median=7000, Mean=7317.9, SD=3891.1	
Indoor smoking status (n=402)	202	50.2
Smoker is husband (n=202)	158	78.2
Smokers are other family members (n=202)	60	29.7
Number of cigarettes/cigars smoker in house per day (n=202)		
Less than 5 cigarettes/cigars	78	38.6
5 – 9 cigarettes/cigars	52	25.7
10 – 19 cigarettes/cigars	50	24.8
20 cigarettes/cigars and more	22	10.9

4.1.4. Respiratory Effects

4.1.5.1. Respiratory Symptoms

According to table 7, there were 65 women who have cough with or without cold which occurred for one month or more per year, corresponding to 16.2%. Meanwhile, 49 women (12.2%) reported having phlegm from the chest that lasted one month or more per year when they have or have not gotten cold. The percentage of participants who got both cough and phlegm symptoms with the duration of one month or more per year was less than that of cough, phlegm; which was 11.9%. Having shortness of breath when hurrying on level ground or walking up a small hill was respiratory symptom of 60.2% women who particpated in this study. The study finding also reported that the percentage of women those have ever got wheeze with or without cold along with shortness of breath as an adult was 24.4%.

Table 7 Respiratory symptoms

Respiratory Symptoms (n=402)	Frequency	Percentage
Cough with or without cold for one month or more per year	65	16.2
Phlegm with or without cold for one month or more per year	49	12.2
Cough and Phlegm with or without cold for one month or more per year	48	11.9
Shortness of breath when hurrying on level ground	242	60.2
Wheeze with shortness of breath in adulthood	98	24.4

4.1.5.2. Doctor – diagnosed diseases

Table 8 has presented the statistics regarding doctor – diagnosed diseases. There were 19.9% women who have been diagnosed chronic bronchitis by doctor. The prevalence of current doctor-diagnosed emphysema was observed in 3.2% participants. Current COPD was not directly reported from participants. If a woman got either current chronic bronchitis or emphysema or she got both these doctor-diagnosed diseases, this case was defined having current COPD. Accordingly, the percentage of current COPD was 19.9% participants (See Table 8).

Table 8 Doctor – diagnosed diseases

Doctor – diagnosed diseases	Frequency	Percentage
Currently had doctor-diagnosed COPD (n=402)*	80	19.9
Chronic bronchitis is currently diagnosed (n=402)	80	19.9
Emphysema is currently diagnosed (n=402)	13	3.2

(*) Indirectly estimated by either having doctor-diagnosed chronic bronchitis or emphysema

4.2. Inferential Analysis

4.2.1. Bivariate Analysis

Bivariate analysis was the foundation for setting of multivariable logistic regression models. Univariable Logistic Regression was used in bivariate analysis for the relationship between each pair of one independent and one dependent variable. There were 6 dependent variables that concerned in the study including cough with or without cold for 1 month or more, phlegm with or without cold for 1 month or more, cough and phlegm with or without cold for 1 month or more, shortness of breath when hurrying on level ground (SOB), wheeze with SOB in adulthood and current COPD. Within the scope of the study, independent variables were divided into three components, which were cooking fuel practices, house environments and socio-demographic factors. Several independent variables were dichotomized to be two values and recategorized such as occupation, education, cooking place. The relationship of each pair was presented by crude OR, 95% of confidence interval (95%CI) and p-value in the tables below.

Only independent variables which had the relationship in pair with each independent variable with p-value ≤ 0.15 was shown in these tables, other independent variables were out of the condition were not given. This cut-off point of p-value was selected after the trials for the best multivariable logistic regression models

According to bivariate analysis results; classfication of household by using cooking fuel with three values which were gas use only, both beehive coal and gas use, beehive coal use only; number of year to use solid fuel consisting of biomass and beehive coal were found the relationship with all six outcome variables. The relationships between cooking time, quantity of cooking fuel and respiratory effects were found but not for all six symptoms and illnesses. Four associations of cooking fuel emission exposure from neighboring households with cough, both cough and phlegm for one month or more per year, SOB when hurrying on level ground and wheeze with SOB in adulthood were pointed out in bivariate analysis results (See table 9, 10).

Regarding house environments; dampness and mould in house, distance from house to main road, farmland were found the relationship with all six respiratory effects. Indoor smoking status associated with SOB when hurrying on level ground (OR=1.36) (See table 11, 12).

For socio-demographic characteristics; age, occupation, education and gas or chemical fumes exposure in workplace associated with six respiratory symptoms and illness (See table 13, 14).

All the relationships in pair as given above were used to construct 6 multivariable logistic regression models for all outcome variables, which are cough, phlegm, both cough and phlegm for more and equal to 1 month, SOB when hurrying on level ground, wheeze with SOB in adulthood and current COPD.

Table 9 Bivariate analysis for cooking fuel practice and respiratory symptoms including cough, phlegm, both cough and phlegm for one month or more per year

Cooking fuel practices	**Cough for one month or more per year**		**Phlegm for one month or more per year**		**Cough and Phlegm for one month or more per year**	
	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value
Current cooking fuel use (*)						
Both beehive coal and gas	3.42 (1.63-7.14)	0.001	2.77 (1.22-6.26)	0.014	2.77 (1.22-6.26)	0.014
Beehive coal use only	2.39 (1.11-5.14)	0.025	2.22 (0.96-5.15)	0.061	2.08 (0.89-4.86)	0.089
Cooking time per day in households using gas only *(hours)*	0.59 (0.38-0.9)	0.016	0.65 (0.41-1.03)	0.071	0.66 (0.42-1.05)	0.083
Cooking time in per day in households using beehive coal only *(hours)*	1.06 (0.97-1.15)	0.14	_	_	_	_
Cooking time per day with beehive coal in households using both coal and gas *(hours)*	1.13 (0.99-1.29)	0.052	1.14 (0.99-1.32)	0.06	1.15 (1-1.3)	0.047
Quantity of gas in household using gas only *(kg)*	0.85 (0.76-0.96)	0.008	0.86 (0.76-0.98)	0.026	0.87 (0.77-0.99)	0.031

Cooking fuel practices	Cough for one month or more per year		Phlegm for one month or more per year		Cough and Phlegm for one month or more per year	
	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value
Ever used beehive coal	6.97 (2.13-22.7)	<0.001	7.56 (1.8-31.8)	0.001	7.38 (1.75-31)	0.002
Number of years used beehive coal *(years)*	1.075 (1.04-1.1)	<0.001	1.08 (1.05-1.1)	<0.001	1.079 (1.05-1.1)	<0.001
Ever used biomass	5 (2.76-9.28)	<0.001	4.7 (2.39-9.42)	<0.001	5.2 (2.56-10.5)	<0.001
Number of years used biomass *(years)*	1.073 (1.05-1.09)	<0.001	1.074 (1.05-1.09)	<0.001	1.076 (1.05-1.1)	<0.001
Cooking fuel emission exposure from neighboring households	1.83 (1.05-3.17)	0.003	_	_	1.56 (0.83-2.94)	0.15

(*) Compared to the gas use only as reference group
Blank cells indicate variables will not be entered in multivariable logistic models due to p-value>0.15

Table 10 Bivariate analysis for cooking fuel practices and respiratory symptoms including SOB when hurrying on level ground; wheeze with SOB in adulthood and current COPD

Cooking fuel practices	SOB when hurrying on level ground		Wheeze with SOB in adulthood		Current COPD	
	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value
Current cooking fuel use (*)						
Both beehive coal and gas	6.5 (3.83-11.24)	<0.001	2.32 (1.23-4.34)	0.009	2.73 (1.32-5.63)	0.007
Beehive coal use only	4.2 (2.52-7)	<0.001	3.39 (1.83-6.26)	<0.001	4.49 (2.23-9.04)	<0.001
Cooking time per day in households using gas only *(hours)*	0.41 (0.31-0.55)	<0.001	0.54 (0.37-0.78)	0.001	0.47 (0.3-0.74)	0.001
Cooking time in per day in households using beehive coal only *(hours)*	1.06 (0.99-1.14)	0.065	1.11 (1.03-1.19)	0.004	1.12 (1.04-1.2)	0.002

Cooking fuel practices	SOB when hurrying on level ground		Wheeze with SOB in adulthood		Current COPD	
	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value
Cooking time per day with beehive coal in households using both coal and gas *(hours)*	1.31 (1.14-1.49)	<0.001	_	_	_	_
Quantity of beehive coal in household using beehive coal only *(briquettes)*	1.001 (1-1.003)	0.041	1.002 (1-1.003)	0.008	1.001 (1-1.003)	0.047
Quantity of gas in household using gas only *(kg)*	0.83 (0.78-0.89)	<0.001	0.87 (0.79-0.95)	0.002	0.8 (0.71-0.9)	<0.001
Quantity of beehive coal in household using both gas and beehive coal *(briquettes)*	1.003 (1.001-1.005)	0.013	_	_	_	_
Ever used beehive coal	7.02 (4.09-12.04)	<0.001	5.66 (2.38-13.4)	<0.001	6.7 (2.38-18.8)	<0.001
Number of years used beehive coal *(years)*	1.13 (1.1-1.17)	<0.001	1.07 (1.05-1.1)	<0.001	1.084 (1.05-1.1)	<0.001
Ever used biomass	7.8 (4.84-12.8)	<0.001	4.98 (3.02-8.23)	<0.001	5.32 (3.05-9.27)	<0.001
Number of years used biomass *(years)*	1.14 (1.1-1.19)	<0.001	1.089 (1.06-1.11)	<0.001	1.087 (1.06-1.11)	<0.001
Cooking fuel emission exposure from neighboring households	1.7 (1.07-2.6)	0.02	1.53 (0.94-2.48)	0.085	_	_

(*) Compared to the gas use only as reference group
Blank cells indicate variables will not be entered in multivariable logistic models due to p-value>0.15

Table 11 Bivariate analysis for house conditions and respiratory symptoms including cough, phlegm and both cough and phlegm for one month per year and more

House conditions	Cough for one month or more per year		Phlegm for one month or more per year		Cough and Phlegm for one month or more per year	
	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value
Dampness and mould status	2.54 (1.48-4.35)	0.001	3.44 (1.85-6.38)	<0.001	3.29 (1.77-6.13)	<0.001
Distance from house location to main road *(m)*	0.999 (0.998-1)	0.01	0.998 (0.997-0.999)	0.002	0.998 (0.997-0.999)	0.002
Distance from house location to farmland *(m)*	0.999 (0.998-0.999)	<0.001	0.999 (0.998-0.999)	<0.001	0.999 (0.998-0.999)	<0.001

Table 12 Bivariate analysis for house conditions and respiratory symptoms including SOB when going up stairs, wheeze with SOB in adulthood and current COPD

House conditions	SOB when hurrying on level ground		Wheeze with SOB in adulthood		Current COPD	
	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value
Dampness and mould status	3.27 (2.06-5.2)	<0.001	3.06 (1.91-4.89)	<0.001	3.95 (2.37-6.58)	<0.001
Distance from house location to main road *(m)*	0.99 (0.997-0.998)	<0.001	0.997 (0.996-0.998)	<0.001	0.997 (0.997-0.998)	<0.001
Distance from house location to farmland *(m)*	0.99 (0.998-0.999)	<0.001	0.999 (0.998-0.999)	<0.001	0.99 (0.998-0.999)	<0.001
Indoor smoking status	1.36 (0.91-2.03)	0.13	_	_	_	_

Blank cells indicate variables will not be entered in multivariable logistic models due to p-value>0.15

Table 13 Bivariate analysis for socio-demographic factors and respiratory symptoms including cough, phlegm and both cough and phlegm for one month or more per year per year

Characteristics	Cough for one month or more per year		Phlegm for one month or more per year		Cough and Phlegm for one month or more per year	
	OR (95%CI)	**P-value**	**OR (95%CI)**	**P-value**	**OR (95%CI)**	**P-value**
Age	1.066 (1.04-1.09)	<0.001	1.066 (1.037-1.096)	<0.001	1.065 (1.03-1.09)	<0.001
Education upper secondary school (*)	0.45 (0.24-0.84)	0.011	0.451 (0.22-0.91)	0.024	0.46 (0.23-0.94)	0.034
Occupation (5 levels) (†)		0.087		0.12		0.112
Gas or chemical fumes exposure in workplace	1.69 (0.95-3.01)	0.068	1.92 (1.02-3.6)	0.04	1.99 (1.05-3.75)	0.031

(*) Compared to education below secondary school as the reference group
(†) P-value for whole factor, not for each category of factor

Table 14 Bivariate analysis for socio-demographic factors and respiratory symptoms including SOB when hurrying on level ground, wheeze with SOB in adulthood and current COPD

Socio-Demographic Characteristics	SOB when hurrying on level ground		Wheeze with SOB in adulthood		Current COPD	
	OR (95%CI)	**P-value**	**OR (95%CI)**	**P-value**	**OR (95%CI)**	**P-value**
Age	1.058 (1.04-1.077)	<0.001	1.058 (1.037-1.08)	<0.001	1.068 (1.04-1.09)	<0.001
Education upper secondary school (*)	0.436 (0.288-0.661)	<0.001	0.4 (0.23-0.68)	0.001	0.355 (0.19-0.64)	<0.001
Occupation (5 levels) (†)		0.004		0.141		0.089
Gas or chemical fumes exposure in workplace	2.78 (1.65-4.66)	<0.001	1.47 (0.88-2.44)	0.13	1.61 (0.94-2.75)	0.084

(*) Compared to education below secondary school as the reference group
(†) P-value for whole factor, not for each category of factor

4.2.2. Multivariable Analysis

In order to give modeled magnitudes of effect of more than one independent variable simultaneously, multivariable logistic regression was used with two steps after bivariate analysis.

In the first step, all the independent variables which had p-value ≤ 0.15 in bivariate analysis were entered into the first multivariable logistic regression models of all six dependent variables. The tables below presented the first-step multivariable logistic regression models with coefficient (β), OR, 95%CI. Only independent variables which had p-value ≤ 0.15 in each model were given in these tables, those independent variables were out of this range were not mentioned in here.

Table 15 The first-step multivariable logistic model of cough for one month or more per year

Independent variables	β	OR (95%CI)	P-value
Cooking fuel practice			
Current cooking fuel use (*)			0.067 (†)
Both gas and coal use	0.188	1.2 (0.2-6.98)	0.834
Beehive coal use only	-1.435	0.23 (0.03-1.89)	0.175
Cooking time per day with beehive coal only	0.218	1.24 (1.03-1.5)	0.024
Number of year used beehive coal	0.068	1.07 (1.03-1.1)	<0.001
Number of year used biomass	0.068	1.07 (1.04-1.1)	<0.001
Distance from house location to farmland	<0.001	0.998 (0.998-1)	0.069

(*) Compared to the gas use only as reference group
(†) P-value for whole factor, not for each category of factor

Table 16 The first-step multivariable logistic model of phlegm for one month or more per year

Independent variables	β	OR (95%CI)	P-value
Number of year used beehive coal *(years)*	0.078	1.08 (1.03-1.12)	<0.001
Number of year used biomass *(years)*	0.073	1.07 (1.04-1.1)	<0.001
Dampness and mould status	0.622	1.86 (0.9-3.85)	0.094

Table 17 The first-step multivariable logistic model of both cough and phlegm for one month or more per year

Independent variables	β	OR (95%CI)	P-value
Number of year used beehive coal	0.085	1.08 (1.04-1.13)	<0.001
Number of year used biomass	0.079	1.08 (1.04-1.11)	<0.001

Table 18 The first-step multivariable logistic model of SOB when hurrying on level ground

Independent variables	β	OR (95%CI)	P-value
Cooking time per day with gas only	-0.490	0.61 (0.34-1.09)	0.097
Number of year used beehive coal	0.146	1.15 (1.1-1.21)	<0.001
Number of year used biomass	0.156	1.16 (1.11-1.22)	<0.001
Cooking fuel emission exposure from neighboring households	0.732	2.08 (1.05-4.09)	0.034
Indoor smoking status	0.546	1.73 (0.95-3.14)	0.073
Education upper secondary school (*)	0.776	2.17 (1.00-4.69)	0.048
Occupation			0.096 (†)
Gas or chemical fumes exposure in workplace	0.839	2.31 (1.1-4.83)	0.026

(*) Compared to education under secondary school as reference group

(†) P-value for whole factor, not for each category of factor

Table 19 The first-step multivariable logistic model of wheeze with SOB in adulthood

Independent variables	β	OR (95%CI)	P-value
Number of year used beehive coal	0.081	1.08 (1.04-1.12)	<0.001
Number of year used biomass	0.098	1.10 (1.07-1.13)	<0.001
Cooking fuel emission exposure from neighboring households	0.578	1.78 (0.91-3.46)	0.087
Dampness and mould status	0.493	1.63 (0.89-2.98)	0.108
Distance from house location to main road	-0.002	0.998 (0.997-0.999)	0.002

Table 20 The first-step multivariable logistic model of current COPD

Independent variables	**β**	**OR (95%CI)**	**P-value**
Quantity of beehive coal in household using beehive coal only	-0.002	0.998 (0.995-1.001)	0.135
Number of year used beehive coal	0.081	1.08 (1.04-1.12)	<0.001
Number of year used biomass	0.091	1.09 (1.06-1.12)	<0.001
Dampness and mould status	1.003	2.72 (1.4-5.3)	0.003
Distance from house location to farmland	<0.001	0.999 (0.998-1)	0.074

In the second step, all the independent variables which had p-value ≤ 0.15 in the first step of multivariable logistic regression were entered into the final multivariable logistic regression models of all six dependent variables. The tables below presented the final multivariable logistic regression models with coefficient (β), adjusted OR, 95% CI and bivariate analysis results of the independent variables which were kept in the final multivariable logistic models with crude OR and 95%CI in order to compared the differences between bivariate analysis finding and multivariable logistic regression.

Table 21 Final Multivariable Logistic Regression Model for cough for one month or more per year

Independent variables	Cough for one month or more per year	Cough for one month or more per year		
	Crude OR (95%CI)	β	Adjusted OR (95%CI)	P-value
Number of years used beehive coal *(years)*	1.075 (1.04-1.1)	0.075	1.078 (1.04-1.11)	<0.001
Number of years used biomass *(years)*	1.073 (1.05-1.09)	0.072	1.074 (1.04-1.10)	<0.001
Cooking time per day with beehive coal only	1.06 (0.97-1.15)	0.199	1.220 (1.01-1.46)	0.032
Cooking fuel use				
Gas use only	1		1	0.051 (†)
Both gas and coal use	3.42 (1.63-7.14)	0.019	1.020 (0.42-2.45)	0.965
Coal use only	2.39 (1.11-5.14)	-1.591	0.200 (0.04-0.87)	0.032
Distance house location to farmland *(m)*	0.999 (0.998-1)	<0.001	0.999 (0.998-1)	0.076

(†) P-value for whole factor

Final multivariable logistic regression model for cough with or without cold for one month or more per year was shown in Table 21. All variables which associated with cough for one month or more per year in the first step including current cooking fuel use, cooking time per day by hour with beehive coal only, cooking smoke exposure from neighboring households, distance from house to main road and socio-demographic factors were redone multivariable logistic model. The final multivariable logistic regression model of cough for one month or more per year gave the marginally significant relationship with current cooking fuel use; but this noticeably varied from bivariate analysis. Both gas and coal use was out of significance in the final model (p-value=0.965). Meanwhile, coal use only still kept in final multivariable logistic regression model of cough for one month or more per year as in bivariate analysis; but the direction of relationship between coal use only and cough for one month or more per year which found in final multivariable logistic regression model was completely inverse to that of bivariate analysis. Apart from these, the final model pointed out the positively significant relationship of cough with or without cold for one month or more per year with number of years used biomass and beehive coal; distance from house location to the nearest farmland and cooking time per day with beehive coal only. The model showed that a one unit increase in years have used beehive coal and biomass increased the odds of having cough for one month or more per year by multiplicative factor of 1.072 and 1.073, 95% CI from 1.04 to 1.1 and 1.04 to 1.09 respectively. Meanwhile, the increase of one hour cooking per day with beehive coal only increased the odds of of having cough for one month or more per year by multiplying by 1.22, 95% CI=1.01-1.46. Distance house location to farmland also had the negative association with cough for more and equal to 1 month. The modeled odds of having cough for one month or more per year, per one meter increase of distance from house location to farmland, were 0.99 (95%CI=0.999-1). These relationships seem to be stable in both bivariate and multivariable analysis results.

Table 22 Final Multivariable Logistic Regression Model for phlegm for one month or more per year

Independent variables	Phlegm for one month or more per year	Phlegm for one month or more per year		
	Crude OR (95%CI)	β	Adjusted OR (95%CI)	P-value
Number of years used beehive coal *(years)*	1.08 (1.05-1.1)	0.078	1.081 (1.04-1.11)	<0.001
Number of years used biomass *(years)*	1.074 (1.05-1.09)	0.072	1.075 (1.04-1.1)	<0.001
Dampness and mould in house	3.44 (1.85-6.38)	0.695	2.004 (1-4.02)	0.05

In multivariable logistic regression models for phlegm with or without cold for one month or more per year, number of years used beehive coal and biomass were shown the positive association with OR=1.081 and 1.075; 95% CI=1.04-1.11 and 1.04-1.1 respectively. Dampness and mould in house was also reported the positive association with phlegm for one month or more per year through OR=2.004; 95%CI=1-4.02. It can be seen clearly that number of years used solid fuel stayed the same in multivariable logistic regression model of phlegm for one month or more per year, compared to bivariate analysis. However, OR of relationship between phlegm for equal or more than one month and dampness and mould status in house decrease from 3.44 in bivariate analysis to 2.004 in multivariable logistic regression model (See table 22).

Table 23 Final multivariable Logistic Regression Model for cough and phlegm for one month or more per year

Independent Variables	Cough and Phlegm for one month or more per year	Cough and Phlegm for one month or more per year		
	Crude OR (95%CI)	β	Adjusted OR (95%CI)	P-value
Number of years used beehive coal *(years)*	1.079 (1.05-1.1)	0.083	1.087 (1.05-1.12)	<0.001
Number of years used biomass *(years)*	1.076 (1.05-1.1)	0.076	1.079 (1.05-1.10)	<0.001

Once again, number of years used beehive coal and biomass positively associated with cough and phlegm for one month or more per year in multivariable logistic regression model with OR=1.087 and 1.079 respectively; 95%CI=1.05-1.12 and 1.05-1.1 in that order, it is nearly equal to OR which showed in bivariable analysis (See table 23).

Table 24 Final Multivariable Logistic Regression Model for SOB when hurrying on level ground

Independent variables	SOB when hurrying on level ground	SOB when hurrying on level ground		
	Crude OR (95%CI)	β	Adjusted OR (95%CI)	P-value
Number of years used beehive coal *(years)*	1.13 (1.1-1.17)	0.147	1.16 (1.11-1.2)	<0.001
Number of years used biomass *(years)*	1.14 (1.1-1.19)	0.164	1.18 (1.12-1.23)	<0.001
Gas or chemical fumes exposure in workplace	1.47 (0.88-2.44)	0.9	2.46 (1.21-5.02)	0.013
Cooking emissions exposure from neighboring households	1.7 (1.07-2.6)	0.689	1.99 (1.04-3.80)	0.037
Indoor smoking status	1.36 (0.91-2.03)	0.454	1.57 (0.89-2.77)	0.117
Education upper secondary school (*)	0.436 (0.288-0.661)	0.526	1.69 (0.84-3.40)	0.140
Occupation (†)		0.004		0.196
Cooking time per day with gas only	0.41 (0.31-0.55)	-0.198	0.82 (0.56-1.18)	0.290

(*) Compared to education below secondary school as the reference group
(†) P-value for whole factor, not for each category of factor

There are four factors have strongly positive associations in multivariable logistic regression model for SOB when hurrying on level ground, which are number of years used beehive coal and biomass, exposure to the cooking fuel smokes from next-door households and exposure to gas or chemical fumes exposure in workplace. ORs of years used beehive coal and biomass was nearly similar to the result in bivariate analysis, presented by OR =1.159 and 1.178 along with 95%CI=1.11-1.2 and 1.12-1.23 respectively. Exposure to cooking emissions from neighboring households and to gas or chemical fumes in workplace were considered having the stronger relationship with SOB when hurrying on level ground with OR=1.99 (95%CI=1.04-3.8) and OR=2.46 (95%CI=1.21-5.02) respectively in multivariable logistic model than in bivariate analysis (See table 24).

Table 25 Final Multivariable Logistic Regression Model for wheeze with SOB in adulthood

Independent variables	Wheeze with SOB in adulthood	Wheeze with SOB in adulthood		
	Crude OR (95%CI)	β	Adjusted OR (95%CI)	P-value
Number of years used beehive coal *(years)*	1.07 (1.05-1.1)	0.070	1.072 (1.04-1.1)	<0.001
Number of years used biomass *(years)*	1.089 (1.06-1.11)	0.088	1.092 (1.06-1.11)	<0.001
Distance from house location to main road *(m)*	0.997 (0.996-0.998)	-0.002	0.998 (0.997-0.999)	0.001
Dampness and mould in house	3.06 (1.91-4.89)	0.480	1.616 (0.91-2.86)	0.100
Cooking emissions exposure from neighboring households	1.53 (0.94-2.48)	0.508	1.663 (0.7-3.065)	0.103

According to table 25, there are the strongly positive associations of number of years used beehive coal and biomass with wheeze along with SOB in adulthood. The magnitude effect of number of years used biomass is greater than that of beehive coal with OR=1.072 and 1.092 respectively. Exposure to cooking emissions from neighboring households and dampness and mould in house also positively associated with wheeze along with SOB in adulthood with OR=1.663 and 1.616, 95% CI=0.9-3.065 and 0.91-2.86 respectively. Only one negative association was found in the multivariable logistic regression model for wheeze with SOB in adulthood, which is distance from house location to mainroad with OR=0.998, 95% CI=0.997-0.999. It means that the modeled odds ratio for having wheeze with SOB in adulthood, per unit in increase in distance from house location to farmland, was 0.998. Compared to results of bivariate analysis, number of years used solid fuel and distance from house location to main road in multivariable logistic model were still steady in relation to wheeze with SOB in adulthood. Meanwhile, exposure to cooking emissions from neighboring households showed the stronger association and exposure to gas came up with the weaker one with wheeze along with SOB in multivariable logistic regression.

Table 26 Final Multivariable Logistic Regression Model for current COPD

Independent variables	Current COPD	Current COPD		
	Crude OR (95%CI)	β	Adjusted OR (95%CI)	P-value
Number of years used beehive coal *(years)*	1.07 (1.04-1.1)	0.078	1.081 (1.04-1.11)	<0.001
Number of years used biomass *(years)*	1.08 (1.05-1.118)	0.087	1.091 (1.06-1.11)	<0.001
Dampness and mould in house	3.95 (2.37-6.58)	0.885	2.423 (1.31-4.46)	0.005
Distance from house location to farmland *(m)*	0.99 (0.998-0.999)	-0.001	0.999 (0.998-1)	0.009
Quantity of beehive coal in household using beehive coal only	0.8 (0.71-0.9)	<0.001	1 (0.999-1.002)	0.725

The positive relationships of number of years used beehive coal and number of years used biomass were pointed out once again in multivariable logistic regression model for current COPD with OR=1.081 and 1.091 respectively. It refers that per one unit increase in number of year using beehive coal and in number of year using biomass, the modeled odds of having current COPD were 1.081 and 1.091 respectively. The positive relationship between COPD and dampness and mould in house were given by the model with OR=2.42 (95%CI=1.31-4.46). Another relationship with opposite direction was found between distance from house location to farmland and current COPD, the longer distance from house location to farmland, the less risk of COPD is (OR=0.999, 95%CI=0.998-1) (See Table 26). The relationships of current COPD with duration of solid fuel use and distance from house location to farmland just inconsiderably increased in multivariable logistic regression. However, the magnitude of relationship between dampness and mould in house and current COPD plainly dropped off in multivariable logistic regression model from 3.95 to 2.42.

In additional, there was a wide range of changes in the relationship between current cooking fuel use and respiratory impairments in multivariable logistic regression models, compared to bivariate analysis. Most of associations between current cooking fuel use and six respiratory effects which were significant in bivariate analysis have gone away in multivariable logistic regression models. Only multivariable logistic model of cough for one month or more per year came up with the marginally significant relationship with cooking fuel use; however, this result was entirely converse to that in bivariate analysis finding. Meanwhile, number of years used beehive coal and biomass virtually constant in both bivariate analysis results and all six multivariable logistic regression models of respiratory impairments. These findings led to the conclusion that in bivariate analysis, it initially appeared that current cooking fuel use was a risk factor for respiratory effects, but further exploration with multivariable logistic regression models indicated that history of solid fuel use were likely to be mainly responsible for what caused the apparent increase in odds of respiratory effects caused by current cooking fuel use in the bivariate analysis finding. Or it can be said that the history of solid fuel use of non-smoking women was the significantly stronger risk factor for respiratory effects than current cooking fuel use. This point of view is mentioned in detail in discussion parts.

CHAPTER V

DISCUSSION, CONCLUSION AND RECOMMENDATION

The study with the aim was to determine the health burden due to indoor air pollution caused by cooking fuel emissions focusing on beehive coal use by comparing the respiratory effects among three groups, which are group using gas only, using both gas and coal; and using coal only. Besides, the study also determined the association between respiratory effects and house conditions, socio-demographic factors. The study findings were explored by interviewing 402 non-smoking women who are mainly responsible for cooking in the family from two villages in Tu Liem suburban district. This chapter is divided into 4 parts as follows:

1) Discussion on descriptive findings in the study
2) Discussion on respiratory effects in relation to cooking fuel use, house conditions and socio-demographic factors
3) Conclusions
4) Recommendation

5.1. Discussion on descriptive findings in the study

Based on the descriptive information on socio-demographic characteristics of study population, the average age of women who have principal role in cooking in the family was 42.6. This finding can be explained by cultural characteristics. In Vietnam, multigenerational household is popular and traditional family-setting as a household unit, in which several generations live together within a single household. In this type family, women often play the important role in housework for the entire family. In which, grandmother usually takes the leading roles in family for cooking due to the fact that they have the most experience as well as the spare time; meanwhile, their offsprings spend almost the time outside to earn money to cover all the expenditure for the family (Tinh, 2008). As the results, the middle age women were the predominant age group in the present study.

The highest education level of the majority of study subjects was secondary school with 47.3%; it was slightly higher than the education status of general women in Vietnam. According to Vietnam Population and housing Census in 2009, women who completed secondary school occupied 23.2% total of Vietnamese women (General Statistics Office, 2009). Nearly a half of participants were trader (41%) such as wine brewery, tofu making in house. Meanwhile, farmer was second common occupation in this area (20.9%). Clearly, population in suburban area no longer mainly based on agricultural work as before. This characteristic was similar to other suburban regions in Vietnam. According to the research on "Trends of urbanization and suburbanization in Southeast Asia", the proportion of labourer based on agriculture sector in suburban areas of Vietnam occupied 5-40% (Ton Nu Quynh Tran et al., 2008). According to these study findings, it can be seen that the study area and study population were typical for the suburban regions in Vietnam.

Respiratory symptoms

The prevalence of cough with or without cold for one month or more per year in the current study was 16.2%; it seems to be quite higher than the results of the study on "Health-seeking behaviour among adults with prolonged cough in Vietnam" with 4.6% (Hoa et al., 2011). However, another study had the 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 (Lam, et al., 2011). Regarding phlegm with or without cold for one month or more per year, 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 (Lam, et al., 2011). However, there were the differences of the prevalence of shortness of breath and wheeze between two studies. The previous study reported 4.5% attack of SOB, meanwhile; the current study showed 60.2% SOB when hurrying on level ground. This different can be explained by the unlike tools used in the study and data on SOB was also dissimilar. The study of Lam used the Swedish OLIN-questionnair with the question regarding SOB that was referred the attacks of SOB in the last 12 month when having asthma symptoms. The current study with modified version of the American Thoracic Society Questionnaire (adult version) defined SOB as participants have ever gotten any SOB when hurrying on level ground or walking up a small hill. As a result, the percentage of SOB in current study was far higher than the other. Wheeze with SOB in adulthood was shown in the current study with 24.4%, however, this prevalence in the study on "Increase in asthma and a high prevalence of bronchitis: Results from a population study among adults in urban and rural Vietnam" was 6.5% (Lam, et al., 2011; Sembajwe et al., 2010) and in the study on "National income, self-reported wheezing and asthma diagnosis from the World Health Survey" was 2.4% (Sembajwe, et al., 2010). It can be seen that the reports of wheeze symptom were different in other studies; even these studies were conducted at nearly point time. The reason of this different can be ascribed by the age of sample size, the diverse socio-demographic factors of study populations.

Current doctor-diagnosed COPD in the present study finding occupied 19.9%; which was indirectly estimated through the reports of doctor-diagnosed chronic bronchitis and emphysema. However, this prevalence was triple higher than the report from Regional COPD working group in 2003 with the estimation of 6.7% (Group, 2003) and over double higher than the results of Lam'research with 7.1% (Lam, et al., 2011). The higher prevalence may be due to the fact that current doctor-diagnosed COPD was estimated by the prevalence of chronic bronchitis and emphysema. However, it is enable the study subjects to misunderstand between acute and chronic bronchitis. Based on the prevalence of respiratory symptoms regarding cough and phlegm for one month or more per year with 11.9%, which was considered as one of symptoms to diagnose chronic bronchitis, it was much lower than the prevalence of chronic bronchitis that was collected from community.

Cooking fuel practice

With the purpose to compare the health burden due to cooking fuel between three levels of exposure, the study samples were selected with equal number of participants from three groups. Therefore, the prevalence of cooking fuel use in the target population cannot estimate in this study. However, among women in households using concurrently gas and beehive coal, beehive coal was still predominant cooking fuel use with 67.9%, only 11.9% using gas as the main cooking fuel and 20.2% households using beehive coal and gas with the equal proportion. Almost of these households using both gas and beehive coal with different purposes such as wine brewery or mash cooking for livestocks along with cooking the meal for their family. The Global Alliance for Clean Cookstoves conducted the assessment in Vietnam and also showed that 40% households in Northern Vietnam using two cookstoves, one for cooking meal, another one for other purposes in which cooking mash for pig occupied 42% (ADP, 2012). The study participants reported that the common place for gas stove was inside the house without separate section (37.3%); meanwhile, 61.9% women chose outside the house was the favourite place for beehive coal stove. This status was different from the findings from Vietnam Multiple Indicator Cluster Survey in 2011 (MICS4). They showed that the major cooking place of households in Red River Delta region, to which Hanoi belong was in a separate building with 87.7% (Vietnam General Statistics Office, 2011). The report of ventilation system that used in cooking place in the current study was nearly same as stated in MICS3 in 2006. This information was not mentioned in MICS4. MICS3 found that 64.8% households in Red River Delta open their door or windows as the ventilation method in cooking place (Vietnam General Statistics Office, 2006). Similarly, 69.1% households used the same method to ventilate the emissions of cooking fuel in the present study. The average cooking time per day of households using beehive coal only and both gas and beehive coal were 5.42 and 5.18 hours/day respectively, which was higher than 2.6 hours per day that found in the study of Global Alliance for Clean cookstoves (ADP, 2012). However, the households using gas only had the cooking time less than that study with 1.54 hours/day. The reason of this difference was that the previous study figured out the average of cooking time regardless of the type of used cooking fuel; however, the present study classified the average cooking time with each kind of cooking fuel.

The current study findings were pointed out that among 402 study participants who classified into three groups, there was a majority of women have ever used beehive coal (80.1%) with the average year of 15 and 43.8% have ever used biomass with 18.3 average years. Therefore, it enables that a number of women currently using gas only have the long-term exposure with solid fuel emissions. This point of view is discussed more intensely in the next part.

As mentioned above, the study found that 61.9% households using both gas and beehive coal had the beehive coal stove which placed outside the house. This is also the factor not only contributed to outdoor air pollution, but also indirectly caused respiratory effects due to beehive coal emissions on people who do not use beehive coal. There were 28.9% study subjects who reported that they usually expose with cooking fuel emission from next-door households in which 29% is households using gas only.

House conditions

Indoor smoking status was investigated in this study with 50.2% and the majority of indoor smokers were husbands of participants. Compared to the statement was found from the Global Adult Tobacco Survey (GATS) in Vietnam, the percentage of indoor smoker in the current study was lower by nearly 20% (King, Mirza, & Babb, 2012). However, in the study on "Who is exposed to smoke at home? A population-based cross-sectional survey in central Vietnam", the finding presented the nearly same result as the current study with 57.1% women who were exposed to smoke at home (Suzuki et al., 2010).

Hanoi has subtropical climate with the relative humidity range of 53-98%. The driest climate is in two last months of year and the most humid in August (NCHM, 2012). According to the findings of the study, dampness and mould in house was reported with 35.1%.

5.2. Discussion on inferential findings in the study

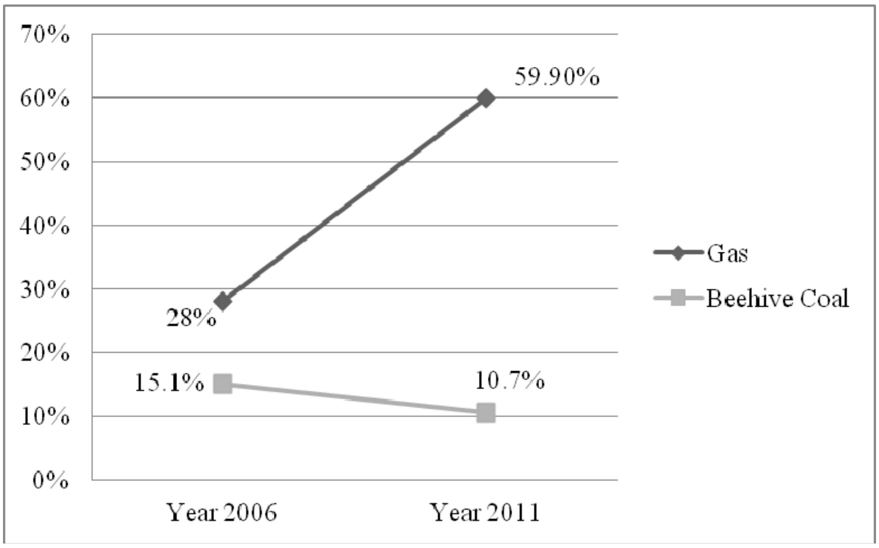
Respiratory effects in relation to the cooking fuel use

According to the results of multivariable logistic regression, most of relationships between current cooking fuel use and respiratory effects were insignificant. However, history of solid fuel pointed out the positively strong association with all five respiratory symptoms and current COPD. Odds ratio of number of years used beehive coal and biomass with cough for one month or more per year were 1.065 (95%CI=1.02-1.1) and 1.067 (95%CI=1.04-1.09); with phlegm for one month or more per year were 1.079 (95%CI=1.03-1.12) and 1.075 (95%CI=1.04-1.1); with both cough and phlegm for one month or more per year were

1.087 (95%CI=1.044-1.13) and 1.081 (95%CI=1.048-1.11); with SOB when hurrying on level ground were 1.151 (95%CI=1.09-1.12) and 1.165 (95%CI=1.11-1.22); and with wheeze along with SOB in adulthood were 1.079 (95%CI=1.04-1.11) and 1.1 (95%CI=1.06-1.13). This can be explained that study sample was divided into three groups by current kind of cooking fuel use in order to compare the respiratory effects among three groups; however, current cooking fuel use cannot estimate the duration of exposure to adverse cooking fuel emissions. Meanwhile, duration of exposure was principal determinants to the occurrence of health effects. The study which was conducted in China figured out that the largest total amount of average lifetime exposed with solid fuel significantly associated with decreases of pulmonary function with $p<0.001$ (Lee et al., 2013). 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 with OR=1.73 and 95%CI=1.45-2.06 (Lee, et al., 2012). The IARC through the research on "Lung Cancer and Indoor Pollution from Heating and Cooking with Solid Fuels" also concluded that the risk of lung cancer get higher if amount of time in their life used solid fuel for cooking increased ($p<0.001$). Lung cancer in the group used solid fuel in whole their life have OR=1.8 (95% CI=1.35-2.40) (Lissowska et al., 2005). Hence, a woman, who currently uses gas only as cooking fuel, but had used beehive coal 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.

Figure 8 presented the trend of gas and beehive coal use in Red Delta Region during 6 years from 2006 to 2011. The percentage of gas use rapidly increased over twice times higher in 2006 with 28% than in 2011 with 59.9%. Meanwhile, the proportion of beehive coal declined more slowly by 4.4% from 15.1% in 2006. As can be seen that households currently consume gas as cooking fuel, they have just switched cooking fuel from solid fuel use for the recent years. However, the first few months in 2012 along with the dramatic raise of gas price to the peak created the new trend, in which the households currently using gas only return to coal use or concurrently using both beehive coal and gas for cooking to reduce expenditure of cooking fuel (ADP, 2012). Beehive coal enterprises reported that in the first couple of months in 2012, average daily productivity doubly increase in order to meet market demand (Times, 2012). With this trend, it can be predicted that the percentage of beehive coal use tends to increase and the growth of gas use gets slowed.

Figure 8 The trend of gas use and beehive coal use in Red Delta Region 2006 – 2011



Source: Vietnam Multiple Indicator Cluster Survey 2006, 2011

Table 27 provided the information regarding to the relationship between current cooking fuel use and history of solid fuel use. It can be seen clearly that among 136 households using gas only in the study sample, there was approximately a half of sample size have ever used beehive coal and 26.5% have ever used biomass before. Noticeably, although these households currently use gas only for cooking; they have already had duration of solid fuel use in the past. Similarly, 59.7% households using both beehive coal and gas have used biomass before, even higher than households using beehive coal only in the study sample with 45.5%. Besides, this statistic in table 27 pointed out the significant relationship between cooking fuel use and history of solid fuel with p-value<0.001.

Table 27 Relationship between current cooking fuel use and history of solid fuel use

Outcomes variables	N (%) Gas use only (n=136)	Both gas and beehive coal use (n=134)	Beehive coal use (n=132)	χ^2	P-value
Have ever used beehive coal before					
Yes	56 (41.2)	134 (100)	132 (100)	195.3	**<0.001**
No	80 (58.8)	0 (0)	0 (0)		
Have ever used biomass before					
Yes	36 (26.5)	80 (59.7)	60 (45.5)	30.5	**<0.001**
No	100 (73.5)	54 (40.3)	72 (54.4)		

More clearly, table 28 presented the duration of solid fuel use among three current cooking fuel use group, the number of years used beehive coal and biomass were different in three groups. Number of years used beehive coal was the highest in beehive coal use group (16.26 years), the less in both gas and beehive coal use group (14.41 years) and the least in gas use only (4.72 years). Nevertheless, the group currently used both gas and beehive coal had the longer exposure duration to biomass than beehive coal use only with 11.07 and 9.6 years respectively (See Table 28).

Table 28 Number of years used beehive coal and biomass by current cooking fuel use group

Cooking fuel use	Number of years used beehive coal (Mean ± SD)	Number of years used biomass (Mean ± SD)
Gas use only	4.72 ± 8.56	3.5 ± 7.95
Both gas and coal use	14.41 ± 9.78	11.07 ± 12.95
Coal use only	16.26 ± 10.03	9.6 ± 13.2

As given, women in gas currently use only group had considerable exposure to adverse emissions from solid fuel including beehive coal with nearly 50% and average duration of 4.72 years and biomass with approximately 30% and 3.5 years of exposure duration. More noticeably, the exposure to beehive coal of gas and coal concurrently use and coal use only group was nearly the same with 14.41 and 16.26 years of duration; even the exposure to biomass of both gas and coal use was more serious than coal use only with longer exposure duration (11.07 and 9.6 respectively) and the higher percentage of women who have used biomass before (59.7 and 45.5% in that order). Therefore, the comparation respiratory effects among three groups of current cooking fuel cannot figure out the comprehensive picture in term of health burden due to cooking fuel use. Moreover, the statistically significant relationship between current fuel use and duration of beehive coal and biomass, which shown in table 27 with $p<0.001$, maked the large changes of effects of cooking fuel use on respiratory episodes in multivariable logistic regression models. Thus, it can be said that duration of solid fuel use in lifetime contributed to causality of respiratory effects greater than current cooking fuel use. Therefore, the study results just showed that respiratory effects strongly associated with history of using solid fuel but not with current cooking fuel use. In addition, within the scope of this study with cross-sectional study design, it unable to exactly determine temporal relationship between current cooking fuel use and health effects development.

Another cooking-related factor, namely cooking emissions exposure from neighboring households, was found in relation to the respiratory effects including SOB when hurrying on level ground and wheeze with SOB in adulthood with OR=1.99 and 1.663 respectively (95%CI=1.04-3.8 and 0.9-3.065). As given in the descriptive part, nearly 30% households in sample size exposed cooking fuel emission from neighbourhood. The source of cooking fuel emission from neighbourhood can be attributable to beehive coal because 61.9% households that reported using beehive coal outside their house.

Respiratory effects in relation to other factors

There were three house condition–related factors that were found the association with respiratory effects, which were dampness and mould, distance from house location to the main road and farm zone.

The relationships of dampness and mould in house with phlegm for one month or more per year (OR=2.004, 95%CI=1-4.02), with wheeze attached SOB in adulthood (OR=1.616, 95%CI=0.91-2.86) and current COPD status (OR=2.42, 95%CI=1.31-4.46) were found in the current study. These statements were also mentioned in the wide range of researches. The European Community Respiratory

Health Survey was conducted in 2002 and pointed out that mould exposure have strong relationship with asthma symptoms and bronchial responsiveness with the OR in the range from 1.14 to 1.44 (Zock, 2002). According to the findings from quantitative meta-analyses regarding to the association between dampness and mould in houses and respiratory health effects, estimated point of ORs of the association between the occurrence of dampness and mould and asthmatic symptoms in original studies was in the range of 1.34-1.75 with the lower bound of CIs was larger than 1.2. Derived from this finding, the Institute of Medicine of the National Academy of Sciences concluded that dampness and mould in house was related to about 30-50% raises in respiratory and asthmatic effects (Fisk, Lei-Gomez, & Mendell, 2007). The similar results can be found in a remarkable number of studies (Sahakian, Park, & Cox-Ganser, 2008); (Norback, Wieslander, Nordstrom, & Walinder, 2000); (Mendell, Mirer, Cheung, Tong, & Douwes, 2011).

The current study figured out the contribution of distance from house location to farm zone to adverse health effects with statistical data of OR=0.99 (95%CI=0.999-1) with cough for one month or more per year and OR=0.999 (95%CI=0.998-1) with current COPD. The common pollutant in farmland which effected on human health can be ascribed to pesticide-related factors. According to the survey that conducted in Vietnam, the authors pointed out 96.6% famers consumed pesticide excessively and not follow the directions for use on the pesticide label (Huan & Thiet, 2000). "Poverty-Environment Report: Pesticide Use in the Mekong Delta, Vietnam" stated that the pesticide use in Vietnam is increasing more and more and the substances in pesticide composition were very adverse to health and environment (Craig Meisner & DECRG-IE, 2006). Prohibited pesticides were investigated with 2500 kg such as methamidophos, DDT and other chemicals, accompany with 4,753 l and 5,645 kg of illegally imported pesticides in Vietnam (PPD, 2000). There was no denying the fact of adverse respiratory health effects of pesticide. A great deal of researches provided the scientific evidences regarding the relationship between pesticide and respiratory symptoms. For instance, the study in Colorado demonstrated that pesticide exposure associated with respiratory symptoms consisting of cough in non-smoker, wheeze, allergy and organic dust toxic syndrome by logistic regression model; and with lung function including forced vital capacity (FVC) and forced expiratory volume (FEV1) by linear regression model (Beseler & Stallones, 2009). Strong relationship between pesticide use and respiratory effects was also found in the study with the participation of 1379 people in Brazil. This study showed the odds of asthma and chronic respiratory diseases were 1.51 (95%CI=1.07-2.14) and 1.34 (95%CI=1-1.81) respectively times higher in women who exposed to pesticide than non-exposure women (Faria, Facchini, Fassa, & Tomasi, 2005). Differently from the studies above, the current research indirectly found the association between pesticide exposure and respiratory symptoms through the OR of distance of house location to farmland with cough and current COPD was 0.99. It means that the longer distance of house location to farmland was; the less risk of cough for one month or more per year and current COPD was. This statement was reinforced more in the current study when the relationship of SOB when hurrying on level ground and exposure to gas or chemical fumes in workplace was found with OR=2.46 (95%CI=1.21-5.02). Among 100 respondents who reported exposure to gas or chemical fumes in workplace, there was 82% exposed to gas or chemical fumes in workplace, which were pesticide exposure through spraying and/or mixing.

The association between distance of house location to main road and wheeze with SOB in adulthood was observed in the current study with OR=0.997 and 95%CI=0.996-0.998. This result was consistent with the study in China, the house adjacent to the road associated with asthma-related symptoms (OR=2.64; 95%CI=1.52–4.59) (Dong, et al., 2008). Another study in Laos also showed the same result with the OR between house nearby road and having wheeze was 3.4 (95%CI=0.8–14.5) (Vongxay, 2011). In addition, Vietnam National State of Environment report in 2007 was stated that road transport was greatest source of outdoor air pollution in Vietnam, attributed 70% of total pollution (MONRE, 2007). However, the current study found that there was the strongly positive correlation between distances from house location to main road and farmland (r=0.513, p<0.001) (See Table 29). This characteristic is popular in Vietnam; the main road is usually constructed nearby the farmland in order to the advantage for transport of agricultural products. Therefore, the association of distance from house location to both main road and farmland was detected with respiratory effects in the present study.

Table 29 The correlation between distance from house location to main road and farmland

Variables	1	2
1. Distance from house location to main road	_	
2. Distance from house location to farmland	0.513*	_
Mean[a]	566	939.4
SD	289.5	663.5

Mean[a] with unit by meter
(*) Spearman Correlation with p<0.001

In this study, the relationship between passive smoking and the presence of respiratory effects could not be shown clearly with p-value = 0.117 (See Table 24); although, nearly a half of study participants reported that they have at least one family member usually smoke in house. Meanwhile, other studies in the world clearly pointed out this relationship (Sonnenschein-van der Voort et al., 2012), (Zhao et al., 2013). The inconsistency can be explained by the fact that this study just assessed whether study participants have at least one family member who usually smoke in house but not directly assessed women exposed to cigarette or cigar smoke from their family members or not. In cases that even participants live with indoor smoker but they usually keep stay away each time those smoke, these cases could not take into account to be secondhand smoking because they did not actually expose with the smoke cigarette or cigar.

5.3. Conclusion

This is a cross-sectional study with the participation of 402 non-smoking women whom equally divided into 3 groups, which are gas use only, coal use only and both coal and gas use for cooking. These women are selected by multi-stage sampling technique. Information related to cooking fuel practices, house environments, socio-demographic factors and six respiratory symptoms including cough, phlegm, both cough and phlegm with or without cold for 1 month or more, SOB when hurrying on level ground, wheeze with SOB in adulthood, current COPD were collected by interview structured questionnaire, a modified version of the American Thoracic Society Questionnaire (adult version); and household observation.

Data were analyzed by bivariate analysis with univariate binary logistic regression; and multivariable logistic regression.

The prevalence of cough and phlegm for one month or more per year which found in this study were consistent with the previous studies in Vietnam (16.2% and 12.2% respectively). However, that of SOB when hurrying on level ground; wheeze with SOB in adulthood and current COPD tended to be remarkably higher than the other studies.

The association between respiratory effects and the current cooking fuel use including gas use only, both gas and beehive coal use only after adjustment for other factors cannot figure out in this study. It can be attributable to a wide range of changes in cooking fuel use which have taken place in recent years with rapid increase of gas consumption for cooking in household; meanwhile, women in three groups for current cooking fuel use had gotten long-term exposure to cooking emissions of beehive coal and biomass in the past. Additinally, the study finding also verified strongly positive association of all six respiratory episodes with duration of beehive coal and biomass use in the lifetime. Furthermore, the cross-sectional study design cannot determine temporal relationship of current cooking fuel use and respiratory health effects development. Due to these, the study just found the strong relationship of respiratory health with duration of beehive coal and biomass use, not with current cooking fuel use. In conclusion, the study findings provided more evidences for hypothesis that the longer people expose to beehive coal and biomass emissions, the greater risk of respiratory effects they will get. Apart from effects of cooking fuel emissions, the study also investigated those other factors such as dampness and mould in house and outdoor air pollutants from main road and farmland also effected on the prevalences of some respiratory symptoms and illness.

5.4. Recommendations

5.4.1. Recommendations for Policy Makers

1) At national level, it is essential for the government to set up the National strategy on reduction of health effects due to cooking fuel use or integrate into National strategy on health or environment protection or into National Energy

Efficiency Programme in order to control health burdens in relation to cooking fuel use. This action would attract the interest of stakeholders and the community.

2) A monitoring and evaluation systems on this issue at national level should be constructed and frequently updated as the baseline data for the future researches and the intervention projects. An indoor air quality standard at national level such as allowed benchmark for $PM_{2.5}$, PM_{10}, VOCs, PAHs, SO_2 and other pollutants should be set up to control the indoor air quality. Researches regarding to this issue in Vietnam also should be encouraged more and more as the baseline datums for establishment or adjustment the information system on this issue.

3) The innovation initiatives such as new cheap-safe fuels and non-smoke stove and efficient ventilation system should be encouraged through national programmes, scientific prizes.

4) Government should have strategy to control the fluctuation of fuel price in order to avoid the situation that people turn back to use solid fuel due to increase of gas price.

5) At community level, risk communication on the respiratory health burdens due to beehive coal and biomass should be taken place, prioritizing rural and suburban regions in Vietnam because these are the regions where have higher prevalence of solid fuel use than urban regions. Therefore, communities in rural and suburban regions are considered more vulnerable groups in relation to respiratory effects due to solid fuel combustion emission.

6) The intervention programmes such as behavioral change communication (BCC), the application of innovation initiatives related to reduction cooking fuel emissions need to be carried out at community level.

5.4.2. Recommendations for future researches

1) The future research should be carried out with clinical measurement to assess more accurately respiratory effects; pollutant measurement should be taken into account.

2) The interventional studies to reduce solid fuel smoke exposure among women who are ultilizing solid fuel should be carried out to assess directly and accurately the effects of combustion emission from solid fuel for cooking on the human health.

3) A longitudinal research can be considered to determine the temporal relationship between cooking fuel use and the development of respiratory impairments.

4) Qualitative data on this issue should be collected in the future study to investigate more deeply about the reasons of the choice of cooking fuel use or effects of cultural and regional characteristics on cooking fuel practice as the baseline data for behavioral change communication programmes or other intervention projects.

5) Future research should applied sampling technique that not based on particular cooking fuels to estimate the prevalence of cooking fuels that are used in the community.

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APPENDICES

APPENDIX A Time schedule and budget plan

1. Time schedule

DURATION: 11 MONTHS												
No.	**Research process/ activities**	**2012**						**2013**				
		7	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**
1.	Research question formulation and literature review											
2.	Proposal writing											
3.	Ethical approval											
4.	Field work: ask for corporation and recruit samples, Pre-test											
5.	Field work: data collection											
6.	Data analysis											
7.	Report writing and presentation											

2. Budget Plan

No	Activities	Unit Price (THB)	Quantity	Total (THB)
1.	**Pretesting in Vietnam** Questionnaires + Obs form + Informed consent form	25	30 sets	750
	Stationary	150	1 set	150
2.	**Ethical approval fee in Vietnam**	1500	1 research	1500
3.	**Data collection in Vietnam** Questionnaires + Obs form + Informed consent form	25	500 sets	12500
	Stationary	150	5 sets	750
	Travel cost in study area for researcher by car	400	10 days	4000
	Interviewers perdiem including travel cost	45	404 questionnaires	18180
	Incentives	55	404 respondents	22220
	A round flight ticket Thailand-Vietnam	12000	1 trip	12000
	Training for questionnaire use (stationary + photocopy quest + perdiem)	200	10 persons	2000
	Hiring place for training	500	1 day	500
4.	**Entry data for analysis in Vietnam**	10	404 questionnaires	4040
5.	**Document printing in Thailand** Paper + printing	4	900 pages	3600
	Photocopy (exam + final submit)	0.5	12 x 400 pages	2400
	Stationary	500	1 set	500
	Binding Paper (exam)	150	7 sets	1050
	Binding paper (submit)	150	7 sets	1050
	Total			**87,190**

APPENDIX B Informed Consent

Title of Research: **Respiratory effects among women in relation to household cooking fuel uses: liquefied petroleum gas only, coal only and both liquefied petroleum gas and coal in Tu Liem suburban district, Hanoi, Vietnam**

Researcher: Nguyen Thi My Hanh, MPH student, College of Public Health Sciences, Chulalongkorn University

Research on respiratory effects among women in relation to three household cooking fuel uses: gas, coal and both, we would like to identify your respiratory symptoms and cooking fuel uses as well as indoor air pollution source in your house by interview. The information that we collect from this research will be kept confidential. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will lock that information up with a lock and key. This consent form may contain words that you do not understand. Please ask me to stop as we go through the information and I will take time to explain.

There will be no direct benefit to you, but your participation is likely to help us find out more about respiratory effects among women in relation to three household cooking fuel uses: gas, coal and both. You will also not be provided any incentive to take part in the research.

Your participation in this research is entirely voluntary. It is your choice whether to participate or not. If you choose not to participate all the services you receive from administration will continue and nothing will change.

If you have any question, you can ask us now. If you wish to ask questions later, you may contact directly to Ms. Nguyen Thi My Hanh, MPH student, College of Public Health Sciences, Chulalongkorn University, cell phone: +84903232944/+66287931501.

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Name of Participant_______________________

Signature of Participant ___________________

Date____________________________________

APPENDIX C Questionnaire

☐ ☐☐☐

Village Individual

RESPIRATORY EFFECTS AMONG NON-SMOKING WOMEN IN RELATION TO HOUSEHOLD COOKING FUEL USES: LIQUEFIED PETROLEUM GAS ONLY, COAL ONLY AND BOTH LIQUEFIED PETROLEUM GAS AND COAL IN TU LIEM SUBURBAN DISTRICT HANOI, VIETNAM

Please read the following before beginning the survey.

This survey asks you some questions about respiratory symptoms related to cooking fuel use. The questions should take about 10 - 15 minutes to answer. We appreciate your answering these questions as honestly as possible. You feel free to stop at any time or to skip any questions that you do not wish to answer.

GENERAL INSTRUCTIONS: *For each question, place an "X" in the box that matches your answer or fill in the blank. Please pay special attention to the skip cues, which are indicated in the far right column, where relevant. For questions where there are multiple responses, respondents can choose more than one answer*

I. SOCIO-DEMOGRAPHIC CHARACTERISTICS

Ques1. When was your birth year? ☐☐☐☐ *Record 99 if not answer.*

Ques2. What is the highest level of education that you have completed?

(Please choose only one answer)

1. ☐ No formal education
2. ☐ Primary school (Grade 1-5)
3. ☐ Secondary school (Grade 6-9)
4. ☐ High school (Grade 10-12)
5. ☐ College/university/Graduate school
99. ☐ No answer

Ques3. What is your current occupation?

(Please choose only one answer)

1. ☐ Government officer
2. ☐ Industrial worker
3. ☐ Office staff at private sector
4. ☐ Daily paid worker
5. ☐ Trader
6. ☐ Famer or Agricultural worker
7. ☐ Housewife
8. ☐ Other

(Specify ________________________)

99. ☐ No answer

Ques4. What is average monthly income of your family?

(Please choose only one answer)

1. ☐ Less than 3 million VND
2. ☐ 3 - 7 million VND
3. ☐ Over 7 - 10 million VND
4. ☐ Over 10 - 20 million VND
5. ☐ More than 20 million VND

99. ☐ No answer

Ques5. Poverty status

(Please choose only one answer)

1. ☐ Under national poverty line
2. ☐ Marginally national poverty line
3. ☐ Upper national poverty line

Ques6. Have you currently or ever worked in any dusty job for a year or more?

(Please choose only one answer)

0. ☐ No
1. ☐ Yes

If "Yes", please specify your type of job/industry?

____

Ques7. Have you currently or ever exposed to gas or chemical fumes in your workplace or outside your house?

(Please choose only one answer)

0. ☐ No→ **Skip to Ques.8**   1. ☐ Yes

If "Yes", please specify your type of job / industry?

Ques8. If <u>YES</u> in <u>Ques.6 or Ques.7</u> questions, do you use the personal protective equipments such as mask?

(Please choose only one answer)

0. ☐ No   1. ☐ Yes

Ques9. In your workplace, is there any your co-worker who smoke inside your office?

(Please choose only one answer)

0. ☐ No   1. ☐ Yes → **Skip to Ques.11**

Ques10. How many total average cigarettes or cigars do they smoke per day inside your office?

(Please choose only one answer)

1. ☐ Less than 5 cigarettes or cigars
2. ☐ 5 – 9 cigarettes or cigars
3. ☐ 10 – 19 cigarettes or cigars
4. ☐ 20 or more cigarettes or cigars

Ques11. Do you have history of allergies to food, drugs, or pollen which cause irritation in respiratory tract such as sneezing, coughing, bronchoconstriction, wheezing and dyspnea?

(Please choose only one answer)

0. ☐ No
1. ☐ Yes

Ques12. Have you ever smoked before?

(Please choose only one answer)

0. ☐ No
1. ☐ Yes → **THE END**

II. COOKING FUEL PRACTICE

Ques13. What are the fuel do you use now for cooking?

(*Can select more than one choice*)

1. ☐ Wood _______(hours/week)
2. ☐ Dung _______(hours/week)
3. ☐ Charcoal _______(hours/week)
4. ☐ Beehive coal _______(hours/week)
5. ☐ Gas _______(hours/week)
6. ☐ Electricity_______(hours/week)
7. ☐ Others_______(hours/week)

(Specify_____________________)

(If the respondent select one kind of fuel only →* Skip to II.B*)

Ques14. What is the main fuel do you use for cooking?

(Please choose only one answer)

1. ☐ No main fuel
2. ☐ Wood
3. ☐ Dung
4. ☐ Charcoal
5. ☐ Beehive coal briquette
6. ☐ Gas
7. ☐ Electricity
8. ☐ Others

(Specify_____________)

<u>II.A. FOR HOUSEHOLD USING BOTH GAS AND COAL (time use of either fuels less than 80% and more than 20%)</u>

II.A.1. Where do you usually cook?

(Please choose only one answer)

PLACE FOR GAS STOVE	PLACE FOR BEEHIVE COAL STOVE
1. ☐ Outside the house	1. ☐ Outside the house
2. ☐ Inside without separate section.	2. ☐ Inside without separate section.
3. ☐ Inside with separate section	3. ☐ Inside with separate section
4. ☐ In kitchen outside the house	4. ☐ In kitchen outside the house

II.A.2. Do you have ventilation system in the cooking place?

(Please choose only one answer)

PLACE FOR GAS STOVE	PLACE FOR BEEHIVE COAL STOVE
0. ☐ No	0. ☐ No
1. ☐ Yes	1. ☐ Yes

II.A.3. If yes, what kind of ventilation system in the cooking place does your family use?

(Can select more than one choice)

PLACE FOR GAS STOVE	PLACE FOR BEEHIVE COAL STOVE
1. ☐ Chimney	1. ☐ Chimney
2. ☐ Ventilator fan	2. ☐ Ventilator fan
3. ☐ Open windows and/or doors	3. ☐ Open windows and/or doors
4. ☐ Other (Specify _______________)	4. ☐ Other (Specify _______________)

→ **SKIP TO QUES.16**

II.B. FOR HOUSEHOLD USING GAS OR COAL ONLY (consider use gas or coal more than 80% the time use)

II.B.1. Where do you usually cook?

(Please choose only one answer)

1. ☐ Outside the house
2. ☐ Inside without separate section.
3. ☐ Inside the house with separate section

II.B.2. Do you have ventilation system in the cooking place?

(Please choose only one answer)

0. ☐ No → **Skip to Ques.16** 1. ☐ Yes

II.B.3. If yes, what kind of ventilation system in the cooking place does your family use?

(*Can select more than one choice*)

1. ☐ Chimney
2. ☐ Ventilator fan
3. ☐ Open windows and/or doors
4. ☐ Other (Specify ________________)

Ques16. Please let me know quantity of fuel your family used per month

(Please choose only one answer)

Kind of fuel	**Quantity of fuel used per month**
1. ☐ Beehive coal briquette only	_______________(Briquettes)
2. ☐ LPG only	_______________(kg)
3. ☐ Both LPG and coal	

*Beehive coal*_______________(Briquettes)

LPG _______________(kg)

Ques17. How many hours do you spend on using stove includes cooking, water boiling per day

For gas only:

For coal only:

For both:

Gas: *Coal:*

Ques18. Up to now, how many total years have you used solid fuels?

(Can select more than one choice)

Kind of fuel	Using years
1. ☐ Beehive coal briquette	_______________(Years)
2. ☐ Biomass (wood, straw, core corn, charcoal...)	_______________(Years)
3. ☐ No solid fuel use	
4. ☐ No answer/Unknown	

Ques19. How often do you clean the stove?

(Please choose only one answer)

1. ☐ Daily with more than one time per day
2. ☐ Three to four times per week
3. ☐ One to two times per week
4. ☐ 2 times per month or less
5. ☐ Seldom (not often)

99. ☐ No answer

Ques20. Do you usually use mask during cooking such as mask?

(Please choose only one answer)

0. ☐ No
1. ☐ Yes

Ques21. Do you usually expose to cooking fuel emissions from neighboring households?

(Please choose only one answer)

0. ☐ No
1. ☐ Yes

III. HOUSE CONDITIONS

Ques22. What type of house do you live?

(Please choose only one answer)

1. ☐ Permanent type, wall and proof completely made by concrete and brick
2. ☐ Semi-permanent type, wall made by cement and tailing proof
3. ☐ Less-permanent, made wood
4. ☐ Simple, made by bamboo

Ques23. How many floors does your house have?

(Please choose only one answer)

1. ☐ One
2. ☐ Two
3. ☐ More than two

Ques24. How much is the total area of your house? _____________(m2)

Ques25. How many rooms are there in your house? _____________(rooms)

Ques26. How many people are there in your house? _____________(persons)

Ques27. How many under 5 year-old children living in the house? ____(children)

Ques28. How many 5-9 year-old children living in the house? ____(children)

Ques29. How old is your house? ____________(years)

Ques30. Does your house have dampness and mould?

(Please choose only one answer)

0. ☐ No   1. ☐ Yes

Ques31. How far is your home from main road? _____________***(m)***

Ques32. How far is your home from farmland? _____________***(m)***

Ques33. How far is your home from industrial area? _____________***(m)***

Ques34. Do you have ventilation system in your house?

(Please choose only one answer)

0. ☐ No → **Skip to Ques.36**   1. ☐ Yes

Ques35. If yes, what kind of ventilation system in house does your family use?

(*Can select more than one choice*)

1. ☐ Ventilator fans
2. ☐ Open windows and/or doors
3. ☐ Ventilator system for whole house
4. ☐ Other (Specify ___________________)

Ques36. Does your family use air conditioner?

(Please choose only one answer)

0. ☐ No   1. ☐ Yes

Ques37. How often do you clean your house?

(Please choose only one answer)

1. ☐ Daily with more than one time per day
2. ☐ Three to four times per week
3. ☐ One to two times per week
4. ☐ Two times per month or less
5. ☐ Seldom (not often)
99. ☐ No answer

IV. MAN-MADE INDOOR AIR POLLUTION SOURCES

Ques38. Is there any family member living with you smoke inside the house?

(Please choose only one answer)

0. ☐ No → **Skip to Ques.42** 1. ☐ Yes

Ques39. How many family member living with you smoke inside the house?_______(persons)

Ques40. Who are they?

(*Can select more than one choice*)

1. ☐ Your husband
2. ☐ Your parents
3. ☐ Your sons or daughters
4. ☐ Your brother/sister
5. ☐ Other (Specify_______________________)

Ques41. How many average cigarette or cigar do they smoke per day inside your house?

(Please choose only one answer)

1. ☐ Less than 5 cigarettes or cigars
2. ☐ 5 – 9 cigarettes or cigars
3. ☐ 10 – 19 cigarettes or cigars
4. ☐ 20 or more cigarettes or cigars

Ques42. Do you usually burn household waste/dry leaves/votive papers nearby your house?

(Please choose only one answer)

0. ☐ No → **Skip to Ques.44** 1. ☐ Yes

Ques43. If yes, how often do you burn household waste/dry leaves/votive papers nearby your house?

(Please choose only one answer)

1. ☐ Daily
2. ☐ Three to four times per week
3. ☐ One to two times per week
4. ☐ Two times per month or less
5. ☐ Seldom (not often)

99.☐ No answer

Ques44. Do you burn incense in your house?

(Please choose only one answer)

0. ☐ No → **Skip to Ques.47**
1. ☐ Yes

Ques45. If yes, how often do you burn incense in your house?

(Please choose only one answer)

1. ☐ Daily
2. ☐ Three to four times per week
3. ☐ One to two times per week
4. ☐ Two times per month or less
5. ☐ Seldom (not often)

99.☐ No answer

Ques46. Where do you usually burn incense in your house?

(Please choose only one answer)

1. ☐ Separate room for worship only
2. ☐ In living room
3. ☐ Outside the house
4. ☐ Other

(Specify__________________)

Ques47. Do you burn insect repeller stick in your house?

(Please choose only one answer)

0. ☐ No → **Skip to Ques.49**
1. ☐ Yes

Ques48. If yes, how often do you burn insect stick in your house?

(Please choose only one answer)

1. ☐ Daily or more than one time per day	4. ☐ Two times per month or less
2. ☐ Three to four times per week	5. ☐ Seldom (not often)
3. ☐ One to two times per week	99.☐ No answer

Ques49. Do you spray insect repellant in your house?

(Please choose only one answer)

0. ☐ No → **Skip to Ques.51**   1. ☐ Yes

Ques50. If yes, how often do you spray insect repellant in your house?

(Please choose only one answer)

1. ☐ Daily	4. ☐ One to two times per month
2. ☐ Three to four times per week	5. ☐ Seldom (not often)
3. ☐ One to two times per week	99.☐ No answer

Ques51. Do you make house heating by fire in the winter?

(Please choose only one answer)

0. ☐ No → **Skip to Ques.53**   1. ☐ Yes

Ques52. If yes, what kind of fuel do you use to fire?

(Can select more than one choice)

1. ☐ Wood	5. ☐ Gas
2. ☐ Charcoal	6. ☐ Electricity
3. ☐ Beehive coal briquettes	7. ☐ Other
4. ☐ Agriculture residue (straw, core corn...)	(Specify____________________________)

V. RESPIRATORY SYMPTOMS

Cough with or without cold

Ques53. When you have a cold, do you usually have a cough?

(Please choose only one answer)

0. ☐ No   1. ☐ Yes

Ques54. When you DO NOT have a cold, do you usually have a cough?

(Please choose only one answer)

0. ☐ No   1. ☐ Yes

Ques55. If YES in Ques.53 or Ques.54, how many months per year do you cough?

(Please choose only one answer)

1. ☐ Less than 1 month
2. ☐ 1 month to 2 months
3. ☐ 3 months or more

Ques56. If YES in Ques.53 or Ques.54, how many years have you coughed like this?

(Please choose only one answer)

1. ☐ 0 or 1 year   2. ☐ 2 years or more

Phlegm with or without cold

Ques57. When you have a cold, do you usually bring up phlegm or mucus from your chest? (Phlegm/mucus from nose & throat doesn't take into account)

(Please choose only one answer)

0. ☐ No   1. ☐ Yes

Ques58. ***When you <u>DO NOT</u> have a cold, do you usually bring up phlegm or mucus from your chest? (Phlegm or mucus from nose and throat does not take into account)***

(Please choose only one answer)

0. ☐ No 1. ☐ Yes

Ques59. ***If <u>YES</u> in <u>Ques.57 or Ques.58</u>, how many months per year do you bring up phlegm like this?***

(Please choose only one answer)

1. ☐ Less than 1 month
2. ☐ 1 month to 2 months
3. ☐ 3 months or more

Ques60. ***If <u>YES</u> in <u>Ques.57 or Ques.58</u>, how many years have you brought up phlegm like this?***

(Please choose only one answer)

1. ☐ 0 or 1 year 2. ☐ 2 years or more

<u>Wheeze with or without cold</u>

Ques61. ***Have you ever had wheezing or whistling in your chest?***

(Can select more than one choice)

1. ☐ No, never → **Skip to Ques.64**
2. ☐ Yes, as a child
3. ☐ Yes, as an adult

Ques62. If <u>YES</u> in <u>Ques.61</u>, have you ever had an attack of wheezing that made you feel shortness of breath?

(Can select more than one choice)

1. ☐ No, never → **Skip to Ques.64**
2. ☐ Yes, as a child
3. ☐ Yes, as an adult

Ques63. If <u>YES</u> in <u>Ques.62</u>, have you ever taken medicine to help make your breathing easier?

(Can select more than one choice)

1. ☐ No, never
2. ☐ Yes, as a child
3. ☐ Yes, as an adult

<u>**Shortness of breath**</u>

Ques64. Do you get shortness of breath when hurrying on level ground or walking up a small hill?

(Please choose only one answer)

0. ☐ No   1. ☐ Yes

Ques65. Do you ever have to stop to catch your breath when you are walking on level ground?

(Please choose only one answer)

0. ☐ No   1. ☐ No

Ques66. About how many respiratory colds have you had in past 3 months? (Count only colds with cough)

(Please choose only one answer)

1. ☐ No cold
2. ☐ 1 or 2 colds
3. ☐ 3 colds or more

Doctor-diagnosed diseases

Ques67. This question refers only to diseases that have been diagnosed by a doctor. For each disorder listed in the table below, please check whether a doctor has ever said that you had the disorder, and whether you have had the disorders within the past 12 months?

Doctor-diagnosed diseases	Has a doctor ever diagnosed this disease for you? Check "Yes" or "No"		Has a doctor ever diagnosed this disease for you in the past 12 months? Check "Yes" or "No"	
	☐ Yes	☐ No	☐ Yes	☐ No
CHRONIC BRONCHITIS				
EMPHYSEMA				
PULMONARY TUBERCULOSIS				
ASTHMA				
PNEUMONIA				
HEART DISEASE				

THANK YOU FOR YOUR TIME SPENT ON RESPONDING THE QUESTIONNAIRE!

Date of interview: ____/____/2013

Name of interviewer: __________________

Respondent's signature: __________________

APPENDIX D Interviewer Observation Form

☐ ☐☐☐

Village Individual

INTERVIEWER OBSERVATION FORM

GENERAL INSTRUCTIONS: *For each question, place an "X" in the box that matches your observation or fill in the blank. Please pay special attention to questions where have skip, multiple choice.*

I. COOKING FUEL PRACTICE

1. What is the main fuel does the household use for cooking?

(Please choose only one answer)

1. ☐ Wood
2. ☐ Dung
3. ☐ Charcoal
4. ☐ Beehive coal briquette
5. ☐ Gas
6. ☐ Electricity
7. ☐ Others

(Specify_____________________)

2. What other types of fuel does the household use for cooking?

(Can select more than one choice)

1. ☐ No other type of fuel → **Skip to I.b**
2. ☐ Wood
3. ☐ Dung
4. ☐ Charcoal
5. ☐ Beehive coal briquette
6. ☐ Gas
7. ☐ Electricity
8. ☐ Others

(Specify______________________)

I.a. FOR HOUSEHOLD USING BOTH GAS AND COAL

3. Where does the household usually cook?

PLACE FOR GAS STOVE

1. ☐ Outside the house
2. ☐ Inside without separate section
3. ☐ Inside the house with separate section

PLACE FOR BEEHIVE COAL STOVE

1. ☐ Outside the house
2. ☐ Inside without separate section
3. ☐ Inside the house with separate section

4. Does the household have ventilation system in the cooking place?

PLACE FOR GAS STOVE

1. ☐ Yes
2. ☐ No

PLACE FOR BEEHIVE COAL STOVE

1. ☐ Yes
2. ☐ No

5. If yes, what kind of ventilation system in the cooking place does the household use?

(Can select more than one choice*)*

PLACE FOR GAS STOVE

1. ☐ Chimney
2. ☐ Ventilator fan
3. ☐ Open windows
4. ☐ Other
5. (Specify ______________________)

PLACE FOR BEEHIVE COAL STOVE

1. ☐ Chimney
2. ☐ Ventilator fan
3. ☐ Open windows
4. ☐ Other

(Specify _____________________)

→ **SKIP TO II.1**

I.b. FOR HOUSEHOLD USING GAS OR COAL ONLY

6. Where does the household usually cook?

1. ☐ Outside the house
2. ☐ Inside without separate section.
3. ☐ Inside the house with separate section

7. Does the household have ventilation system in the cooking place?

1. ☐ Yes   2. ☐ No → **Skip to II.1**

8. If yes, what kind of ventilation system in the cooking place does the household use?

(Can select more than one choice)

1. ☐ Chimney
2. ☐ Ventilator fan
3. ☐ Open windows
4. ☐ Other (Specify ______________)

II. HOUSE CONDITIONS

1. What type of house?

1. ☐ Permanent type, wall and proof completely made by concrete and brick
2. ☐ Semi-permanent type, wall made by cement and tailing proof
3. ☐ Less-permanent, made wood
4. ☐ Simple, made by bamboo

2. How many floors does the house have?

1. ☐ One
2. ☐ Two
3. ☐ More than two

3. How much is the total area of the house? ___________________(m^2)

4. How many rooms are there in the house? ____________________(rooms)

5. Does the house have dampness and mould? (the mould traces in the wall or celling)

1. ☐ Yes   2. ☐ No

6. How far is the house away from main road? ____________________(m)

7. How far the house away from industrial area? ____________________(m)

8. Does the house have ventilation system?

1. ☐ Yes   2. ☐ No → **Skip to II.10**

9. If yes, what kind of ventilation system does the household use?

(*Can select more than one choice*)

1. ☐ Ventilator fans
2. ☐ Open windows
3. ☐ Other (Specify ____________________________)

10. Does your family use air conditioner?

1. ☐ Yes   2. ☐ No

THE END

APPENDIX E Ethical Approval Letter

MINISTRY OF HEALTH
HANOI SCHOOL OF PUBLIC HEALTH

No.: 03/2013/YTCC-HD3
Subject: Ethical Approval

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom - Happiness

Ha Noi, January 24, 2013

DECISION

On Ethical approval for research involving human subject participation

THE CHAIR OF THE ETHICAL REVIEW BOARD FOR BIOMEDICAL RESEARCH
HANOI SCHOOL OF PUBLIC HEALTH

- Based on Decision No. 201/QD-YTCC by the Dean of Hanoi School of Public Health on Establishment of The Institutional Ethical Review Board of Hanoi School of Public Health; 12 April 2012 ;
- Based on decision No. 202/QD-YTCC by the Dean of Hanoi School of Public Health on the Issuing Regulation of the Insitutional Ethical Review Board of Hanoi School of Public Health; 12 April 2012;
- After reviewing research ethics application No. **013-003/DD-YTCC;**
- And based on the memo dated **Janury 21, 2013.**

DECIDED

Article 1. Grant ethical approval for ethnographic study project:

- Project Title: **Respiratory effects among non- smoking women in ralation to household cooking fuel uses: liquefied petroleum gas only, coal only and both liquefied petroleum gas and coal in Tu Liem suburban district, Hanoi, Vietnam**
- Principal Investigator : **Nguyen Thi My Hanh**- MPH Student, College of Public Health Sciences, Chulalongkorn University, Thailand.
- Supervisor: Asst. Prof. Naowarat Kanchanakhan, Ph.D. College of Public Health Sciences, Chulalongkorn University, Thailand.
- Research site: Tu Liem district, Hanoi capital, Vietnam.
- Baseline study time: from 01/02/2013 to 05/03/2013
- Project time: from 01/01/2013 to 30/05/2013
- Review process: expedited review

Article 2. This decision is effective from **24/01/2013**

Article 3. Principle Investigator should notify the Institutional Ethical Review Board of Hanoi School of Public Health (IRB of HSPH) immediately of any adverse effects arising from this study (e.g. unexpected adverse outcomes, unexpected community/subject risk factors or complaints, etc.). Active research projects are subject to random audit by the IRB of HSPH.

CHAIR OF INSTITUTIONAL ETHICAL REVIEW BOARD

(Signature and full name)

Do Mai Hoa

SECRETARY

(Signature and full name)

Nguyen Thi Minh Thanh

APPENDIX F Distribution of three kinds of cooking fuel use in study areas

Dai Cat village: 635 households

- 188 households using gas: 29.6% households
- 157 households both gas and beehive coal: 24.7% households
- 125 households using beehive coal: 19.6% households
- 93 households unidentified the cooking fuel use: 14.6% households
- 72 households that use other cooking fuels: dung, wood, electricity, mixed cooking fuel use: 11.5% households.

Me Tri Thuong village: 843 households

- 168 households using gas: 19.9% households
- 335 households using both gas and beehive coal: 39.7% households
- 236 households using beehive coal: 27.9% households
- 104 households unidentified the cooking fuel use: 12.5% households

VITAE

PERSONAL DETAILS

Full Name: Ms. Nguyen Thi My Hanh

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Phone: (+84)903232944

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Date of birth: 03rd May, 1987

Nationality: Vietnamese

Sex: Female

EDUCATION/QUALIFICATIONS

Hanoi School of Public Health, Hanoi, Vietnam ***2005 – 2009***

Bachelor of Public Health

WORK EXPERIENCES

Center for Community Health and Development (COHED) ***2009 – May 2012***

Project Officer

National Institute Hygiene and Epidemiology (NIHE) ***2008 – 2009***

Collaborator at Epidemiology Department

Solidarités Jeunesses Vietnam (SJ) ***2008***

Project Assistance