RESPIRATORY SYMPTOM AND ILLNESS PREVALENCE IN RELATION TO BIOMASS FUEL USE IN CHAN AYE THAR ZAN TOWNSHIP, MANDALAY CITY, MANDALAY REGION, MYANMAR

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อาการของระบบทางเดินหายใจ การเจ็บป่วย และความชุกที่สัมพันธ์กับการใช้เชื้อเพลิงมวลชีวภาพ ในชานเอธาร์ซานทาวน์ชิฟ เมืองมันฑะเลย์ ภูมิภาคมันฑะเลย์ ประเทศพม่า

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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรมหาบัณฑิต
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Thesis Title	RESPIRATORY SYMPTOM AND ILLNESS PREVALENCE IN RELATION TO BIOMASS FUEL USE IN CHAN AYE THAR ZAN TOWNSHIP, MANDALAY CITY, MANDALAY REGION, MYANMAR
By	Ms. Moe Myint Theingi Tun
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โม มินท์ เทียน กิ ตุน: อาการของระบบทางเดินหายใจ การเจ็บป่วย และความชุกที่สัมพันธ์กับการใช้เชื้อเพลิงมวลชีวภาพในชานเอธาร์ซานทาวน์ชิฟ เมืองมันฑะเลย์ ภูมิภาคมันฑะเลย์ ประเทศพม่า . (RESPIRATORY SYMPTOM AND ILLNESS PREVALENCE IN RELATION TO BIOMASS FUEL USE IN CHAN AYE THAR ZAN TOWNSHIP, MANDALAY CITY, MANDALAY REGION, MYANMAR) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: นพ.โรเบิร์ต แชปแมน, 95 หน้า.

การศึกษาแบบภาคตัดขวางทำในชานเอธาร์ซานทาวน์ชิฟ เมืองมันฑะเลย์ ประเทศพม่า ในช่วงเดือนมีนาคม 2012 มีจุดประสงค์เพื่อหาความสัมพันธ์ระหว่างการใช้เชื้อเพลิงชีวภาพ (ไม้ หรือ ถ่าน) ในการประกอบอาหารและหาความชุกของโรคระบบทางเดินหายใจและความเจ็บป่วยในพ่อแม่และลูกที่อายุต่ำกว่า 5 ปี มีจำนวนครอบครัวเข้าร่วมในการศึกษาครั้งนี้ 425 ครอบครัว โดยใช้แบบสอบสอบถามมาตรฐานในการสัมภาษณ์ พบว่ามีการใช้เชื้อเพลิงชีวภาพในครอบครัวจำนวน 273 ครอบครัว คิดเป็นร้อยละ 64.2 นอกจากนี้มีการหาความชุกที่มีความสัมพันธ์กับตัวแปรอื่นๆ 18 ตัวแปร ได้แก่ การประกอบอาหาร 7 ตัวแปร สภาวะแวดล้อม 6 ตัวแปร และสังคม 5 ตัวแปร ในเด็กและพ่อแม่ ตามลำดับ ใช้การวิเคราะห์ตัวแปรครั้งละ 2 ตัวแปรนั้น ตัวแปรอิสระแต่ละตัวจะวิเคราะห์ความสัมพันธ์ แยกกันในแต่ละความชุกข้างต้น มีการวิเคราะห์การถดถอยโลจิสติกเชิงพหุขั้นที่ 1 สำหรับแต่ละความชุก เชื้อเพลิงชีวภาพที่ใช้ในการประกอบอาหาร และตัวแปรอิสระอื่นๆที่มีค่า p จากการวิเคราะห์ตัวแปรครั้งละ 2 ตัว น้อยกว่า 0.15 ($p<0.15$) และการวิเคราะห์การถดถอยโลจิสติกเชิ งพหุขั้นที่ 2 สำหรับแต่ละความชุก เชื้อเพลิงชีวภาพที่ใช้ในการประกอบอาหาร และตัวแปรอิสระอื่นๆที่มีค่า p จากการวิเคราะห์การถดถอยโลจิสติกเชิงพหุขั้นที่ 1 น้อยกว่า 0.15 ($p < 0.15$) พบว่า การใช้เชื้อเพลิงทางชีวภาพมีความสัมพันธ์เชิงบวกกับ 16 ตัวแปรจากทั้งหมด 18 ตัวแปร คิดเป็นร้อยละ 88.9 และ พบความสัมพันธ์เชิงบวกอย่างมีนัยสำคัญทางสถิติที่ $p \leq 0.05$ หรือ $0.05< p \leq 0.01$ ในแม่ ได้แก่ อาการไอ มีเสมหะ หายใจลำบาก หายใจสั้น และอาการหวัด ในพ่อ ได้แก่ อาการไอ และ หายใจลำบาก และในเด็ก ได้แก่ อาการไอ มีเสมหะ หายใจลำบาก อาการหวัด ปอดบวมในช่วง 12 เดือน และ วัณโรค ดังนั้นการศึกษาครั้งนี้สรุปว่า การใช้เชื้อเพลิงชีวภาพในครัวเรือนในเมืองมันฑะเลย์ก่อให้เกิดผลกระทบด้านสุขภาพต่อระบบทางเดินหายใจ โดยเฉพาะในแม่และเด็ก และควรให้มีการลดการใช้เชื้อเพลิงชีวภาพในครัวเรือนเพื่อลดผลกระทบต่อระบบทางเดินหายใจ

สาขาวิชา......................สาธารณสุขศาสตร์......................ลายมือชื่อนิสิต............................ ....

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MOE MYINT THEINGI TUN: RESPIRATORY SYMPTOM AND ILLNESS PREVALENCE IN RELATION TO BIOMASS FUEL USE IN CHAN AYE THAR ZAN TOWNSHIP, MANDALAY CITY, MANDALAY REGION, MYANMAR. ADVISOR: ROBERT S. CHAPMAN, M.D., M.P.H., 95pp.

A cross-sectional study was conducted in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar, in March, 2012, with the purpose of ascertaining associations between using biomass fuel (wood or charcoal) for cooking and prevalences of respiratory symptoms and illnesses in mothers, fathers, and children <5 years old. This study was conducted in 425 households, using a standardized interviewer-administered questionnaire. Biomass fuel was used in 273 households (64.2%). In addition to biomass fuel use, prevalences were evaluated in relation to other cooking-related variables, other environmental characteristics, and socio-demographic variables. Seven, six, and five types of prevalences were assessed in children, mothers, and fathers, respectively (total 18). In a bivariate analysis, each independent variable was assessed separately in relation to each type of prevalence. First-stage multivariable logistic regression models were then constructed for each type of prevalence; biomass cooking and other independent variables for which $p<0.15$ in bivariate analysis were included in these. Second-stage multivaiable logistic models were then constructed for each type of prevalence; biomass cooking and all independent variables for which $p<0.15$ in first-stage models were included. In these models, biomass fuel use was positively associated with 16 of 18 types of prevalence assessed (88.9%). Positive associations were statistically significant ($p\leq0.05$) or marginally significant ($0.05<p\leq0.10$) for cough, phlegm, wheeze, shortness of breath, and respiratory colds in mothers; cough and wheeze in fathers; and cough, phlegm, wheeze, colds, diagnosed pneumonia in the past 12 months, and diagnosed tuberculosis in children. These results strongly suggest that household biomass fuel use impairs respiratory health in Mandalay, especially in mothers and young children. It appears highly likely that reduction in biomass fuel use would improve respiratory health.

Field of Study: …Public Health ……………..…Student's Signature………………...

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LIST OF ABBREVIATIONS

ARI	Acute respiratory infection
BMF	Biomass fuel
COPD	Chronic obstructive pulmonary disease
DALY	Disability-Adjusted Life Years
IAP	Indoor air pollution
LPG	Liquid petroleum gas
OR	Odds ratio
PM	Particulate matter
TB	Tuberculosis
URI	Upper respiratory infection
USD	United States dollars
WHO	World Health Organization

Chapter I
INTRODUCTION

1.1 Background

Human health can be threatened by indoor air pollution (IAP) because people closely live with it. Indoor air pollutants released have more opportunity to get into lungs than that of outdoor air pollutants. A number of pollutants such as smoke, asbestos, fossil fuels, cleaning and hobby products, radon, pesticides and even mold can affect indoor air. In addition, outside pollutants may enter a home through windows, doors, air conditioners and natural ventilation. Indoor pollutants are likely to cause many times more exposure than outdoor pollutants because most of the people globally spend their time indoors (Smith, 2003).

Around 1.6 million deaths per year that is 20 seconds per one death and 2.7% of the global burden of disease is attributable to IAP. In terms of disability adjusted life years lost (DALYs), indoor smoke from solid fuels ranks eighth globally and in terms of mortality it ranks eleventh (Ezzati et al., 2002). The percentage of people using solid fuels varies widely among countries and regions, ranging from respectively 77%, 74%, and 74% in sub-Saharan Africa, South-East Asia, and Western Pacific Region, to 36% in Eastern Mediterranean Region, and 16% in Latin America and in Caribbean and in Central and Eastern Europe. In the majority of industrialized countries, solid fuels are used in <5% of households (Perez-Padilla et al., 2010).

Indoor smoke from solid fuel use contains harmful substances, ranges from carcinogens to small particulate matter, all of which cause damage to the lungs. Indoor smoke from solid fuel contributes 21% of lower respiratory infection deaths worldwide, 35% of chronic obstructive pulmonary deaths and about 3% of lung cancer deaths. Of these deaths, about 64% occur in low-income countries, especially in South-East Asia and Africa. A further 28% of global deaths caused by indoor smoke from solid fuels occur in China (WHO, 2009).

Cooking and heating with solid fuels such as dung, wood, crop waste and charcoal on open fires or traditional stoves results in high levels of indoor air pollution. By comparing children in households using low pollution fuels, those in households using high pollution fuels had a considerably more prominent mortality rate (here, low pollution fuels were defined as electricity, kerosene, LPG and biogas) (Smith, 2003).

Active smoking is accepted as the most important risk factor for the development of chronic obstructive pulmonary disease (COPD), and is responsible for over 70% of cases in high income countries, although far fewer (~40%) in lower income countries (Jordan et al., 2011). Lung cancer is the cancer most commonly associated with smoking: around 90% of all lung cancers are caused by smoking. Several studies have found a strong relationship between tobacco smoking and TB with the disease being more common among smokers than nonsmokers (Cancer Research UK, 2010).

Passive exposure to cigarette smoke is accepted as an independent risk factor for heart disease and lung cancer, and has also been implicated in the etiology of COPD, although the association between passive smoking and COPD is less well defined. But there is increasing evidence that passive smoking is an important risk factor in chronic respiratory diseases (Jordan et al., 2011). Exposure to secondhand smoke is a known risk factor for development of asthma and exacerbates symptoms (Cabana et al., 2005). Parental smoking is a cause of asthma in children and the prevalence of asthma increases with the number of smokers in the home (Lewis et al., 2005). Children who suffer from asthma, and whose parents smoke, are twice as likely to suffer asthma symptoms compared to the children of non-smokers. Wheeze and physician-diagnosed asthma is more common in children who live with a smoker (Cabana et al., 2005).

Mosquito coils are used to prevent mosquito bites in most of the tropical and subtropical regions in Asia and in limited extent in other parts of the world. In spite of mosquito coil smoke may harm to human respiratory health; it is used in developing world to forbid mosquito borne diseases (Liu et al., 2003).

Incense burning is a daily practice for worship in Asian countries where Buddhism and Taoism are practiced. Incense burning lets out smoke containing particulate matter, gas products and other organic compounds and causes indoor air pollution, airway disease and health problems. However, several conflicting reports have also been documented. The effect of incense smoke on health and the mechanism behind it needs to be further studied in an animal model (Lin et al., 2008).

Asthma continues to be a major public health concern worldwide. 4.5% clinical asthma prevalence to the current world population of 7 billion translates to 315 million individuals with asthma. However, nearly 623 million individuals are currently living with some level of asthma-related symptoms worldwide. While proper long-term management will allow individuals with asthma to achieve good levels of control enabling them to live with good quality of life, asthma control is not optimal in many countries. Worldwide, nearly half of the asthma population reported wheezing in the last 12 months, and only a moderate proportion had been diagnosed and/or received treatment. In addition, the high prevalence of smoking continues to be one of the major barriers in combating the global burden of asthma. While the highest overall prevalence of asthma was observed in resource-rich countries, many resource-poor nations also have a high prevalence of this disease (To et al., 2012).

Tuberculosis (TB) is one of the greatest killers among respiratory illnesses worldwide. TB is also regarded as a social disease and it is associated with many environmental and social factors such as poor housing, poor ventilation, overcrowding and under nutrition. In 2010, 8.8 million people fell ill with TB and 1.4 million died from TB. About half a million children (0-14 years) fell ill with TB, and 64,000 (a range of 58,000 to 71,000) children died from the disease in 2010. Tuberculosis is curable and preventable. About one-third of the world's population has latent TB, which means people have been infected by TB bacteria but are not (yet) ill with disease and cannot transmit the disease. persons with compromised immune systems, such as people living with HIV, malnutrition or diabetes, or people who use tobacco, have a much higher risk of falling ill (WHO, 2012a).

Myanmar is divided administratively, into 7 regions, 7 states and Nay Pyi Taw Union Territory. It is bounded on the north and north-east by the People's Republic of China, on the east and south-east by the Lao People's Democratic Republic and the Kingdom of Thailand, on the west and south by the Bay of Bengal and Andaman Sea, on the west by the People's Republic of Bangladesh and the Republic of India. The population of Myanmar estimated is about 58.38 million and that of Mandalay region is around 12 million (Health in Myanmar, 2010). Mandalay region is the second largest region in Myanmar and it is found in the central part of Myanmar.

In Mandalay, Myanmar, traditionally, the kitchen was not located in the house but in the garden and is normally open on all sides except one. In such kitchen smoke has not been a health hazard as the pollutants are easily diluted. However traditional kitchen are changing fast and preference is now given to indoor kitchens and with walls on all sides. People in Mandalay, Myanmar use open fires for indoor cooking commonly found in the household both in the rural and urban areas, hardly ever fitted with a chimney to remove the pollutants. Their homes often have poor ventilation because of indoor cooking and share living in small rooms.

Children and women are apparently most likely to be affected because they spend the greatest amount of time indoors in the home. By the year 2002 in Myanmar according to WHO estimates, ALRI deaths attributable to solid fuel use (<5 year) was 11,590 and COPD deaths attributable to solid fuel use (30 years) was 3,070. Total deaths and total DALYs attributable to solid fuel use were 14,700 and 469,200 respectively, and the percentage of national burden of disease attributable to solid fuel use was 3.2% (WHO, 2007). So it is important to observe the prevalence of respiratory problems among population using biomass fuel in Myanmar. Globally, as a cause of soil degradation, of deforestation, and as a major source of indoor air pollution, the traditional use of biomass fuels (i.e., agricultural wastes, animal dung, and firewood) has been repeatedly identified as a problem (Emmelin and Wall, 2007).

The researcher conducted a cross-sectional study in Mandalay, Myanmar to observe respiratory symptom and illness prevalence in relation to biomass fuel use for cooking. To the best of my knowledge, this is the first study that directly assesses respiratory effects of biomass fuel use in Myanmar.

1.2 Research Objectives

1. To describe prevalences of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.
2. To investigate biomass fuel use for cooking is associated with increased risk of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.
3. To examine the relationships between other household environmental characteristics and prevalences of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.
4. To examine the relationships between socio-demographic characteristics and prevalences of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.

1.3 Research Questions

1. What are the prevalences of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar?
2. Is there any association between biomass fuel use for cooking and respiratory symptom and illness prevalences in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar?
3. Is there any association between household environmental characteristics and increased risk of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar?
4. Is there any relationship between socio-demographic characteristics and prevalences of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar?

1.4 Research Hypotheses

1. Biomass fuel use for cooking is associated with increased risk of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.
2. There is association between other household environmental characteristics and increased risk of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.
3. There is association between socio-demographic characteristics and increased risk of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.

1.5 Operational definitions

Biomass fuel- refers to wood, dung or charcoal fuel burned for household cooking

Socio-demographic characteristics- age, gender, education and occupation of mother and father

Dusty job- means type of the employment in which the employer is usually exposed to dust during most of the working hours.

Smoking- smoking is the inhalation of the smoke of burning tobacco encased in cigarettes, pipes, and cigars

Family size- is defined as number of people living under the same shelter and sharing common kitchen.

Monthly income- total monthly household income earned by all family members

Location of kitchen- is defined as the location of the cooking place for foods and meals. It is assessed by whether the cooking place either inside the house (indoor) or outside the house (outdoor)**.**

Meals cooked per week in the home- means total number of meals cooked inside the home during one week

Doors and windows open during cooking- means door and windows are opened while cooking in the home

Smokiness during cooking- means mixed or filled with smoke when cooking

Eye irritation during cooking- means redness, itchiness and tearing in the eyes due to smoke from cooking

Housing condition- refers to physical structure of the house based on number of storied and nature of constructed materials e.g. wooden, bamboo**,** etc

Smoke-producing mosquito repellent- some are made from a dried paste of pyrethrum powder with spiral shaped and it is a form of mosquito-repelling incense and others made of natural products like dried turmeric or dried orange peel.

Incense- used mainly for religious purpose and it is composed of aromatic biotic materials, which release fragrant smoke when burned.

Prevalence in mother, father and children- means percentage of mothers, fathers and children who reported respiratory symptoms or illnesses in the present study at a single point in time, or during a specified time period.

Cough- is defined as a sudden and often repetitively occurring reflex which helps to clear the throat. Cough can be associated with or without cold.

Phlegm- production of secretion from the respiratory tract when coughing with or without cold**.**

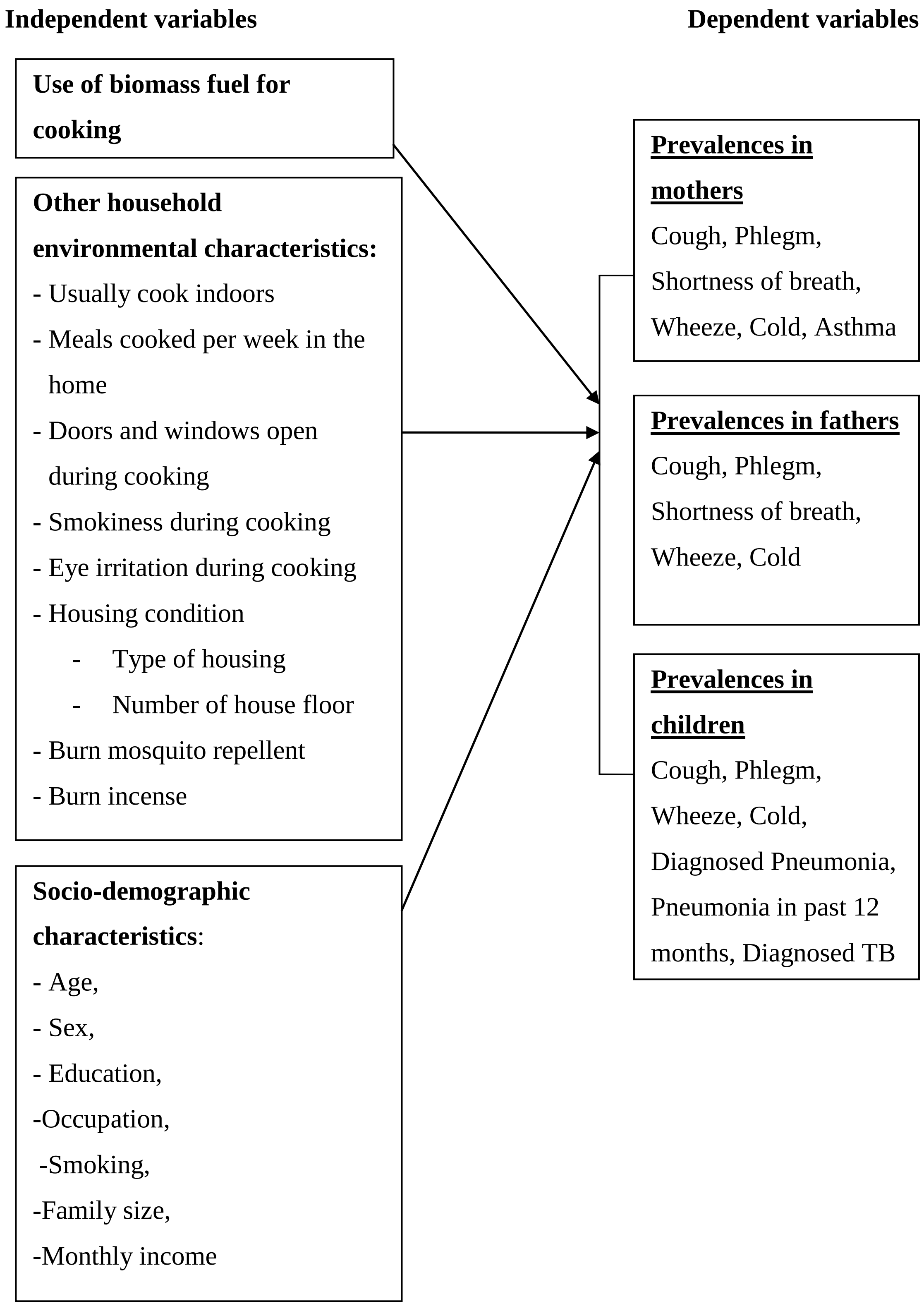
Shortness of breath- is defined as difficulty in breathing.

Wheeze- continuous, coarse, whistling sound produced in the respiratory airways during breathing with or without cold.

Cold- is defined as having symptoms with sneezing and running nose accompanied by dry cough, sometimes accompanied by headache and muscle and joint aches**.**

Asthma- is the common chronic inflammatory disease of the airways characterized by variable and recurring symptoms, reversible airflow obstruction, and bronchospasm. Symptoms include wheezing, coughing, chest tightness, shortness of breath, and mucus hypersecretion.

1.6 Conceptual framework



Chapter II
LITERATURE REVIEW

In general, people pass the majority of their time indoors; **indoor air pollution** acts as a significant role in affecting health and is thus an important health issue. Indoor environments include dwellings, workplaces, schools and day care centers, bars, discotheques and vehicles. Environmental tobacco smoke, particulate matter, nitrogen dioxide, carbon monoxide, volatile organic compounds and biological allergens are common indoor pollutants. In developing countries, relevant sources of indoor pollution include biomass and coal burning for cooking and heating. Pollutants in indoor air can be more concentrated than that of the outdoors (Viegi et al., 2004).

Biomass fuels were used by nearly 50% that is around 3 billion world population as their primary source of domestic energy for cooking, home heating, and light (Torres-Duque et al., 2008). In most societies, women are in charge of cooking and depending on the demands of the local cuisine - they spend between three and seven hours per day near the stove for preparing food. Thus, 59% of all indoor air pollution-attributable deaths fall on females. Young children are often carried on their mother's back or kept close to the warm hearth during their first year of life, infants spend many hours breathing indoor smoke which makes their developing airways vulnerable to hazardous pollutants. As a result, 56% of all indoor air pollution-attributable deaths occur in children under five years of age (WHO, 2005).

Active and passive smoking is an important risk factor for respiratory diseases. Additive effect for the risk of COPD due to tobacco smoking and exposure to biomass smoke and exposure to biomass smoke alone are OR=4.39 (95% CI=3.4-5.7) and OR=2.55 (95% CI=2.0-3.1) respectively. Therefore biomass fuels place as a great risk as active smoking and a greater threat than passive smoking for COPD (Hu et al., 2010).

In one of the studies in Myanmar migrant workers in Thailand, after adjusting confounding factors such as household number, household education, windows in house, incense use, windows open during cooking and household member current smoking, mosquito coil use was still positively significantly associated with cough with or without cold (OR=1.84, 95% CI=1.02-3.33, p=0.045), phlegm with or without colds (OR=2.02, 95%CI=1.28-3.19, p=0.003) and wheeze with or without colds (OR=2.47, 95% CI=1.52-4.00, p<0.001) (Tharaphy, 2009).

Biomass fuel (BMF) refers to burned plant or animal material; wood, charcoal, dung and crop residues account for more than one-half of domestic energy in most developing countries and for as much as 95% in lower income countries. Biomass burning, particularly wood, also leads to outdoor air pollution. In developing countries, the main source of ambient (outdoor) pollution in rural areas is household solid fuel use and it may significantly contribute to outdoor pollution in some urban areas. In several parts of the western United States, wood smoke may be the major source of particulate matters (PM) during winter months, and comparable to that emitted from automobiles, industries, or power plants (Torres-Duque et al., 2008).

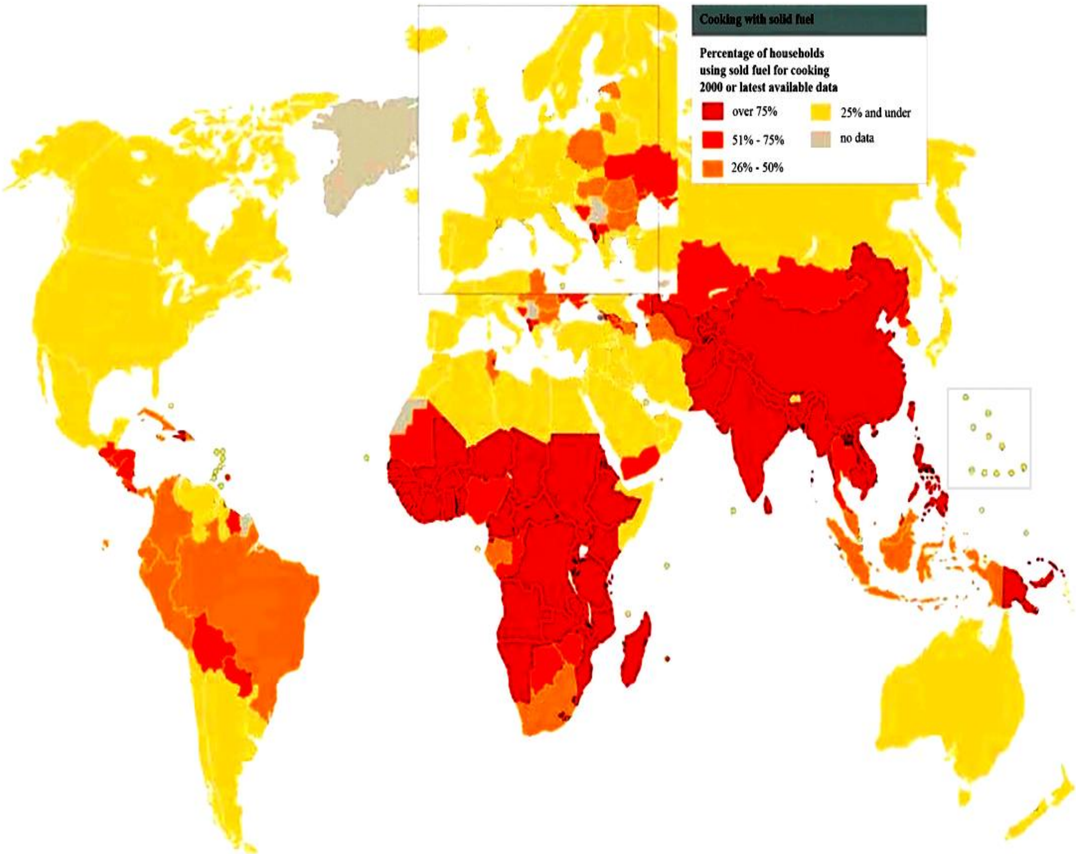
One of the main roadblocks to the adoption of cleaner fuels is the poverty. The slow pace of development in many countries suggests that biomass fuels will continue to be used by the poor for many decades. It is estimated that 50% of all households worldwide and 90% of all rural households continue to use biomass fuel as their main domestic source of energy although the modern world has replaced these highly polluting fuel sources with cleaner sources such as liquefied petroleum gas and electricity (Bruce et al., 2000). The persistent rise in cost of energy has prompted an increasing number of households to use wood or other biomass fuels for cooking and heating purposes even in some developed countries such as Canada, Australia, and the western states of the United States (Torres-Duque et al., 2008).

Table 1: Attributable mortality and DALYs from solid fuel use, by age group and sex

	Age group (years)				Sex	
	0- 4	5- 14	15- 59	60+	Male	Female
Distribution of attributable deaths (% of attributable events)	56	0	5	38	41	59
Distribution of attributable DALYs (% of attributable events)	83	0	8	9	49	51

Source: World health report (2002)

Figure 2: Map of worldwide solid fuel use in year 2000



Source: Torres-Duque et al., 2008

BMF smoke contributes to indoor air pollution

It is estimated that about 3 billion people are exposed to indoor smoke from the burning of biomass fuel and are at risk for its adverse respiratory effects (Salvi and Barnes, 2010). Smoke from biomass combustion gives rise to a large number of health damaging pollutants; such as particles, carbon monoxide, nitrous oxides, sulfur oxides (more from coal), formaldehyde, and carcinogens such as benzo (a) pyrene. Small particles with diameter 10 microns (PM_{10}), and in particularly those less than 2.5 microns are able to penetrate into the lungs deeply and come along to have the greatest health-damaging potential (Bruce et al., 2002).

The United States of America (USA) Environmental Protection Agency annual standard for particulate matter less than 10 μm in diameter (PM_{10}) is 50 μg/ m^3, and for carbon monoxide is 9 ppm over eight hours. Over a 24- hour period typical mean PM10 concentrations in households utilizing solid fuels can exceed 1000 μg/ m^3, and that of the carbon monoxide concentrations can exceed 20 ppm. The levels of these two pollutants can exceed their 24- hour averages during actual cooking or heating by an additional order of magnitude (Desai M et al., 2004).

It is difficult to measure the indoor air pollution from biomass combustion because of the temporal and spatial distribution within the household, and the characteristics of the ventilation. The levels of indoor air pollution in homes using biomass fuels for cooking in developing countries far exceed the health-based standards in the whole household, in both cooking and sleeping or living areas, with repeated episodes of intense emissions. Concentrations of respirable particulate matter ranged from 500 to 2,000 μg/ m^3 during cooking in biomass-using households, and average 24-hr exposures ranged from 90 ± 21 μg/ m^3 for those not involved in cooking to 231 ± 109 μg/ m^3 for those who cooked. For those in households using clean fuels, the 24-hr exposures were around 82 ± 39 μg/ m^3. The most important determinants of exposure across these households were fuel type, type and location of the kitchen, time spent near the kitchen while cooking, stove type and cooking duration (Balakrishnan et al., 2002).

Respiratory problems related to BMF smoke

Adults chronically exposed to biomass fuel smoke show the presence of multiple dark anthracitic pigmentations in the large airway mucosa, mainly due to deposition of carbon particles, iron, lead, cadmium, silica, phenol, hydrocarbon complexes, and other inorganic and organic substances (Chang and Lin, 1998). The report of respiratory symptoms, especially phlegm and cough, is consistently higher in women cooking with biomass fuels in comparison with those using cleaner fuels (gas, kerosene) (Shrestha and Shrestha, 2005).

Table 2: Relative risks for respiratory health outcomes associated with solid fuel smoke inhalation

Evidence	Health Outcome	Group, Age (year)	Relative Risk	95%CI
Strong	ALRI	Children, 5	2.3	1.9- 2.7
	COPD	Women, >30	3.2	2.3- 4.8
	Lung cancer (coal smoke exposure)	Women, ≥30	1.9	1.1- 3.5
Moderate I	COPD	Men, >30	1.8	1.0- 3.2
	Lung cancer (coal smoke exposure)	Men, >30	1.5	1.0- 2.5
Moderate II	Lung cancer (biomass smoke exposure)	Women, >30	1.5	1.0- 2.1
	Asthma			
	Asthma	Children, 5- 14	1.6	1.0- 2.5
	Tuberculosis	All, >15	1.2	1.0- 1.5
		All, >15	1.5	1.0- 2.4

Source: Desai M et al., 2004

From above table we can see that there is strong association of biomass fuel smoke inhalation with certain kind of respiratory illnesses (Desai M et al., 2004).

Women who used solid fuels for cooking have increased respiratory symptoms, including chronic cough and phlegm and decrease in lung function (Perez-Padilla et al., 2010). Compared with those cooking with gas, current use of a stove burning biomass fuel was associated with increase reporting of phlegm, reduced lung function and cough were more common (OR=1.7, 95% CI=1.0-2.8) (Regalado et al., 2006). Households with wood use were found to have significantly more cough symptoms than other groups. The association remained significant when controlling for a large number of other environmental variables (Ellegard, 1996).

Asthma is a major cause of disability, health resource utilization and poor quality of life for those who are affected. It is a disease characterized by recurrent attacks of breathlessness and wheezing, which vary in severity and frequency from person to person. In an individual, they may occur from hour to hour and day to day. This condition is due to inflammation of the air passages in the lungs and affects the sensitivity of the nerve endings in the airways so they become easily irritated. In an attack, the lining of the passages swell causing the airways to narrow and reducing the flow of air in and out of the lungs (WHO, 2012b). The global prevalence rates of doctor diagnosed asthma, clinical/treated asthma and wheezing in adults were 4.3%, 4.5%, and 8.6% respectively. About 300 million people worldwide had asthma, and projected that this number would increase to 400 million by 2025, as countries became more urbanized (To et al., 2012).

It is limited and inconsistent that the evidence on exposure to biomass smoke and asthma in developing countries. Mixed findings have also been reported from developed countries, several studies having found positive associations and some having found no association. There is also evidence that biomass smoke is associated with reduced risk, reflecting a possible protective effect. It should not be assumed that smoke exposure is protective among rural populations where biomass fuels are used most although asthma is less common (Bruce et al., 2000).

One of the studies in India showed that elderly men and women living in households using biomass fuels have a significantly higher prevalence of asthma than do those living in households using cleaner fuels (OR=1.59, 95%CI=1.30-1.94), after controlling potentially confounding factors such as age, tobacco smoking, education and living standard. Availability of a separate kitchen in the house and a higher living standard of the household were associated with lower asthma prevalence. The adjusted effect of cooking smoke on asthma was greater among women (OR=1.83, 95% CI=1.32-2.53) than among men (OR=1.46, 95%CI=1.14-1.88) (Mishra, 2003a).

BMF smoke is responsible for **COPD** (chronic obstructive pulmonary disease) in non-smoking women living in rural areas (Orozco-Levi et al., 2006). Biomass smoke could attribute close to 50% of the deaths from COPD in developing countries, and about 75% of these are in women (Lopez et al., 2006). 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 (WHO, 2012c). There are two major phenotypes of COPD, emphysema and chronic bronchitis. People with COPD have a chronic inflammation in the bronchi of their lungs (chronic bronchitis) or the air sacs in their lungs are damaged (emphysema). If bronchi are chronically inflamed, they become swollen and less air can pass through them. A persistent cough and mucous congestion are often signs of an inflammation. Chronic bronchitis was clinically diagnosed as chronic productive cough for 3 months in each of 2 successive years with no known causative factors but emphysema were not (Hu et al., 2010).

People exposed to biomass smoke have an odds ratio (OR) of 2.44 (95% CI=1.9-3.33) for developing COPD, relative to those not exposed to biomass smoke. Biomass smoke exposure was clearly identified as a risk factor for developing COPD in both women (OR=2.73, 95%CI=2.28-3.28) and men (OR=4.30, 95%CI=1.85-10.01), and in both the Asian population (OR=2.31, 95%CI=1.41-3.78) and the non-Asian population (OR=2.56, 95%CI=1.71-3.83). This risk factor has also been revealed in patients with chronic bronchitis (OR=2.56, 95%CI=1.77-3.70) and COPD (OR=2.65, 95%CI=1.75-4.03), and in cigarette smokers (OR=4.39, 95%CI=1.40-4.66) and non-cigarette smokers (OR=2.55, 95%CI=2.06-3.15) (Hu et al., 2010).

Acute respiratory infections (ARI) are the second-most-common cause of death under 5 years old children and these account for 19% of total deaths in children within that age group. While ARI contributes 2 to 4% of deaths in children under 5 years of age in the low mortality member states, these contribute 19 to 21% of child deaths in the Eastern Mediterranean, Africa, and South East Asia regions, and 12 to 14% in Europe, Americas, and the Western Pacific region (WHO, 2005). ARI is defined as children who suffered from cough accompanied by short and rapid breathing at any time during the last two weeks (Mishra, 2003b).

ARI comprise two main forms: upper respiratory tract infections (URI) and acute lower respiratory tract infections (ALRI). Clinical and epidemiological criteria are available for separating URI from ALRI but, unfortunately, worldwide there are no uniformly accepted criteria and the definitions in use are not fully consistent. ARI, a synonym of pneumonia is being the most serious form and most commonly caused by bacteria, but sometimes by viral. Air pollutants could increase the incidence of ALRI by adversely affecting specific and nonspecific host defenses of the respiratory tract against pathogens (Smith et al., 2000).

Indoor air pollution attributes 1 million deaths of children under 5 annually worldwide because of acute lower respiratory infections (ALRI) (Torres-Duque et al., 2008). Young children living in households exposed to solid fuel (BMF) have a two to three times more chance to get pneumonia compared with those living in households using cleaner fuels or suffering less exposure to smoke (Smith et al., 2000). The amount of indoor air pollution that a child exposed is directly correlated with the risk of developing pneumonia stated in one relatively small cohort study in rural Kenya (Ezzati and Kammen, 2001).

After adjusting for child's age, sex, birth order, nutritional status, mother's age at child birth, education, religion, household living standard and region of residence, preschool age children in households using biomass fuels were more than twice as likely to have suffered from ALRI as children from households using gas or electricity (OR=2.20, 95% CI=1.16-4.19) (Mishra, 2003b). Studies on the relationship between indoor air pollution and upper respiratory infections in children both from developed and developing nation have not been able to establish (ICMR bulletin, 2001).

Tuberculosis or TB is a common, and in many cases lethal, infectious disease caused by various strains of mycobacteria, usually *Mycobacterium tuberculosis* (Kumar et al., 2007). It is spread through the air when people who have an active infection cough, sneeze, or otherwise transmit their saliva through the air. The classic symptoms are a chronic cough with blood-tinged sputum, fever, night sweats, and weight loss (Konstantinos, 2010). One third of the world's population is thought to have been infected with *M. tuberculosis* and new infections occur at a rate of about one per second (WHO, 2011). In 2007, there were an estimated 13.7 million chronic active cases, and in 2010, there were 8.8 million new cases, and 1.5 million deaths, mostly in developing countries (WHO, 2012a). As Myanmar is one of the world's 22 high tuberculosis (TB) burden countries, the previous WHO estimated survey in 2009 for all TB cases including TB in children, extra-pulmonary TB and bacteriologically negative TB are taken into consideration, the TB prevalence (all cases) could be could be 600 or more per 100,000 population (WHO, 2012a). Today, tuberculosis is responsible for the death of more young people than any other communicable disease. Some groups of children are at greater risk for tuberculosis than others. These include:

- children living in a household with an adult who has active tuberculosis
- children living in a household with an adult who is at high risk for contracting TB i.e. HIV infection, medically underserved, low-income, and foreign-born persons recently arrived (within 5 years) from countries that have a high TB incidence or prevalence
- children infected with HIV or another immunocompromising condition
- children born in a country that has a high prevalence of tuberculosis (American Lung Association, 2010).

The mechanism by which cooking smoke can increase the risk of tuberculosis is not well understood and there were not much evidence that indoor smoke is a risk factor for tuberculosis. However, exposure to polycyclic aromatic hydrocarbons, especially benzo (a) pyrene can cause immune suppression in both animals and humans. Benzo (a) pyrene is a known carcinogen that is found in large quantities in biomass smoke, along with several other polyaromatic hydrocarbons. Once a person immunosuppressed, many pathogens including *M. tuberculosis* from outside environment could easily invade into the human body. It should also be noted that treatments of chronic respiratory diseases brought on by cooking smoke often include immunosuppressive drugs, such as corticosteroids, which may predispose to reactivation of tuberculosis (Mishra et al., 1999).

Odds ratio of association between TB and biomass fuel use in Mexico City Metropolitan area and the center of Mexico was 2.4 (95%CI=1.04-5.6), adjusted for age, sex, level of education, crowding, smoking, socio-economic level, zone of residence and state of birth (Perez-Padilla et al., 2001). One of the studies in India showed that persons living in households that primarily use biomass for cooking fuel have substantially higher prevalence of active tuberculosis than persons living in households that use cleaner fuels (OR=3.56, 95%Cl=2.82-4.50). This effect is reduced somewhat when availability of a separate kitchen, house type, indoor crowding, age, gender, urban or rural residence, education, religion, caste or tribe, and geographic region are statistically controlled (OR=2.58, 95%Cl=1.98-3.37). Fuel type also has a large effect when the analysis is done separately for men (OR=2.46, 95%Cl=1.79-

3.39) and women (OR=2.74, 95%Cl=1.86-4.05) and separately for urban areas (OR= 2.29, 95%Cl=1.61-3.23) and rural areas (OR=2.65, 95%Cl=1.74-4.03). The analysis also indicates that, among persons age 20 years and above, 51% of the prevalence of active tuberculosis is attributable to cooking smoke (Mishra et al., 1999).

Chapter III
RESEARCH METHODOLOGY

3.1 Research design

The research design was a quantitative, cross-sectional study which was used to describe the situation of biomass fuel use, socio-demographic factors and household environmental factors; and also used to assess relationships between above individual factor and prevalences of respiratory symptoms and illnesses in mothers, fathers and children in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.

3.2 Study area

This study was done in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar. In Mandalay City, there were 7 townships and industrial and residential zones were being separated among these townships. This township was selected as the study area due to holding of the highest population proportion in Mandalay and it was also limited to residential area, not having any industries. There were 20 quarters in this township and population is about 2 millions. There were about 40,000 families living in that township.

3.3 Study population

Mothers (respondents) and fathers aged less than 60, and under five years old children residing in Chan Aye Thar Zan Township constituted the target study population. Persons with age more than 60 years were not included in my study as they might prone to have underlying cardiopulmonary defects which could mimic with my study topic of respiratory problems. Children above 5 years were not specifically considered in data analysis, because they spent most of their time at school or outdoors, rather than inside their homes.

3.4 Sample Size

Sample size was calculated by using the following Cochran's formula provided by Daniel 2005.

$$n = \frac{Z^2_{\alpha/2}(p*q)}{(d)^2} = \frac{(1.96)^2 * 0.5*0.5}{(0.05)^2} = 384$$

Where n = minimum sample size,

α= level of significance (0.05),

$Z^2_{\alpha/2}$ = critical value for 95% confidence interval = 1.96,

p =0.5 (estimated prevalence of 50% was used in order to have the maximum sample size)

q = 1-p = 1-0.5 = 0.5

Taking the 10% of non-responding rate into account, n = 384 + 38 = 422

3.5 Sampling Technique

Multi-stage sampling design was used for conducting sampling survey. Chan Aye Thar Zan Township was purposively selected from Mandalay Region, Myanmar. From that township, quarters were chosen by simple random sampling method. 5 quarters were chosen among 20 quarters. In one quarter that I chose, one street was selected by drawing lots and survey was conducted in all households along that street. Another street in that quarter was continued by above mentioned drawing lots method to set 85 households. Data were collected in this same way in all 5 quarters. Households were taken according to inclusion and exclusion criteria. So my study size was 425. From each household, the interviewee was women with aged less than 60 (mother or female guardian of the family).

3.5.1 Inclusion criteria

- Households with mother or female guardian age < 60 years
- Households which have at least one child less than 5 years old
- Households with respondent who can understand and willing to answer the survey questions

3.5.2 Exclusion criteria

- Households with respondents who are not willing to participate.

3.6 Measurement tools

The data were collected by using structured interviewer-administered questionnaires. The questionnaires drew upon the American Thoracic Society Children's and Adults' Respiratory Questionnaires, the St. George's Respiratory Questionnaire, the International study of Asthma and Allergies in Childhood (ISAAC) Questionnaires and the China Urban Full-scale Study Questionnaire (Zhang et al., 2002). The questionnaires were checked by three experts and were revised according to their comments. There were four parts of the questionnaires: 1. Socio-demographic characteristics of household members 2. Household environmental conditions 3. Respiratory symptoms and illnesses in mother and father, and 4. Respiratory symptoms and illnesses in children under 5 years old. The questionnaire was translated into Myanmar language.

3.7 Data Collection

A pre-test of the questionnaire was done in 20 households in a different township in Mandalay City which was not included in the full-scale study. The structured questionnaires were used after the pre-test confirming all the questions were clearly understood. Data collection was done by face to face interview of the study subjects by trained interviewers using questionnaires. 9 interviewers were hired and they all were trained for 2 days to ensure familiarity of the questionnaires and how to approach to the respondents.

The interviewers conveyed the information in participant information sheet and obtained informed consent correspondence from the respondents. During the interview in their houses, the interviewers also observed the housing conditions such as type of housing, number of floors and location of kitchen.

3.8 Data analysis

The data analysis of this study was done by SPSS software. Descriptive statistics such as frequency and percentage were used to describe the socio-demographic characteristics, household environmental characteristics and prevalences of respiratory symptom and illness in mother, father and child except in description of continuous variables such as age and total number of people in the household, for which mean and standard deviation were used. There were 425 households included in my study and each household had one child or more under 5 years old.

Data analysis was conducted in 2 phases. Phase 1 was a bivariate analysis by using chi-square for categorical independent variables such as main cooking fuel, usually cooks indoors, meals cooked per week, smoky during cooking, eyes irritation during cooking, burn mosquito repellent, burn incense, wooden house, 2 storied house, mother ≤primary education, mother's occupation, mother smokes, father ≤primary education, father daily paid worker, father dusty job, father smokes, monthly income <100,000 Kyats, and interviewer ID, and binary logistic regression for continuous independent variables such as age and total number of people in the household to find out associations of these independent variables with the dependent variables. Cough with or without cold, phlegm with or without cold, wheeze, shortness of breath when hurrying on level ground, cold with cough in past 12 months, and doctor-diagnosed asthma are mother’s outcome as well as in father except diagnosed asthma. In children, respiratory outcomes were cough with or without cold, phlegm with or without cold, wheeze, diagnosed pneumonia, pneumonia in past 12 months and diagnosed TB. Each independent variable was assessed separately in relation to each dependent variable.

Phase 2 was multivariable analysis which was divided into 2 stages. In first-stage multivariable logistic regression analysis, for each dependent variable, independent variables for main cooking fuel (gas or electricity, wood, charcoal), as well as other independent variables for which $p<0.15$ in the bivariate analysis were included. All the independent variables with $p<0.15$ in first-stage model and main cooking fuel were included in second-stage regression model. Main cooking fuel was included in all stages of analysis regardless of its p-value because it was the independent variable of primary interest in this study.

3.9 Ethical consideration

Ethical approval was obtained from Chulalongkorn University Ethics Review Committee. Approval number was 190.1/54 and issued date was 21 February, 2012. The objectives and aims of the study were mentioned and written informed consent was done before data collection. The respondents were also assured that they could terminate the interview at any time for any reason. The community leader of the township that I selected as my study area was informed and explained how to conduct this survey in that township.

3.10 Limitation

- A cross-sectional study design measured the exposure and effects at a particular point of time and not over time.
- This study was done in only one township in Mandalay, Myanmar so this study could not be generalized for the whole population in Mandalay, Myanmar.
- Information for fathers was somewhat uncertain because fathers were not being interviewed directly, and mothers may not have known fathers' activities or medical histories in detail.

3.11 Expected Benefit & Application

Indoor air pollution due to biomass fuel smoke and other risk factors related to respiratory problems will be identified and serve as a working principle for future prevention and control measures in Mandalay, Myanmar. Research findings may help to aware indoor air pollution using biomass fuel by general public and that awareness may take appropriate steps to prevent respiratory problems. Furthermore, I also hope that people in Myanmar use cleaner fuels instead of using high pollution fuel in the future.

Chapter IV
RESULTS

The findings of the data analysis are divided in two main parts: (1) descriptive part and, (2) analytical part.

Part 1: Descriptive part

4.1 Household environmental characteristics

4.2 Socio- demographic characteristics

4.3 Respiratory symptom and illness prevalences in mothers and fathers

4.4 Respiratory symptom and illness prevalences in children under 5 years old

4.1 Household environmental characteristics

Household environmental characteristics are shown in table 3. There were 11 characteristics such as main cooking fuel , usually cooks indoors, number of meals cooked per week in the home, doors open during cooking, windows open during cooking, smokiness during cooking, eye irritation during cooking, burn mosquito repellent, burn incense, type of house and floor in house. Households using biomass fuels such as wood and charcoal as main cooking fuels were 32% and 32.2%, and those of using cleaner fuels such as gas or electricity were 35.8%. Most of the households cooked indoors mainly about 83.5%. Number of meals cooked per week in the home was categorized into 3 groups, 10 or less, 11 to 15 and 16 or more and their prevalences were 14.8%, 44.7% and 40.5% respectively. Most of the home that is about 99.5% opened doors and windows during cooking. 58.8% of households had smokiness during cooking and 37.4% of respondents suffered eye irritation during cooking. 27.5% of households burned smoke- producing mosquito repellent and 30.8% of those burned incense. Most of the respondents lived in wooden house about 60.7%. 2 storied houses were nearly doubled than one storied houses, 66.8% and 33.2% respectively.

Table 3: Household environmental characteristics

Characteristic	Number (Total= 425)	Percentage
Main cooking fuel		
Wood	136	32.0
Charcoal	137	32.2
Gas or Electricity	152	35.8
Usually cooks indoors	355	83.5
Number of meals cooked per week in the home		
10 or less	63	14.8
11- 15	190	44.7
16 or more	172	40.5
Doors open during cooking	423	99.5
Windows open during cooking	423	99.5
Smokiness during cooking	250	58.8
Eye irritation during cooking	159	37.4
Burns mosquito repellent	117	27.5
Burns incense	131	30.8
Type of house		
Wood	258	60.7
Bamboo	46	10.8
Others	121	28.5
Floors in house		
One	141	33.2
Two	284	66.8

4.2 Socio- demographic characteristics

It included mothers', fathers', and children's socio-demographic characteristics, monthly income and total number of people in the household are shown in table 4. Totally, 425 households (both mothers and fathers) and 449 children in the households were included in my survey. Mean age of mothers was 29.48. Mothers’ education levels were 43.8% with primary education or less and 56.2% with above primary education. Among the mothers’ occupation, housewife was the most common occupation and it was about 51. 8%. Very few mothers (5.2%) smoked but majority of fathers smoked (56%). Fathers’ mean age was 31.4. 41.9% of fathers had primary education or less and 58.1% had above primary education. 48.0% of fathers were daily paid workers and 6.4% of fathers ever had dusty job. In children’s characteristics, number of male (55.7%) was more than that of female (44.3%) and child’s mean age was 2.58. About 43.5% of the households had monthly income between 100,000 and 149,999 Kyats (between 123 USD and 184 USD), 27.3% of them had less than 100,000 Kyats (123 USD) and 29.2% had above 150,000 Kyats (184 USD) respectively. There were 94.8% of households with 1 child under 5 and 5.2% of those with 2 or 3 children. A total of 449 children were included in this study.

Table 4: Socio-demographic characteristics

Characteristic	Number (Total=425)	Percentage
Mothers' characteristics		
Age	Mean= 29.48, SD= 6.19	
Education		
Primary education or less	186	43.8
Above primary education	239	56.2
Occupation		
Daily paid worker	110	25.9
Housewife	220	51.8
Others	95	22.4
Smokes*	22	5.2
Fathers' characteristics		
Age	Mean= 31.4, SD= 6.01	
Father’s education level		
Primary education or less	178	41.9
Above primary education	247	58.1
Father’s occupation		
Daily paid worker	204	48.0
Others	221	52.0
Smokes*	237	56.0
Father ever had dusty job	27	6.4
Children's characteristics		
Gender		
Males	250	55.7
Females	199	44.3
Age	Mean= 2.58, SD= 1.40	
Monthly income (Kyats)		
<100,000	116	27.3
100,000- 149,999	185	43.5
≥ 150,000	124	29.2
Total persons in household	Mean= 5.98, SD= 2.234	
Total number of children<5 years old		
1	403	94.8
2 or 3	22	5.2
Total number of people≥5 years old	Mean= 4.93, SD= 2.21	

* Information on smoking was missing for 2 mothers and 2 fathers.

4.3 Respiratory symptom and illness prevalences in mothers and fathers

Table 5 shows respiratory symptom and illness prevalences in mothers and fathers. Prevalences of cough with or without cold were 65.4% in mothers and 64.5% in fathers. 53.2% of mothers as well as 43.4% of fathers reported phlegm from the chest with or without cold. About 40% of mothers ever had wheezing but it occurred only in 14.6% of fathers. 18.6% of mothers had shortness of breath when hurrying on level ground while only 7.1% of fathers had shortness of breath. Prevalences of cold with cough in past 12 months were observed in 54.4% of mothers as well as 43.4% of fathers. Prevalence of asthma diagnosed in fathers was very low (0.9%) compared with that in mothers (12.9%). Prevalence of diagnosed TB in mothers was 3.3% and that in fathers was 1.9%.

Table 5: Respiratory symptom and illness prevalences in mothers and fathers

	Mother		Father	
	Number (Total= 425)	Percentage	Number (Total= 425)	Percentage
Has cough with or without cold	278	65.4	274	64.5
Has phlegm from the chest with or without cold	226	53.2	184	43.3
Ever had wheezing	170	40	62	14.6
Has shortness of breath when hurrying on level ground	79	18.6	30	7.1
≥ 1 cold with cough in past 12 months	231	54.4	184	43.3

* Fathers' diagnosed asthma not included in analysis because sample size too small.

4.4 Respiratory symptom and illness prevalences in children under 5 years old

Cough with or without cold and phlegm with or without cold were found as 68.2% and 24.9% of children respectively as shown in table 6. About 45.7% had wheeze in past 12 months. Cold with cough in past 12 months was found as 56.8%. Pneumonia ever diagnosed and pneumonia in past 12 months were reported in 27.4% and 21.2% respectively. Prevalences of tuberculosis ever diagnosed and asthma ever diagnosed were 12.5% and 1.8%, respectively.

Table 6: Respiratory symptom and illness prevalences in children under 5 years old

	Number (Total= 449)	Percentage
Has cough with or without cold	306	68.2
Has phlegm with or without cold	112	24.9
Wheeze in past 12 months*	205	45.7
≥ 1 cold with cough in past 12 months	255	56.8
Pneumonia ever diagnosed	123	27.4
Pneumonia in past 12 months	95	21.2
Tuberculosis ever diagnosed	56	12.5
Asthma ever diagnosed	8†	1.8

* Data on wheeze in past 12 months missing for 2 subjects.
† Children's diagnosed asthma not included in analysis.

Part 2: Analytical part

4.5 Bivariate analysis

Chi-square test for independent categorical variables and binary logistic regression for independent continuous variables were used to find out the association of each dependent variable with individual independent variables, and used as the basis for constructing multivariable models. There were 21 independent variables to find out the association with prevalences of mothers’ and fathers’ respiratory symptoms and illnesses. For children, there were 24 independent variables including children’s age and gender. Both parents' ages were included for children, but that only mothers' age was considered for mothers, and only fathers' age was considered for fathers. Prevalences of fathers’ asthma and children’ asthma were too small to analyze meaningfully, so these outcomes were not included in analysis. Totally, there were 6 dependent variables for mothers, 5 dependent variables for fathers and 7 dependent variables for children. In the following tables 7, 8, 9 and 10, p-values from bivariate analysis for independent variables that were entered in first-stage multivariable logistic regression models. In these tables, blank cells indicate variables that were not entered in these models.

Table 7: Bivariate analysis for prevalences of respiratory symptoms and illnesses in mothers: p-values for variables entered in first-stage multivariable logistic regression models. Blank cells indicate variables not entered in these models

Characteristic	Cough	Phlegm	Wheeze	Shortness of breath	Cold	Asthma
Main cooking fuel	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Usually cooks indoors		0.001		0.018	0.008	<0.001*
Meals cooked per week	0.011	<0.001	<0.001		0.003*	0.001*
Smokiness during cooking	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Eye irritation during cooking	<0.001*	<0.001	<0.001	<0.001*	<0.001	<0.001
Burn mosquito repellent	<0.001	0.003			0.067*	0.116*
Burn incense	<0.001	0.005*				
Wooden house	<0.001	<0.001	<0.001	0.001*	<0.001	<0.001*
2 storied house	<0.001*	0.007*	0.002*	0.010	0.001*	
Mother's age	<0.001	0.001*	<0.001*	<0.001	0.001*	<0.001*
Mother ≤primary education	<0.001	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Mother's occupation	<0.001	0.003*	<0.001*	<0.001*	<0.001*	
Mother smokes	0.009*	0.006*	0.019*	0.001*	0.007*	0.032*
Father ≤primary education	<0.001	<0.001*	<0.001*	<0.001*	<0.001*	<0.001
Father daily paid worker	<0.001*	<0.001*	<0.001*	<0.001	<0.001	<0.001*
Father dusty job	<0.001*	0.002	<0.012*	<0.011*	<0.001	0.138*
Father smokes	<0.001	0.002*	<0.001*	<0.001	<0.001*	<0.001
Monthly income <100,000 Kyats	<0.001*	0.014	0.018	<0.001*	<0.001	
Number of people <5 years old	0.093		0.091*		0.064*	0.107*
Number of people ≥5 years old	<0.001	0.035			0.004	0.119*
Interviewer ID					0.095*	

*Variable included in first-stage logistic regression model, but not in second-stage model.

Table 8: Bivariate analysis for prevalences of respiratory symptoms and illnesses in fathers: p-values for variables entered in first-stage multivariable logistic regression models. Blank cells indicate variables not entered in these models

Characteristic	Cough	Phlegm	Wheeze	Shortness of breath	Cold
Main cooking fuel	<0.001	<0.001	<0.001	0.495**	<0.001
Usually cooks indoors		0.054		0.133	0.003
Meals cooked per week			<0.001	<0.001	<0.001*
Smokiness during cooking	<0.001	<0.001	<0.001*	0.094	<0.001
Eye irritation during cooking	<0.001	<0.001*	0.099		<0.001*
Burn mosquito repellent	0.002	0.107*	0.033	0.015	
Burn incense	<0.001*	0.079*			
Wooden house	<0.001*	<0.001*	0.073		<0.001
2 storied house	0.017			0.104	0.023*
Mother ≤primary education	<0.001*	<0.001	<0.001	0.063*	<0.001*
Mother's occupation	<0.001*	0.009*	0.003		<0.001
Mother smokes	0.078*	0.004*	0.002*		0.045*
Father's age	<0.001*	<0.001*	<0.001	<0.001	0.001*
Father ≤primary education	<0.001*	<0.001*	<0.001*		<0.001
Father daily paid worker	<0.001*	<0.004	0.011		<0.001*
Father dusty job	0.020*	0.011*	0.004*	0.104*	0.001*
Father smokes	<0.001	<0.001*	<0.001	<0.001	<0.001
Monthly income <100,000 Kyats	<0.001*	0.136	0.061*	0.105*	<0.001
Number of people <5 years old		0.036			
Number of people ≥5 years old	0.144*	0.109			
Interviewer ID					

*Variable included in first-stage logistic regression model, but not in second-stage model.
**Always included, regardless of p-value.

Table 9: Bivariate analysis for prevalences of children's respiratory symptoms: p-values for variables entered in first-stage multivariable logistic regression models. Blank cells indicate variables not entered in these models

Characteristic	Cough	Phlegm	Wheeze	Cold
Main cooking fuel	<0.001	<0.001	<0.001	<0.001
Usually cooks indoors		0.017	0.001	0.003*
Meals cooked per week	0.083	0.034	0.013*	0.001*
Smokiness during cooking	<0.001	<0.001	<0.001	<0.001
Eye irritation during cooking	<0.001	<0.001	<0.001*	<0.001
Burn mosquito repellent	<0.001		0.024*	0.001
Burn incense	<0.001		0.020*	0.008*
Wooden house	<0.001*	<0.001*	<0.001*	<0.001
2 storied house	<0.001*		<0.001*	0.012
Mother's age	<0.001	<0.001*	<0.001	<0.001
Mother ≤primary education	<0.001	<0.001*	<0.001	<0.001
Mother's occupation	<0.001	<0.001	0.016	<0.001
Mother smokes	0.018*	0.001*		0.016*
Father's age	<0.001	<0.001*	0.026	<0.001
Father ≤primary education	<0.001*	<0.001*	0.001*	<0.001*
Father daily paid worker	<0.001*	<0.001	<0.001	<0.001
Father dusty job	0.003*		0.028*	<0.001*
Father smokes	<0.001*	<0.001*	0.003*	<0.001*
Monthly income <100,000 Kyats	<0.001	0.064*	<0.001	<0.001
Number of people <5 years old	0.070	0.138		
Number of people ≥5 years old	0.033	0.048*	0.063*	
Child's age	<0.001	<0.001		<0.001
Child male				0.060*
Interviewer ID				

*Variable included in first-stage logistic regression model, but not in second-stage model.

Table 10: Bivariate analysis for prevalences of children's respiratory illnesses: p-values for variables entered in first-stage multivariable logistic regression models. Blank cells indicate variables not entered in these models

Characteristic	Diagnosed Pneumonia	Pneumonia past 12 months	Diagnosed TB
Main cooking fuel	<0.001	<0.001	<0.001
Usually cooks indoors	<0.001*	0.010*	
Meals cooked in one week	<0.001	0.079*	
Home ever smoky during cooking	<0.001	<0.001	<0.001*
Eyes ever irritated during cooking	<0.001	<0.001	<0.001
Burn mosquito repellent	0.049	0.122	0.019
Burn incense			
Wooden house	<0.001*	0.041*	0.001*
2 storied house		0.014*	
Mother ≤primary education	<0.001*	0.029	0.003*
Mother's occupation	0.145*	0.057	0.024
Mother smokes	0.047*		0.069*
Father ≤primary education	<0.001	0.003*	0.003*
Father daily paid worker	<0.001	<0.001*	0.002*
Father dusty job	0.030		0.036*
Father smokes	0.032*	0.029*	0.003*
Monthly income <100,000 Kyats		<0.001*	0.002*
Number of people <5 years old	0.095*		0.095
Number of people ≥5 years old		0.007*	
Mother's age	0.082		<0.001
Father's age			<0.001*
Child's age		0.119	<0.001
Child's male			
Interviewer ID			

*Variable included in first-stage logistic regression model, but not in second-stage model.

4.6 Multivariable analysis

All independent variables that had p value less than 0.15 and main cooking fuel no matter what its p-value was in bivariate analysis were placed to the first-stage model of multivariable logistic regression analysis. From these, main cooking fuel, together with all other independent variables with p<0.15, were carried forward to second-stage regression models. Only second-stage multivariable logistic regression models were included below.

4.6.1 Multivariable logistic regression of respiratory symptom and illness prevalences in mothers

Table 11 shows second-stage model of multivariable logistic regression for prevalence of mothers' cough. In this model, total number of people 5 years and above was negatively associated with prevalence of mothers' cough but biomass fuel use, meals cooked per week, smokiness during cooking, burn mosquito repellent, wooden house, fathers' primary education or less and fathers smoke were positively associated with prevalence of mothers' cough because their p-values were <0.05. Odds ratios (ORs) for wood and charcoal were 10.80 and 6.05, respectively, as compared to OR=1 for gas/electricity.

Table 11: Second-stage multivariable logistic regression model for prevalence of mothers' cough

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.001**			
Wood	2.38	<0.001	10.80	2.99	38.92
Charcoal	1.80	0.001	6.05	2.04	17.93
Meals cooked per week†		0.002**			
11- 15	1.80	<0.001	6.08	2.22	16.65
>15	0.99	0.051	2.70	1.00	7.33
Smokiness during cooking	1.60	<0.001	4.95	2.14	11.43
Burn mosquito repellent	2.29	<0.001	9.83	3.83	25.19
Burn incense	0.64	0.123	1.90	0.84	4.27
Wooden house	1.90	<0.001	6.67	2.78	15.98
Mother ≤primary education	-0.77	0.129	0.46	0.17	1.25
Mother's occupation‡		0.055**			
Daily paid worker	-1.17	0.047	0.31	0.10	0.98
Housewife	-0.12	0.800	0.89	0.35	2.27
Father ≤primary education	1.75	<0.001	5.77	2.31	14.42
Father smokes	1.09	0.011	2.97	1.29	6.85
Total number of people<5 years	1.81	0.055	6.14	0.96	39.22
Total number of people≥5 years	-0.35	<0.001	0.71	0.58	0.86
Mother's age	-0.06	0.070	0.94	0.88	1.00
Constant	-3.14	0.027	0.04		

† The reference category is <11 meals.

* The reference category is using electricity or gas.
‡ The reference category is all occupations except daily paid worker and housewife.
**p-value for the overall factor.

Table 12 shows the second-stage model of multivariable logistic regression for prevalence of mothers' phlegm. In second-stage regression analysis, monthly income and total number of people 5 years and above were negatively associated with prevalence of mothers' phlegm and all other variables including main cooking fuel were positively significantly associated with prevalence of mothers' phlegm. In households that used wood, OR was 5.04 and those used charcoal was 4.14, as compared to OR=1 for those that used gas or electricity.

Table 12: Second-stage multivariable logistic regression model for prevalence of mothers' phlegm

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.002**			
Wood	1.62	0.001	5.04	1.94	13.10
Charcoal	1.42	0.001	4.14	1.77	9.69
Usually cooks indoors	2.41	0.007	11.08	1.90	64.50
Meals cooked per week†		0.043**			
11- 15	-0.88	0.326	0.41	0.07	2.41
>15	-1.60	0.093	0.20	0.03	1.31
Smokiness during cooking	1.10	0.002	3.01	1.48	6.11
Eye irritation during cooking	1.05	0.006	2.85	1.35	6.02
Burn mosquito repellent	0.71	0.025	2.04	1.10	3.78
Wooden house	0.83	0.017	2.30	1.16	4.54
Father dusty job	1.62	0.023	5.07	1.25	20.62
Monthly income <100,000Kyats	-0.89	0.013	0.41	0.20	0.83
Number of people≥5 years old	-0.18	0.014	0.83	0.72	0.96
Constant	-2.46	<0.001	0.09		

* The reference category is using electricity or gas.
† The reference category is <11 meals.
**p-value for the overall factor.

Table 13 presents second-stage model of multivariable logistic regression for prevalence of mothers who ever had wheezing. Eye irritation during cooking and monthly income were not significantly associated with prevalence of mothers' wheeze (p>0.05). Main cooking fuel was significantly associated with prevalence of mothers' wheeze (for wood, p <0.001, OR= 7.70, 95%CI= 2.93 to 20.21 and for charcoal, p= 0.015, OR= 3.07, 95%CI= 1.25 to 7.58). Meals cooked per week, smokiness during cooking and wooden house were positively associated with prevalence of mothers' wheeze.

Table 13: Second-stage multivariable logistic regression model for prevalence of mothers' wheeze

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		<0.001**			
Wood	2.04	<0.001	7.70	2.93	20.21
Charcoal	1.12	0.015	3.07	1.25	7.58
Meals cooked per week†		<0.001**			
11- 15	1.17	0.003	3.24	1.50	6.98
>15	0.25	0.564	1.28	0.55	2.95
Smokiness during cooking	1.38	<0.001	3.96	1.87	8.37
Eye irritation during cooking	0.42	0.188	1.53	0.81	2.88
Wooden house	0.83	0.014	2.29	1.18	4.44
Monthly income					
<100,000Kyats	-0.40	0.176	0.67	0.37	1.20
Constant	-3.76	<0.001	0.02		

* The reference category is using electricity or gas.
† The reference category is <11 meals.
**p-value for the overall factor.

Second-stage model of multivariable logistic regression for prevalence of mothers' shortness of breath when hurrying on level ground is presented in table 14. After controlling for other independent variables, cooking indoors, father daily paid worker, father smokes and mother's age were positively significantly associated with prevalence of mothers' shortness of breath when hurrying on level ground. Main cooking fuel was also positively significantly associated with prevalence of mothers' shortness of breath (p= 0.017).

Table 14: Second-stage multivariable logistic regression model for prevalence of mothers' shortness of breath when hurrying on level ground

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.017**			
Wood	1.23	0.079	3.43	0.87	13.61
Charcoal	0.39	0.583	1.48	0.37	5.95
Usually cooks indoors	1.77	0.001	5.89	2.17	16.03
Smokiness during cooking	1.23	0.068	3.41	0.91	12.75
2 storied house	-0.91	0.007	0.40	0.21	0.78
Father daily paid worker	1.20	0.002	3.31	1.55	7.05
Father smokes	1.11	0.001	3.04	1.55	5.98
Mother's age	0.10	<0.001	1.11	1.05	1.17
Constant	-8.69	<0.001	0.00		

* The reference category is using electricity or gas.
**p-value for the overall factor.

Table 15 shows the second-stage model for the relationship between each independent variables and prevalence of mothers' cold with cough in past 12 months. Cook indoors, eye irritation during cooking, father daily paid worker and father's dusty job were positively significantly associated with prevalence of mothers' cold as well as main cooking fuel was also positively significantly associated with prevalence of mothers' cold with cough in past 12 months (for wood, p <0.001, OR= 6.14, 95%CI= 2.30 to 16.37 and for charcoal, p= 0.003, OR= 3.63, 95%CI= 1.53 to 8.63).

Table 15: Second-stage multivariable logistic regression model for prevalence of mothers' cold with cough in past 12 months

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.001**			
Wood	1.81	<0.001	6.14	2.30	16.37
Charcoal	1.29	0.003	3.63	1.53	8.63
Usually cooks indoors	1.24	0.002	3.47	1.58	7.64
Smokiness during cooking	0.67	0.073	1.95	0.94	4.05
Eye irritation during cooking	1.41	<0.001	4.11	1.89	8.96
Wooden house	0.65	0.072	1.91	0.94	3.86
Father daily paid worker	0.67	0.044	1.96	1.02	3.78
Father dusty job	2.67	0.002	14.42	2.62	79.49
Monthly income <100,000Kyats	-0.77	0.049	0.46	0.21	1.00
Total number of people≥5 years	-0.26	0.001	0.77	0.66	0.90
Constant	-2.04	<0.001	0.13		

* The reference category is using electricity or gas.
**p-value for the overall factor.

The second-stage logistic regression model for prevalence of mothers' diagnosed asthma is shown in table 16. Although p-value of main cooking fuel was >0.15 in first-stage model, it was included in second-stage model and it was not significantly associated with asthma prevalence of mothers (p=0.655). Other independent variables in this model were significantly associated with prevalence of mothers' diagnosed asthma.

Table 16: Second-stage multivariable logistic regression model for prevalence of mothers' diagnosed asthma

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.655**			
Wood	-0.68	0.359	0.51	0.12	2.17
Charcoal	-0.58	0.433	0.56	0.13	2.39
Smokiness during cooking	2.01	0.024	7.43	1.30	42.50
Eye irritation during cooking	1.02	0.008	2.77	1.30	5.92
Father ≤primary education	1.44	<0.001	4.23	1.93	9.28
Father smokes	1.47	<0.001	4.36	2.06	9.22
Constant	-5.35	<0.001	0.00		

* The reference category is using electricity or gas.
**p-value for the overall factor.

4.6.2 Multivariable logistic regression of respiratory symptom and illness prevalences in fathers

Table 17 presents second-stage model of multivariable regression for association of prevalence of fathers' cough with multiple independent variables in which some of them were left in first-stage model. Smokiness during cooking, eye irritation during cooking, burn mosquito repellent and father smokes were positively associated with prevalence of fathers' cough because of their p values were <0.05. Main cooking fuel was still positively associated with prevalence of fathers' cough after adjusting other independent variables. It was observed that OR for fathers of wood using households was 3.76 and those of charcoal using households was 3.14 compared to OR=1for fathers of gas or electricity using households.

Table 17: Second-stage multivariable logistic regression model for prevalence of fathers' cough

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.001**			
Wood	1.32	0.001	3.76	1.75	8.09
Charcoal	1.14	0.002	3.14	1.54	6.37
Smokiness during cooking	0.94	0.008	2.57	1.27	5.18
Eye irritation during cooking	0.82	0.029	2.28	1.09	4.78
Burn mosquito repellent	0.81	0.006	2.24	1.26	4.00
2 storied house	0.36	0.218	1.43	0.81	2.54
Father smokes	0.98	<0.001	2.66	1.57	4.51
Constant	-1.69	<0.001	0.19		

* The reference category is using electricity or gas.
**p-value for the overall factor.

Second-stage regression model of prevalence of fathers' phlegm with independent variables is shown in table 18 in which main fuel use was included but its p value was >0.15 in first-stage regression model. Usually cooks indoors, smokiness during cooking, mother ≤primary education, father smokes and number of people 5 years and above were significantly associated with prevalence of fathers' phlegm while there was no significant association with main cooking fuel (p>0.05).

Table 18: Second-stage multivariable logistic regression model for prevalence of fathers' phlegm

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.281**			
Wood	0.62	0.140	1.85	0.82	4.20
Charcoal	0.59	0.129	1.80	0.84	3.84
Usually cooks indoors	0.82	0.013	2.27	1.18	4.34
Smokiness during cooking	0.97	0.005	2.64	1.35	5.17
Mother ≤primary education	0.63	0.020	1.88	1.10	3.21
Father daily paid worker	-0.65	0.020	0.52	0.30	0.90
Father smokes	0.81	0.001	2.25	1.41	3.58
Number of people<5 years	0.78	0.087	2.19	0.89	5.36
Number of people≥5 years	0.12	0.016	1.13	1.02	1.25
Constant	-3.74	<0.001	0.02		

*The reference category is using electricity or gas.
**p-value for the overall factor.

Table 19 shows second-stage model of multivariable logistic regression for prevalence of fathers' wheeze where smoky during cooking, mother smokes, father ≤primary education or less, father dusty job and monthly income were not included although they were included in first-stage model. In this model, meals cooked per week, burn mosquito repellent, mother's primary education or less, father smokes and father's age were positively significantly associated with prevalence of fathers' wheeze ($p<0.05$). Main fuel use was marginally associated with prevalence of fathers' wheeze ($p=0.053$).

Table 19: Second-stage multivariable logistic regression model for prevalence of fathers' wheeze

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.053**			
Wood	1.47	0.021	4.33	1.24	15.09
Charcoal	0.79	0.196	2.20	0.67	7.27
Meals cooked per week†		<0.001**			
11- 15	2.84	<0.001	17.20	5.27	56.14
>15	1.00	0.121	2.72	0.77	9.65
Eye irritation during cooking	-0.96	0.028	0.38	0.16	0.90
Burn mosquito repellent	0.92	0.014	2.52	1.20	5.27
Wooden house	-0.78	0.074	0.46	0.19	1.08
Mother ≤primary education	1.56	0.001	4.75	1.85	12.17
Mother's occupation‡		0.125**			
Daily paid worker	1.13	0.052	3.09	0.99	9.61
Housewife	0.56	0.296	1.75	0.61	4.98
Father daily paid worker	-1.31	0.004	0.27	0.11	0.66
Father smokes	1.32	0.001	3.74	1.73	8.12
Father's age	0.10	0.002	1.10	1.04	1.17
Constant	-8.77	<0.001	0.00		

* The reference category is using electricity or gas.
† The reference category is <11 meals.
‡ The reference category is all occupations except daily paid worker and housewife.
**p-value for the overall factor.

Table 20 presents meals cooked per week, burn mosquito repellent, father smokes and father's age were positively significantly associated with prevalence of fathers' shortness of breath when hurrying on level ground ($p<0.05$). Main cooking fuel was included in this model whatever its p-value was in the first-stage model and it was not significantly associated with prevalence of fathers' shortness of breath ($p>0.05$). OR of shortness of breath for father smokers was 4.40 compared to OR=1 in nonsmokers.

Table 20: Second-stage multivariable logistic regression model for prevalence of father's shortness of breath when hurrying on level ground

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.654**			
Wood	-0.65	0.391	0.52	0.12	2.31
Charcoal	-0.60	0.394	0.55	0.14	2.18
Usually cooks indoors	1.64	0.248	5.16	0.32	83.66
Meals cooked per week†		0.001**			
11- 15	1.34	0.353	3.81	0.23	64.19
>15	-0.94	0.539	0.39	0.02	7.83
Smokiness during cooking	-0.23	0.732	0.80	0.22	2.93
Burn mosquito repellent	1.17	0.012	3.24	1.29	8.11
2 storied house	-1.22	0.011	0.30	0.12	0.76
Father smokes	1.48	0.005	4.40	1.58	12.26
Father's age	0.16	<0.001	1.17	1.08	1.27
Constant	-10.02	0.000	0.00		

* The reference category is using electricity or gas.
† The reference category is <11 meals.
**p-value for the overall factor.

Second-stage logistic regression model for prevalence of father ≥1 cold with cough in past 12 months is showed in table 21. Usually cooks indoors, smokiness during cooking, wooden house, mother's occupation, father smokes and monthly income <100,000 Kyats were positively significantly associated with prevalence of father's cold but there was no significant association between main cooking fuel and prevalence of fathers' cold with cough in past 12 months (p>0.05).

Table 21: Second-stage multivariable logistic regression model for prevalence of fathers' cold with cough in past 12 months

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.286**			
Wood	0.63	0.184	1.88	0.74	4.77
Charcoal	0.24	0.595	1.27	0.52	3.09
Usually cooks indoors	1.73	<0.001	5.63	2.62	12.08
Smokiness during cooking	1.84	<0.001	6.32	2.98	13.42
Wooden house	0.84	0.012	2.31	1.20	4.44
Mother's occupation‡		0.010**			
Daily paid worker	0.85	0.041	2.33	1.03	5.26
Housewife	-0.13	0.712	0.88	0.44	1.76
Father ≤primary education	-0.38	0.190	0.68	0.39	1.21
Father smokes	0.56	0.040	1.74	1.03	2.96
Monthly income <100, 000Kyats	0.75	0.015	2.12	1.16	3.89
Constant	-4.24	<0.001	0.01		

* The reference category is using electricity or gas.
‡ The reference category is all occupations except daily paid worker and housewife.
**p-value for the overall factor.

4.6.3 Multivariable logistic regression of respiratory symptom and illness prevalences in children under 5 years old

From table 22, second-stage regression model revealed eight variables (main cooking fuel, meals cooked per week, smokiness during cooking, eye irritation during cooking, burn mosquito repellent, burn incense, mother ≤primary education and mother's occupation) as significant risk factors ($p<0.05$) associated with prevalence of children's cough. It was seen that odds ratios (ORs) for wood and charcoal were 6.08 and 7.93, respectively, as compared to OR=1 for gas/electricity.

Table 22: Second-stage multivariable logistic regression model for prevalence of children's cough

Characteristic	B	p-value	Odds ratio	95% C.I.	
				Lower	Upper
Main cooking fuel*		<0.001**			
Wood	1.81	0.004	6.08	1.79	20.65
Charcoal	2.07	<0.001	7.93	2.87	21.86
Meals cooked per week†		0.023**			
11-15	1.51	0.006	4.55	1.53	13.53
>15	1.36	0.023	3.88	1.21	12.52
Smokiness during cooking	1.47	0.001	4.33	1.79	10.44
Eye irritation during cooking	1.63	0.011	5.11	1.45	18.04
Burn mosquito repellent	1.29	0.002	3.64	1.60	8.27
Burn incense	1.44	<0.001	4.21	1.91	9.28
Mother ≤primary education	0.91	0.032	2.49	1.08	5.73
Mother's occupation‡		0.001**			
Daily paid worker	0.94	0.099	2.57	0.84	7.90
Housewife	-0.90	0.038	0.41	0.17	0.95
Monthly income <100,000 Kyats	0.84	0.093	2.33	0.87	6.22
Mother's age	0.07	0.166	1.07	0.97	1.19
Father's age	-0.10	0.064	0.91	0.82	1.01
Constant	-2.55	0.022	0.08		

* The reference category is using electricity or gas.
† The reference category is <11 meals.
‡ The reference category is all occupations except daily paid worker and housewife.
**p-value for the overall factor.

Multivariable second-stage model in table 23 shows that five variables (meals cooked per week, smokiness during cooking, mother's occupation, total number of people above 5 years and child's age) were significant risk factors ($p<0.05$) of prevalence of children's phlegm whereas main cooking fuel was marginally associated with prevalence of children's phlegm. There was negatively association between usually cooks indoors and prevalence of children's phlegm.

Table 23: Second-stage multivariable logistic regression model for prevalence of children's phlegm

Characteristic	B	p- value	Odds ratio	95% C.I.	
				Lower	Upper
Main cooking fuel*		0.056**			
Wood	0.92	0.118	2.52	0.79	8.00
Charcoal	1.26	0.020	3.54	1.22	10.30
Usually cooks indoors	-2.18	0.007	0.11	0.02	0.55
Meals cooked per week†		0.026**			
11- 15	1.98	0.018	7.21	1.40	37.06
>15	1.43	0.096	4.19	0.78	22.60
Smokiness during cooking	1.00	0.028	2.72	1.11	6.64
Eye irritation during cooking	0.68	0.076	1.97	0.93	4.17
Mother's occupation‡		0.014**			
Daily paid worker	-0.13	0.785	0.88	0.34	2.26
Housewife	-0.97	0.028	0.38	0.16	0.90
Father daily paid worker	-0.54	0.130	0.58	0.29	1.17
Number of people≥5 years old	0.15	0.043	1.16	1.00	1.33
Child's age	1.57	<0.001	4.82	3.11	7.46
Constant	-7.64	<0.001	0.00		

* The reference category is using electricity or gas.
† The reference category is <11 meals.
‡ The reference category is all occupations except daily paid worker and housewife.
**p-value for the overall factor.

Table 24 shows there were six variables (main cooking fuel, usually cooks indoors, smokiness during cooking, father daily paid worker, monthly income<100,000 Kyats and mother's age) positively significantly associated with prevalence of children's wheeze in past 12 months. Odds ratios (ORs) for wood and charcoal were 4.89 and 2.76, respectively, as compared to OR=1 for gas/electricity.

Table 24: Second-stage multivariable logistic regression model for prevalence of children's wheeze in past 12 months

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.003**			
Wood	1.59	0.001	4.89	1.93	12.38
Charcoal	1.01	0.018	2.76	1.19	6.40
Usually cooks indoors	1.52	<0.001	4.56	2.20	9.44
Smokiness during cooking	1.77	<0.001	5.88	2.93	11.79
Mother ≤primary education	-1.07	0.001	0.34	0.18	0.65
Mother's occupation‡		0.088**			
Daily paid worker	-0.80	0.064	0.45	0.19	1.05
Housewife	-0.80	0.032	0.45	0.22	0.93
Father daily paid worker	0.92	0.004	2.52	1.35	4.69
Monthly income <100,000 Kyats	1.34	<0.001	3.82	2.06	7.10
Mother's age	0.11	0.003	1.12	1.04	1.21
Father's age	-0.11	0.003	0.89	0.83	0.96
Constant	-3.05	<0.001	0.05		

* The reference category is using electricity or gas.
‡ The reference category is all occupations except daily paid worker and housewife.
**p-value for the overall factor.

In table 25, multivariable second-stage model shows that eight variables (main cooking fuel, smokiness during cooking, eye irritation during cooking, burn mosquito repellent, 2 storied house, father daily paid worker, monthly income <100,000 Kyats, and respondent's age) were positively significantly associated ($p<0.05$) with prevalence of children's cold with cough in past 12 months. It was also found that odds ratios (ORs) for wood and charcoal were 3.59 and 4.10, respectively, as compared to OR=1 for gas/electricity.

Table 25: Second-stage multivariable logistic regression model for prevalence of children's cold with cough in past 12 months

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.009**			
Wood	1.28	0.008	3.59	1.39	9.27
Charcoal	1.41	0.003	4.10	1.64	10.26
Smokiness during cooking	1.12	0.002	3.06	1.49	6.27
Eye irritation during cooking	2.14	<0.001	8.50	3.84	18.80
Burn mosquito repellent	1.16	0.001	3.20	1.63	6.28
Wooden house	0.69	0.069	1.99	0.95	4.20
2 storied house	0.98	0.004	2.66	1.36	5.21
Mother ≤primary education	-0.57	0.101	0.57	0.29	1.12
Mother's occupation‡		0.086**			
Daily paid worker	-0.65	0.190	0.52	0.20	1.38
Housewife	-0.94	0.028	0.39	0.17	0.90
Father daily paid worker	0.90	0.014	2.47	1.20	5.07
Monthly income <100,000 Kyats	1.23	0.002	3.43	1.60	7.37
Children's age	0.23	0.066	1.26	0.98	1.62
Mother's age	0.10	0.025	1.10	1.01	1.20
Father's age	-0.14	0.001	0.87	0.80	0.94
Constant	-2.13	0.011	0.12		

* The reference category is using electricity or gas.
‡ The reference category is all occupations except daily paid worker and housewife.
**p-value for the overall factor.

Second-stage model of regression analysis in table 26 indicates that there were five variables (meals cooked per week, smokiness during cooking, eye irritation during cooking, burn mosquito repellent and father ≤primary education) positively associated with prevalence of children who ever diagnosed pneumonia. However p-value of main cooking fuel was >0.15 in first-stage regression model, it was included in this second-stage model and it was not significantly associated with prevalence of children who ever diagnosed pneumonia (p= 0.616).

Table 26: Second-stage multivariable logistic regression model for prevalence of children who ever diagnosed pneumonia

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.616**			
Wood	0.14	0.819	1.15	0.35	3.75
Charcoal	0.38	0.509	1.46	0.47	4.50
Meals cooked per week†		0.003**			
11- 15	2.41	0.002	11.13	2.44	50.75
> 15	2.66	0.001	14.23	3.08	65.79
Smokiness during cooking	2.28	<0.001	9.82	3.15	30.66
Eye irritation during cooking	0.73	0.024	2.07	1.10	3.89
Burn mosquito repellent	0.62	0.040	1.86	1.03	3.38
Father ≤primary education	0.66	0.020	1.94	1.11	3.40
Father daily paid worker	0.29	0.342	1.33	0.74	2.40
Father dusty job	0.95	0.052	2.59	0.99	6.73
Mother's age	-0.05	0.048	0.95	0.91	1.00
Constant	-4.96	<0.001	0.01		

* The reference category is using electricity or gas.
† The reference category is <11 meals.
**p-value for the overall factor.

Second-stage regression model in table 27 revealed that smokiness during cooking and eye irritation during cooking were positively significantly associated ($p<0.05$) with prevalence of children who had pneumonia in past 12 months. It was also observed that main cooking fuel was marginally associated with prevalence of children who had pneumonia in past 12 months ($p=0.053$).

Table 27: Second-stage multivariable logistic regression model for prevalence of children who had pneumonia in past 12 months

Characteristic	B	p- value	Odds ratio	95% C. I	
				Lower	Upper
Main cooking fuel*		0.053**			
Wood	1.49	0.018	4.46	1.29	15.36
Charcoal	1.39	0.019	4.01	1.25	12.82
Smokiness during cooking	1.76	0.002	5.82	1.94	17.42
Eye irritation during cooking	0.88	0.006	2.41	1.29	4.51
Burn mosquito repellent	0.52	0.083	1.67	0.93	3.00
Mother ≤primary education	-0.12	0.700	0.89	0.49	1.61
Mother’s occupation‡		0.247**			
Daily paid worker	-0.76	0.099	0.47	0.19	1.15
Housewife	-0.42	0.317	0.66	0.29	1.49
Children’s age	-0.38	<0.001	0.68	0.55	0.84
Constant	-2.97	<0.001	0.05		

* The reference category is using electricity or gas.
‡ The reference category is all occupations except daily paid worker and housewife.
**p-value for the overall factor.

Table 28 shows second-stage multivariable regression model for prevalence of diagnosed TB in children. It was seen that main cooking fuel, eye irritation during cooking, mother's occupation, children's age and mother's age were significantly associated ($p<0.05$) with prevalence of children who ever diagnosed TB. With households using wood and those using charcoal, OR were 7.29 and 6.64 respectively compared to those using gas or electricity with OR=1. Burn mosquito repellent and number of people <5 years old were negatively associated with prevalence of children who ever diagnosed TB.

Table 28: Second-stage multivariable logistic regression model for prevalence of children who ever diagnosed TB

Characteristic	B	p- value	Odds ratio	95% C. I.	
				Lower	Upper
Main cooking fuel*		0.017**			
Wood	1.99	0.005	7.29	1.81	29.36
Charcoal	1.89	0.006	6.64	1.70	25.94
Eye irritation during cooking	0.99	0.009	2.70	1.29	5.65
Burn mosquito repellent	-1.50	0.002	0.22	0.09	0.57
Mother's occupation‡		0.004**			
Daily paid worker	-1.72	0.002	0.18	0.06	0.52
Housewife	-1.54	0.002	0.21	0.08	0.58
Number of people <5 years old	-1.77	0.023	0.17	0.04	0.79
Children's age	0.46	0.027	1.59	1.05	2.40
Mother's age	0.11	0.001	1.12	1.05	1.19
Constant	-5.54	<0.001	0.00		

* The reference category is using electricity or gas.
‡ The reference category is all occupations except daily paid worker and housewife.
**p-value for the overall factor.

4.7 Directions of association for statistically significant associations ($p<0.05$) in second-stage multivariable models of respiratory symptom and illness prevalences in mothers, fathers and children

Tables 29, 30, 31 and 32 summarize, for second-stage logistic regression models, directions of associations for independent variables that were statistically significantly associated with respiratory symptom and illness prevalences in mothers, fathers, and children, respectively. Among the cooking related variables, main cooking fuel was statistically significant associated with prevalences of all respiratory symptoms and illnesses in mothers except asthma. It was also seen that wood and charcoal users have more occurrence of cough, phlegm, wheeze and cold than gas or electricity users. It was observed that there were more chance to get phlegm, shortness of breath and cold in mothers if they cooked more inside the home. Meals cooked per week was significantly associated with prevalences of 3 out of 6 respiratory outcomes in mothers and smoky during cooking was also associated with 4 out of 6 and 3 out of 6 for eye irritation during cooking. There were only 2 respiratory outcomes positively associated with burn mosquito repellent. Some of socio-demographic characteristics of fathers were influenced on prevalences of mothers' outcomes like father's primary education or less and father smokes. In table 30, father smoking was a risk factor for all of the fathers' respiratory symptoms and illnesses. Even in fathers' respiratory outcomes, there were also significantly associated with cooking related elements.

In table 31 and 32, it was seen that prevalences of 4 out of 7 respiratory outcomes in children were statistically significant associated with main cooking fuel and children with wood and charcoal using households were more likely to get these outcomes than those of households using gas or electricity. There were positive associations between smokiness during cooking and 6 out of 7 respiratory outcomes for children, and eye irritation during cooking with those of 5 out of 7 outcomes. Burn mosquito repellent was positively associated with prevalences of children's cough, cold and diagnosed pneumonia. It was found that father smoking had no significant association with any of children's respiratory symptoms or illnesses.

Among all the independent variables, cooking related variables were most statistically significance and could be seen as risk factors for human respiratory health rather than other variables. Some of the other variables such as burn mosquito repellent and father smoking were also positively related with prevalences of respiratory problems.

Table 29: Directions of association for independent variables that were statistically significantly associated with mothers' respiratory symptom and illness prevalences in second-stage multivariable models

	Cough	Phlegm	Wheeze	Shortness of breath	Cold	Asthma
Cooking-related						
Main cooking fuel	Sig*	Sig	Sig	Sig	Sig	
Wood vs. Gas or Electricity	Positive	Positive	Positive	†	Positive	
Charcoal vs. Gas or Electricity	Positive	Positive	Positive		Positive	
Usually cooks indoors		Positive		Positive	Positive	
Meals cooked per week	Sig	Sig	Sig			
11-15 vs. <11	Positive		Positive			
>15 vs.<11						
Smoky during cooking	Positive	Positive	Positive			Positive
Eye irritation during cooking		Positive			Positive	Positive
Other environmental						
Burn mosquito repellent	Positive	Positive				
Burn incense						
Wooden house	Positive	Positive	Positive			
2 storied house				Negative		
Socio-demographic						
Mother's age				Positive		
Mother ≤primary education						
Mother's occupation						
Daily paid worker vs. Others						
Housewife vs. Others						
Mother smokes						

Father ≤primary education	Positive					Positive
Father daily paid worker				Positive	Positive	
Father dusty job		Positive			Positive	
Father smokes	Positive			Positive		Positive
Monthly income <100,000 Kyats		Negative			Negative	
Number of people <5 years old						
Number of people ≥5 years old	Negative	Negative			Negative	

* Sig means p≤0.05 in second-stage multivariable model for the designated factor as a whole.

† Each blank cell indicates that there was not a significant association between the designated independent and dependent variables.

Table 30: Directions of association for independent variables that were statistically significantly associated with fathers' respiratory symptom and illness prevalences in second-stage multivariable models

	Cough	Phlegm	Wheeze	Shortness of breath	Cold
Cooking-related					
Main cooking fuel	Sig*	†			
Wood vs. Gas or Electricity	Positive				
Charcoal vs. Gas or Electricity	Positive				
Usually cooks indoors		Positive			Positive
Meals cooked per week			Sig	Sig	
11-15 vs. <11			Positive		
>15 vs. <11					
Smoky during cooking	Positive	Positive			Positive
Eye irritation during cooking	Positive		Negative		
Other environmental					
Burn mosquito repellent	Positive		Positive	Positive	
Burn incense					
Wooden house					Positive
2 storied house				Negative	
Socio-demographic					
Mother ≤primary education		Positive	Positive		

Mother's occupation					Sig
Daily paid worker vs. Others					Positive
Housewife vs. Others					
Mother smokes					
Father's age			Positive	Positive	
Father ≤primary education					
Father daily paid worker		Negative	Negative		
Father dusty job					
Father smokes	Positive	Positive	Positive	Positive	Positive
Monthly income <100,000 Kyats					Positive
Number of people <5 years old					
Number of people ≥5 years old		Positive			

* Sig means p≤0.05 in second-stage multivariable model for the designated factor as a whole.

† Each blank cell indicates that there was not a significant association beween the designated independent and dependent variables.

Table 31: Directions of association for independent variables that were statistically significantly associated with children's respiratory symptom prevalences in second-stage multivariable models

	Cough	Phlegm	Wheeze	Cold
<u>Cooking-related</u>				
Main cooking fuel	Sig*	†	Sig	Sig
Wood vs. other	Positive		Positive	Positive
Charcoal vs. other	Positive		Positive	Positive
Usually cooks indoors		Negative	Positive	
Meals cooked per week	Sig	Sig		
11-15 vs. <11	Positive	Positive		
>15 vs. <11	Positive			
Smoky during cooking	Positive	Positive	Positive	Positive
Eye irritation during cooking	Positive			Positive
<u>Other environmental</u>				
Burn mosquito repellent	Positive			Positive
Burn incense	Positive			
Wooden house				
2 storied house				Positive
<u>Socio-demographic</u>				
Mother's age			Positive	Positive

Mother ≤primary education	Positive		Negative	
Mother's occupation	Sig	Sig		
Daily paid worker vs. Others				
Housewife vs. Others	Negative	Negative		
Mother smokes				
Father's age			Negative	Negative
Father ≤primary education				
Father daily paid worker			Positive	Positive
Father dusty job				
Father smokes				
Monthly income <100,000 Kyats			Positive	Positive
Number of people<5 years old				
Number of people≥5 years old		Positive		
Child's age		Positive		

* Sig means $p \leq 0.05$ in second-stage multivariable model for the designated factor as a whole.
† Each blank cell indicates that there was not a significant association beween the designated independent and dependent variables.

Table 32: Directions of association for independent variables that were statistically significantly associated with children's diagnosed respiratory illness prevalences in second-stage multivariable models

	Diagnosed Pneumonia	Pneumonia in past 12 months	Diagnosed TB
Cooking-related			
Main cooking fuel	†		Sig*
Wood vs. other			Positive
Charcoal vs. other			Positive
Usually cooks indoors			
Meals cooked per week	Sig		
11-15 vs. <11	Positive		
>15 vs. <11	Positive		
Smoky during cooking	Positive	Positive	
Eye irritation during cooking	Positive	Positive	Positive
Other environmental			
Burn mosquito repellent	Positive		Negative
Burn incense			
Wooden house			
2 storied house			
Socio-demographic			
Mother's age	Negative		Positive

Mother ≤primary education			
Mother's occupation			Sig
Daily paid worker vs. Others			Negative
Housewife vs. Others			Negative
Mother smokes			
Father's age			
Father ≤primary education	Positive		
Father daily paid worker			
Father dusty job			
Father smokes			
Monthly income <100,000 Kyats			
Number of people<5 years old			Negative
Number of people≥5 years old			
Child's age		Negative	Positive

* Sig means p≤0.05 in second-stage multivariable model for the designated factor as a whole.
† Each blank cell indicates that there was not a significant association beween the designated independent and dependent variables.

4.8 Checking collinearity among cooking-related independent variables

There were 5 cooking related independent variables. In analysis part, most of the cooking related variables had positively associated with prevalences of respiratory outcomes. Following table 33 shows that there was collinearity among these 5 variables using chi-square test. There were statistically significant associations in 8 of 10 pairs.

Table 33: Collinearity check: Direction of significant association among cooking related independent variables

	Cooked ≥11 meals per week	Smoky during cooking	Eye irritation during cooking	Usually cooks indoors
Main fuel biomass	Negative	Positive	Positive	Negative
Cooked≥11 per week		Not sig	Positive	Positive
Smoky during cooking			Positive	Not sig
Eye irritation during cooking				Positive

Chapter V

Discussion, Recommendation and Conclusion

5.1 Discussion

The principal purpose of this study was to evaluate respiratory effects of biomass fuel use for cooking in in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar. Other variables, including other cooking-related variables, other household environmental characteristics, and socio-demographic characteristics were assessed in relation to respiratory health outcomes to sharpen the estimates of the effect of biomass fuel use. The respondents in this study were mothers or female guardians in the household. As Myanmar is one of the developing countries, most of the households are still relying on biomass fuel as their main cooking fuel and there are not too many publications about the relationship between occurrence of respiratory symptoms and illnesses and biomass fuel use in Myanmar.

In this study, 64.4% of households used biomass fuel such as wood and charcoal as their main cooking fuel. The rest used gas or electricity and none used dung and coal as their main cooking fuels. In 2002, according to WHO, it was found that more than 95% of households in Myanmar used solid fuels (WHO, 2007) and it seems to be declined using solid fuels in nowadays upon information on this study. 83.5% of households usually cooked indoors and 85.2% cooked meals 11 times and more in a week. 58.8% of mothers exposed to smoke from indoors cooking and 37.4% of them suffered eye irritation during cooking. Nearly all households in this research opened doors and windows of their homes during cooking. These above information are prevalences of cooking related habits in my study area. From these results, it was seen that about two-third of households used biomass fuel as their main cooking fuel and majority of households cooked indoors and they usually cooked indoors at least one time per day. Indoor smokiness during cooking occurred in more than half of households, and half of the mothers of those households with smokiness during cooking had eye irritation. The others are 60.7% of houses were built by wood, 66.8% were 2 storied houses, 27.5% of households used burned mosquito repellents and 30.8% of households burned incense.

The majority of respondents, about >95%, were children's mothers and the rest were female guardians (grandmothers or aunts of the children).Mean ages of mother and father were 29.5 and 31.4 and it is implied that most of the fathers and mothers were in reproductive age. The duration of average living in their homes in years is about 7 in both mothers and fathers. Almost half of the mothers (43.8%) and fathers (41.9%) had got at least primary education and so it was observed that most of the mothers and fathers in this study could read and write well. 51.8% of mothers are housewives and 48% of fathers were daily paid workers. Although more than half of fathers smoked (56%) but only a few mothers (5.2%) smoked. Very few mothers and fathers ever worked dusty jobs. There were no ones who ever worked with gas or fumes. On average, most of the households have at least 5 total household members. There were more male (55.7%) than female child (44.3%). Almost one-third of households had monthly income under 100,000 Kyats (123 USD).

65.4% of mothers and 64.5% of fathers had cough with or without colds. 10% of them coughed more than 1 month. Prevalences of phlegm with or without cold (53.2% and 43.3%) and cold with cough in past 12 months (54.4% and 43.3%) were being nearly same in mothers and fathers. Prevalence of wheeze in mothers was much more than that of fathers as well as asthma prevalence. It was assumed that mothers could know exactly about themselves but they could not know about others as only mothers were respondents and they answered not only about themselves but also about their husbands and children. In one of the studies in China showed that females had a significantly higher risk of asthma-like symptoms and asthma attacks than males after adjusting for age, smoking, county of residence and other exposures (Zhang et al., 2002). Prevalences of diagnosed chronic bronchitis and diagnosed tuberculosis were very few in both mothers and fathers and thus they were not included in analysis.

68.2% of children in this research had cough with or without colds and 24.9% of those had phlegm with or without cold. Everyone who had phlegm with or without cold had cough with or without cold. About 10% of children with cough had more than 1 month duration of cough. 27.4% of children had pneumonia ever diagnosed by doctor, 21.2% of those had pneumonia in past 12 months and 12.5% of them had TV ever diagnosed by doctor.

Globally in 2010, 8.8 million people fell ill with TB and 1.4 million died from TB and about half a million children (0-14 years) fell ill with TB, and 64,000 (a range of 58,000 to 71,000) children died from the disease in 2010 (WHO, 2012a). In this community-based survey, we observed that prevalences of childhood diagnosed TB (12.5%) which was much more than that of adult diagnosed TB (prevalences in mother=3.3% and in father=1.9%). The prevalence of TB in children under 5 years old in this study was quite high, especially in comparison to that in mothers and fathers. Conceivably, some mothers and fathers had actually had TB, but had not been diagnosed with it, or did not remember being diagnosed. If so, the difference between children's and parents' TB prevalences would actually have been smaller than observed in the present study. Another reason was children born in a country that had a high prevalence of tuberculosis could have greater chance to get TB than those born in other countries. There were no children who had bronchitis and very few percentages in prevalence of children’s asthma were observed and they were not put in analysis.

5.1.1 Respiratory symptom and illness prevalences related to independent factors in mothers

Main cooking fuels, meals cooked per week and smokiness during cooking were positively associated with both mothers’ cough and phlegm although usually cooks indoors and eye irritation during cooking were only associated with mothers’ phlegm. These above independent variables are cooking fuel concerned variables and they were linked each other. In 2010, Perez-Padilla and other researchers also showed that women who used solid fuels for cooking have increased respiratory symptoms, including chronic cough and phlegm and decrease in lung function. In this study, OR of mothers’ cough for wood users were 10.80 and those used charcoal fuel was 6.05. It is similar with a study in rural Mexican women after adjusting for passive smoking and level of income, women cooking with biomass stoves had cough or phlegm most of the day than those women cooking with gas stoves (OR=2.3, 95%CI= 1.1-4.8) (Regalado et al., 2006).

Burn mosquito repellent and wooden house were positively associated with mothers’ cough and phlegm. In one of the studies in Myanmar migrant workers in Thailand, after adjusting confounding factors, mosquito coil use was positively significantly associated with cough with or without cold (OR=1.84, 95% CI= 1.02-3.33, p=0.045) and phlegm with or without colds (OR=2.02, 95%CI=1.28-3.19, p=0.003) (Tharaphy, 2009). Father smokes and father primary education or less were associated with mothers' cough as well as father's dusty job was associated with mothers' phlegm. It was observed that the lower the socio-demographic characteristics of father related with prevalences of some of the respiratory outcomes of mothers.

According to mothers' wheeze, there was positively associated with main cooking fuel (ORs for wood and charcoal were 7.70 and 3.07), meals cooked per week and smokiness during cooking but mothers' asthma was not significantly associated with main cooking fuel. One of the previous studies proved that wheezing in the past had a marginally significant association with current cooking with a biomass stove, after adjustment for passive smoking and income in women in rural area of Mexico (OR=1.5; 95%CI=1.1–2.0) (Regalado et al., 2006). It was observed that mothers' asthma was not significantly associated with main cooking fuel but it was positively associated with other aspects of cooking fuel related variables such as smoky during cooking and eye irritation during cooking. The evidence on exposure to biomass fuel use and asthma in developing countries is limited and inconsistent. However, several studies have reported no associations; biomass fuel use is associated with reduced risk, reflecting a possible protective effect in some studies. The use of an open fire was associated with a non-significantly reduced risk of asthma (OR=0.64, 95% CI=0.21–1.91) (Bruce et al., 2000). There was one of the studies which was controversial with my study is that elderly men and women in India living in households using biomass fuels have a significantly higher prevalence of asthma than do those living in households using cleaner fuels (OR= 1.59; 95% CI=1.30 to 1.94), after controlling potentially confounding factors such as age, tobacco smoking, education and living standard (Mishra, 2003a). Wooden house was positively associated with mother's wheeze suggested that low socio-demographic status of the household was linked with mother's wheeze and father's primary education or less was also related with mothers' asthma.

Father's smoke was also positively influenced on both mothers' asthma and mothers' shortness of breath which could indicate that passive smoking was associated with asthma and shortness of breath. This fact was consistent with the study of Jorden and others in 2011 where asthma can be induced by exposure to passive smoking, and there is strong evidence to suggest that passive smoking increases the risk of general respiratory symptoms (Jordan et al., 2011). After controlling age, sex, body mass index (BMI) and study area in 8 areas in Switzerland, passive smoking was associated with an elevated risk of wheeze without colds (OR=1.94, 95% CI=1.39-2.70), an elevated risk of bronchitis symptoms (OR=1.59, 95% CI=1.17-2.15), an elevated risk of symptoms of chronic bronchitis (OR=1.65, 95% CI=1.28-2.16), an elevated risk of dyspnoea (OR=1.45, 95% CI=1.20-1.76), and an elevated risk of physician diagnosed asthma (OR=1.39, 95% CI=1.04-1.86) (Leuenberger et al., 1994). If exposure to passive smoking exceeded 5 hours daily, the risk for wheeze (OR=2.67, 95% CI=1.98–3.61) and physician-diagnosed asthma (OR=1.79, 95%CI=1.02–3.16) in women were increased (Larsson et al., 2003). Main cooking fuel, usually cooks indoors and mother’s age were positively significantly associated with mothers’ shortness of breath. Regarding with mothers’ cold in past 12 months, main cooking fuel, usually cooks indoors, eye irritation during cooking and father’s dusty job were risk factors.

5.1.2 Respiratory symptom and illness prevalences related to independent factors in fathers

In accordance with prevalences of all respiratory symptoms and illnesses, there were positively associated with father smokes in present study. It is consistent with one of the studies to find out association between active smoking and respiratory health showed that after adjusting individual exposure to urban air pollutants, heating method of home, age, sex, occupational exposure, and flu syndrome affecting person or someone in the family in Tehran, active smoking was associated with cough ($p<0.001$, OR=2.271), phlegm ($p<0.001$, OR=2.906) and shortness of breath ($p<0.001$, OR=1.886) (Yunesian et al., 2008). Study in China also showed that symptoms of chronic cough and phlegm increased significantly when cigarette consumption increased (Zhang et al., 2002). Main cooking fuel was positively associated with prevalence of fathers’ cough (ORs for wood and charcoal were 3.76 and 3.14 respectively) and marginally significantly associated with fathers’ wheeze ($p=0.053$). In 1996, Anders Ellegard stated that households with wood use were found to have significantly more cough symptoms than other groups. The association remained significant when controlling other environmental variables. Smokiness during cooking was a significant risk factor for fathers' cough, fathers' phlegm and fathers' cold. Cook indoors was a risk factor for fathers' phlegm and fathers' cold. Meals cooked per week was associated with prevalences of fathers' wheeze and shortness of breath.

Burning mosquito repellent was a risk factor for fathers' cough, fathers' shortness of breath and fathers' wheeze. A study in 2009 by Tharaphy proved that above three respiratory symptoms were associated with burn mosquito coil but that study was done in women and children only. There was negative association between father daily paid worker and prevalences of fathers' phlegm and wheeze because most of the daily paid workers were low socioeconomic conditions and usually used biomass fuel for their household main fuel. This condition might be associated with prevalences of fathers' phlegm and wheeze. In this study, however, there was no association between them. It was seen that mothers answered for fathers and their answers might be uncertainty as stated earlier. This might affect in both direction of relationship and statistically significant association. Mother's primary education or less was significantly associated with prevalences of fathers' phlegm and wheeze. Total number of people above 5 years was associated with prevalence of fathers' phlegm and it could be said that overcrowding is a risk factor for fathers' phlegm. There were positive association between wooden house, mother's occupation, monthly income under 100,000 Kyats (123 USD) and prevalence of father's cold with cough in past 12 months.

5.1.3 Respiratory symptom and illness prevalences related to independent factors in children

There were association between main cooking fuel and prevalences of children's cough, wheeze, cold in past 12 months and TB as well as it was marginally significantly associated with prevalences of children's phlegm (p=0.056) and pneumonia in past 12 months (p=0.053). There was one of the similar findings in Zimbabwe after adjusting for child's age, sex, birth order, nutritional status, mother's age at child birth, education, religion, household living standard and region of residence, preschool age children in households using biomass fuels were more than twice as likely to have suffered from ALRI as children from households using gas or electricity (OR= 2.20, 95% C.I.=1.16 to 4.19) (Mishra, 2003b). Similar findings for association between biomass fuel use and TB were reported but only in adults. Mishra and associates described an OR of 2.7 (95% CI, 1.9–4.0) for people exposed indoor smokes, but it was not adjusted for smoking. Pe´rez-Padilla and coworkers found an OR of 2.4 (95% CI, 1.04–5.6) adjusted for age, sex, level of education, crowding, smoking, socioeconomic level, zone of residence, and state of birth. A recent systematic review and meta-analysis supported a mild or moderate association between indoor air pollution due to biomass fuel use and the risk of tuberculosis (Torres-Duque et al., 2008).

Meals cooked per week was positively associated with prevalences of children's cough, phlegm and diagnosed pneumonia. This means that increased these respiratory symptoms was due to increase in numbers of meals cooked indoors. There was also found that all respiratory symptoms and illnesses except children's TB were positively associated with smokiness during cooking. Even main cooking fuel was not associated with certain respiratory symptoms and illnesses in children; they were strong relationship with cooking related aspect of other independent variables like in mothers and fathers. Burn mosquito repellent was positively associated with prevalences of children's cough, cold and pneumonia diagnosed by doctor. This information was consistent with the study of Azizi and Henry in which mosquito coil use was significantly associated with chronic cough/phlegm (OR= 1.6, 95% CI= 1.1 to 2.4, $p<0.05$) (Azizi and Henry, 1991).

There were negative relationship between mother's occupation (housewife) and prevalences of children's cough, child's phlegm and child's TB. Conceivably, housewives may have kept their children indoors together with them than mothers in other occupations, and thus there was less chance to get transmission of these symptoms and illness from other persons outside to their children. In spite of mother's primary education or less was positively associated with prevalence of children's cough, it was negatively associated with those of children's wheeze and cold.

Father's smoking was not significantly associated with prevalences of children's respiratory outcomes in this study. There is one study done by Cook and his friend in 1999 that is contradicted to my study which showed there was positive association between ALRI in children and father's smoking (OR=1.29, 95%CI=1.16-1.44). They also found that prevalences of cough (OR=1.21, 95%CI=1.09-1.34) and wheeze (OR=1.14, 95%CI=1.06-1.23) in children were positively associated with father's smoking (Cook and Strachan, 1999) but their ORs were not too much.

Associations of biomass fuel use with prevalences of respiratory symptoms and illnesses were observed more frequently in mothers and children than in fathers. The reason for these findings was probably that women do the cooking in most societies and they usually spend 3 to 7 hours per day near the stove for preparing food and they always keep their young children inside the home staying together with them. Thus, 59% and 56% of indoor air pollution attributable death fall on women and children under 5 years old respectively (WHO, 2005). Regarding analytical part, cooking-related characteristics were generally correlated with each other, and this lends some uncertainty to interpretation of the multiple logistic regression models. Even so, this uncertainty is not major, because the standard errors of the coefficients were small, almost always <1, in all second-stage models.

5.2 Conclusion

The survey was collected in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar in March, 2011 by using structured questionnaires. During interviewing mothers or female guardians in the households, interviewers also observed household environmental conditions. There were 425 mothers, 425 fathers and 449 children included in this study. Respiratory symptoms for mothers and fathers are cough with or without cold, phlegm with or without cold, wheeze, shortness of breath when hurrying on level ground and cold with cough in past 12 months and respiratory illness for them is asthma. Respiratory symptoms for children are cough with or without cold, phlegm with or without cold, wheeze, cold with cough in past 12 months and respiratory illness for children are diagnosed pneumonia, diagnosed pneumonia in past 12 months and diagnosed TB. Independent variables are divided into 3 parts, use of biomass fuel as main cooking fuel, socio-demographic characteristics and household environmental characteristics.

This study observed high prevalences of respiratory symptoms in both mothers and children and even high in those of fathers. Respiratory illness such as asthma was more occurred in mothers than fathers. One of the important results is high prevalence of childhood TB in this study. TB control in Myanmar is a global priority, thus it is needless to say there are many TB cases but the burden on childhood TB is still unknown. This study provided a message that childhood TB is as a notifiable disease as adult TB and should give high priority in controlling it. Prevalences of all of the mother's respiratory symptoms are higher than those of fathers as mothers are respondents in this survey and their information on fathers and children could be slightly unsure. This study found that exposure to biomass fuel smoke was positively associated with respiratory symptom and illness prevalences. This result provides support for the hypothesis that use of biomass fuel is associated with increased risk of respiratory symptoms and illnesses in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar. Some of the socio-demographic characteristics were positively associated with prevalences of certain respiratory symptoms and illnesses. Father smoking is positively associated with prevalences of all respiratory symptoms in fathers and it is also a significant risk factor for mothers' cough, shortness of breath and asthma. Also the household environmental characteristics such as burn mosquito repellent and wooden house had significant positive association with prevalences of some of the respiratory symptoms and illnesses.

5.3 Recommendation

Recommendations to reduce prevalence of respiratory hazard due to biomass fuel use are given below.

(1) Public awareness and acceptance. The first and the most important step in the prevention of respiratory symptoms and illnesses resulting from use of biomass fuels is to educate the public, administrators and politicians to ensure their commitments and promoting awareness of the long-term health effects on users. This may lead to people finding ways of minimizing exposure through better kitchen management and infant protection. It will also be essential to ensure that cleaner fuels and cleaner stoves will be culturally acceptable.

(2) The most helpful intervention is to promote widespread use of cleaner fuels such as electricity and gas. Having good accessibility of cleaner fuels and reducing the cost

of vented stove price and cleaner fuel price are likely to be addressed through policies.

(3). Widespread adoption of cleaner fuels is unlikely to occur in the short term in Myanmar, therefore the efforts need to focus on providing improved cook stoves designed to reduce exposure to smoke by means of improved combustion and improved venting.

(4). Ventilation in the kitchen should be given due priority in the design of the houses. In existing houses, measures such as putting a window above the cooking stove and providing cross ventilation through the door may help in diluting the pollution load. Kitchen separates from house could also reduce amount of indoor smoke exposure.

(5). Multisectoral approach- Collaboration and commitment between agencies responsible for health, energy, environment, housing and urban and rural development are required in solving respiratory health problems as a result of biomass fuel use.

Further research suggestion:

(1). Further research should be developed based on not only interviewing respondents but also taking clinical measurements of the study population.

(2). Direct, quantitative measurement of smoke exposure should be conducted in Myanmar when possible.

(3). Further studies should be carried out in order to find out the relationship between biomass fuel use and other non-respiratory illnesses. There is also a need of qualitative studies that address issues of locally and culturally acceptable and economically feasible interventions that can permanently reduce exposure.

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APPENDICES

APPENDIX A

Patient/ Participant Information Sheet

Title of research project: **"*Respiratory symptom and illness prevalence in relation to biomass fuel use in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar*"**

Principle researcher's name: Moe Myint Theingi Tun **Position**: Student

Office address: College of Public Health Sciences, Chulalongkorn University

Home address: 521/3-4 Soi Sriayuthaya 2-4, Sriayuthara Road, Prayathai Distric, Rajthavee, Bangkok

Telephone (office) …………………….. **Telephone (home)** ……………………….

Cell phone: +66(0)803152316 **E-mail:** moemyattheingihtun.cf@gmail.com

Local person's name: Win Maung **Position:** Community leader

Local person's cell phone: +95(0)92017236

Local person's address: No (192), 35th Street, between 76th and 77th Streets, Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.

1. You are being invited to take part in a research project. Before you decide to participate it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and do not hesitate to ask if anything is unclear or if you would like more information.

2. This research project involves finding out the relationship between respiratory symptom and illness prevalence and biomass fuel use in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.

3. Objective (s) of the project.

- To describe prevalences of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.
- To investigate biomass fuel use is associated with increased risk of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.
- To examine the relationships between household environmental characteristics and prevalences of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.

- To examine the relationships between socio-demographic characteristics and prevalences of respiratory symptoms and illnesses in people in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar.

4. Details of participant.
   - The participants are women with aged less than 60 (mother or female guardian of the family).

   4.1 **Inclusion criteria**
   - Households with mother or female guardian age < 60 years
   - Households which have at least one child of less than 5 years old
   - Households with respondent who can understand and willing to answer the survey questions

   4.2 **Exclusion criteria**
   - Households with respondents who are not willing to participate
   - Number of participant needed is 422.

5. Using Multi-Stage sampling design and one out of nine assistant researchers will ask you this survey questions which may last about 30-40 minutes. 18 questions about general characteristics of household members, 17 questions about housing environmental condition, 9 questions about respiratory problems of the mother and father and 8 questions about respiratory problems of under five years old child will be asked. Some of the survey questions will be observed such as the type of house, number of floor and location of kitchen. All your information will be kept confidential and the presentation of research result will be in an overall picture only.

6. You will have no risk when taking part in this research. Further research can be done depending on the data in this research.

7. Your participation in this research is voluntary and you have the right to refuse this participation or to withdraw at any given time with no harm on your benefit and there will be no adverse impact on you.

8. If you have any question or if you would like to obtain more information, the researcher is available at all time.

9. Information that is directly related to you will be kept confidential. Results of the study will be reported as an overall statement with anonymity.

10. There is no payment or compensation for participation in this study.

11. If the researcher does not treat you as stated in the patient's information sheet, you can report to the Ethical Review Committee for Research Involving Human Research Subjects, Health Sciences Group,

Chulalongkorn University (ECCU). Institute Building 2, 4th Floor, Soi Chulalongkorn 62, Phyathai Rd., Bangkok 10330, Thailand, Tel: 0-2218-8147 Fax: 0-2218-8147 E-mail: eccu@chula.ac.th.

APPENDIX B

Informed Consent Form

Address …………………………………………

Date……………………………………..

Code number of participant ……………………………………………………….

I who have signed here below agree to participate in this research project.

Title: "*Respiratory symptom and illness prevalence in relation to biomass fuel use in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar*"

Principle researcher's name: Moe Myint Theingi Tun

Contact address: 521/3-4 Soi Sriayuthaya 2-4, Sriayuthaya Road, Payathai District, Rajthavee, Bangkok,Thailand

Telephone: +66(0)803152316

I have **(read or been informed)** about rationale and objective(s) of the project, what I will be engaged with in details, risk/harm and benefit of this project. The researcher has explained to me and I **clearly understand with satisfaction.**

I willingly **agree** to participate in this project and allow the researcher to ask a series of questions in this structured face to face interview which covers general information, housing environmental condition, biomass fuel use, and behavioral factors and respiratory symptom and illness occurrence.

I have **the right** to withdraw from this research project at any time as I wish with no need to **give any reason**. This withdrawal **will not have any negative impact upon me** (**for instance, health care services are still received as usual**).

Researcher has guaranteed that procedure(s) acted upon me would be exactly the same as indicated in the information. Any of my personal information will be **kept confidential.** Results of the study will be reported as total picture. Any of personal information which could be able to identify me will not appear in the report.

If I am not treated as indicated in the information sheet, I can report to the Ethical Review Committee for Research Involving Human Research Subjects, Health Sciences Group, Chulalongkorn University (ECCU). Institute Building 2, 4 Floor, Soi

Chulalongkorn 62, Phyat hai Rd., Bangkok 10330, Thailand, Tel: 0-2218-8147 Fax: 0-2218-8147 E-mail: eccu@chula.ac.th,

I also have received a copy of information sheet and informed consent form.

Sign …………………..……………

(…..Moe Myint Theingi Tun…..)

Researcher

Sign …………………..……………

(……………………..………)

Participant

Sign …………………..……………

(……………………..………)

Witness

APPENDIX C
Questionnaire

Questionnaire on "Respiratory symptom and illness prevalence in relation to biomass fuel use in Chan Aye Thar Zan Township, Mandalay City, Mandalay Region, Myanmar"

Part One: Questions about general characteristics of household members

Household ID no: ____________

Interviewer ID no: ____________

1. Name, Age and Gender of each household member. List the respondent first.

No.	Position in household	Name	Age	Gender
	Mother			
	Father			
	Child < 5			
	Child < 5			
	Child < 5			
	Child < 5			
	Child < 5			

2. Apart from the people listed in the table above, how many other total people live in this household?

    ________________________ people

3. Total number of people currently living in this household (add number in the table to the number in the previous question)

____

4. Total number of children under 5 living in this household

____

5. Marital status of the respondent

1. [ ] married
2. [ ] divorced
3. [ ] separated
4. [ ] widowed
5. [ ] Others ___________________

6. How many years have you lived in this home?

__________________ years

7. Education status of the respondent:

1. [ ] no formal education
2. [ ] primary education
3. [ ] secondary education
4. [ ] high school level
5. [ ] high school level
6. [ ] others (specify) ___________________

8. What is your current main occupation? [Please choose one from the following]

1. [ ] Gazette government officer
2. [ ] Daily paid government servant
3. [ ] Teacher
4. [ ] Industrial worker
5. [ ] Office staff at private sector
6. [ ] Professional (e.g., doctor, engineer)
7. [ ] Daily paid worker
8. [ ] Farmer or Agricultural worker

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

1. [ ] Yes 2. [ ] No

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

____

10. Have you currently or ever been exposed to gas or chemical fumes in your work outside the home?

1. [ ] Yes 2. [ ] No

If "Yes", please specify job / industry?

____

11. Do you currently smoke?

1. [ ] Yes 2. [ ] No

If "Yes", how many cigarettes or cigars smoked per day at home? (Can respond as average if no accurate number can be mentioned)

1. [ ] Less than 5 cigarettes or cigars
2. [ ] 5 to 9 cigarettes or cigars
3. [ ] 10 to 19 cigarettes or cigars
4. [ ] 20 or more cigarettes or cigars

12. How many years has your husband lived in this home?

__________________ years

13. Education status of the husband of the respondent:

1. [ ] no formal education
2. [ ] primary education
3. [ ] secondary education
4. [ ] high school level
5. [ ] high school level
6. [ ] others (specify) ____________________

14. What is your husband current main occupation? [Please choose one from the following]

1. [ ] Gazette government officer
2. [ ] Daily paid government servant
3. [ ] Teacher
4. [ ] Industrial worker
5. [ ] Office staff at private sector
6. [ ] Professional (e.g., doctor, engineer)
7. [ ] Daily paid worker
8. [ ] Farmer or Agricultural worker

15. Have your husband currently or ever worked in any dusty job for a year or more?

1. [ ] Yes
2. [ ] No

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

____

16. Have your husband currently or ever been exposed to gas or chemical fumes in your work?

1. [ ] Yes
2. [ ] No

If "Yes", please specify job / industry?

____

17. Does your husband currently smoke?

1. [ ] Yes
2. [ ] No

If "Yes", how many cigarettes or cigars smoked per day at home? (Can respond as average if no accurate number can be mentioned)

1. [ ] Less than 5 cigarettes or cigars

2. [ ] 5 to 9 cigarettes or cigars
3. [ ] 10 to 19 cigarettes or cigars
4. [ ] 20 or more cigarettes or cigars

18. What is your average monthly household income (in Kyats)?
    1. [ ] below 50,000
    2. [ ] 50,000 - 99,999
    3. [ ] 10,0000 – 14,9999
    4. [ ] 15,0000 and above

Part Two: Questions about household environmental condition

I. *Obervation questions*

19. Type of housing currently living in
    1. [ ] Pucca type
    2. [ ] Semi-pucca type
    3. [ ] Wooden type
    4. [ ] Bamboo type
    5. Others (Please specify) ________________________

20. How many floors does your house have?
    1. [ ] One
    2. [ ] Two
    3. [ ] More than two

21. Where is the kitchen located? (May check more than one)
    1. [ ] Indoor
    2. [ ] Outdoor

    A. If the kitchen is indoor, does the kitchen is separated with wall or other partition from the main living room?
    1. [ ] Yes

2. [ ] No

II. *Asked questions*

22. Do you usually cook indoors or outdoors? (Please choose only one)

1. [ ] Indoors
2. [ ] Outdoors

23. On the average, how many meals were cooked in your household each week? (Check only one)

1. [ ] 10 or less
2. [ ] 11- 15
3. [ ] 16 or more

24. What is the main fuel do you use for cooking? (Please choose only one answer)

1. [ ] Wood
2. [ ] Dung
3. [ ] Charcoal fuel
4. [ ] Coal
5. [ ] Gas
6. [ ] Electricity
7. [ ] Others
   Please specify______

25. What other types of fuel do you use for cooking? (May choose more than one answer)

1. [ ] Wood
2. [ ] Dung
3. [ ] Charcoal fuel
4. [ ] Coal
5. [ ] Gas
6. [ ] Electricity
7. [ ] Others
   Please specify______

If you choose gas, electricity or others, please skip to question 30.

26. If you ever use wood, how often do you use it/ them per month?

1. [ ] less than ten days per month
2. [ ] ten to twenty days per month
3. [ ] 21 to 25 days per month
4. [ ] more than 25 days per month

27. If you ever use dung, how often do you use it per month?

1. [ ] less than ten days per month
2. [ ] ten to twenty days per month
3. [ ] 21 to 25 days per month
4. [ ] more than 25 days per month

28. If you ever use charcoal, how often do use it per month?

1. [ ] less than ten days per month
2. [ ] ten to twenty days per month
3. [ ] 21 to 25 days per month
4. [ ] more than 25 days per month

29. If you ever use coal, how often do use it per month?

1. [ ] less than ten days per month
2. [ ] ten to twenty days per month
3. [ ] 21 to 25 days per month
4. [ ] more than 25 days per month

30. Is the home's door usually open during cooking?

1. [ ] Yes 2. [ ] No

31. Are windows usually open during cooking?

1. [ ] Yes 2. [ ] No

32. How smoky does the inside of the home become during cooking?

1. [ ] Not smoky at all
2. [ ] A little smoky
3. [ ] Somewhat smoky
4. [ ] Very smoky

33. During cooking, how often do you get eye irritation? (For the mother only)

1. [ ] Never
2. [ ] seldom
3. [ ] Sometimes (10%- 50% of the time)

4. [ ] Often (more than 50% of the time)

34. Does your family use mosquito coil or any traditional mosquito repellent which produce smoke (e.g. burning dried orange peel or turmeric)?

1. [ ] Yes 2. [ ] No

If "Yes", how often does your family use above mentioned mosquito repellent per month?

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

35. Does your family use incense stick?

1. [ ] Yes 2. [ ] No

If "Yes", how often does your family use in one month?

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

Part Three: Questions about respiratory problems of mother and father (Ask these questions separately for the mother and father)

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

1. [ ] Yes 2. [ ] No

37. When you do not have a cold, do you usually have a cough?

1. [ ] Yes 2. [ ] No

A. If “Yes” to 36 or 37, you cough like this for about how many months per year?

1. [ ] Less than 1 month
2. [ ] 1 month to 2 months
3. [ ] 3 months or more

B. If “Yes” to 36 or 37, for about how many years have you coughed like this?

1. [ ] 0 or 1 year
2. [ ] 2 years or more

38. When you have a cold, do you usually bring up phlegm or mucus from your chest? (Do not count phlegm or mucus from your nose or throat)

1. [ ] Yes   2. [ ] No

39. When you do not have a cold, do you usually bring up phlegm or mucus from your chest? (Do not count phlegm or mucus from your nose or throat)

1. [ ] Yes   2. [ ] No

A. If “Yes” to 38 or 39, you bring up phlegm like this for about how many months per year?

1. [ ] Less than 1 month
2. [ ] 1 to 2 months
3. [ ] 3 months or more

B. If “Yes” to 38 or 39, for about how many years have you brought up phlegm like this?

1. [ ] 0 or 1 year
2. [ ] 2 years or more

40. Have you ever had wheezing or whistling in your chest? (May check more than one)

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

A. If “Yes” to 40, have you ever had an attack of wheezing that made you feel shortness of breath? (May check more than one)

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

B. If “Yes” to 40 A, have you ever taken medicine to help make your breathing easier? (May check more than one)

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

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

1. [ ] Yes   2. [ ] No

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

1. [ ] Yes   2. [ ] No

43. About how many respiratory colds have you had in the past year? (Count only colds with cough. Each parent should check only one answer)

1. [ ] No colds
2. [ ] 1 or 2 colds
3. [ ] 3 colds or more

44. Have a doctor ever told you that you have any of the following illnesses?

CONDITION	MOTHER				FATHER			
	Ever diagnosed by a doctor?		Do you have this illness now?		Ever diagnosed by a doctor?		Do you have this illness now?	
	Yes	No	Yes	No	Yes	No	Yes	No
Asthma								
Chronic bronchitis								
Tuberculosis								

Part Four: Questions about respiratory problems of under five years old child.

Ask these questions for each child under 5 years old.

Household ID no: ____________________

Child's number within household ____________________

Child's name ____________________

Child's gender ____________________

Child's age ____________________

45. How many years has your child lived in this home?

_________________ years

46. When this child has a cold, does he/ she usually have a cough?

1. [ ] Yes 2. [ ] No

47. When this child does not have a cold, does he/ she usually have a cough?

1. [ ] Yes 2. [ ] No

A. If "Yes" to 46 or 47, he/ she coughs like this for about how many months each year? Check only one.

1. [ ] Less than 1 month
2. [ ] 1 to 2 months
3. [ ] 3 months or more

B. If "Yes" to 46 or 47, for how many years has he/ she coughed like this?

__________________ Years

48. When this child has a cold, does he/ she usually bring up phlegm or mucus from his/ her chest? (Do not count phlegm or mucus from the nose or throat)

1. [ ] Yes 2. [ ] No

49. When this child does not have a cold, does he/ she usually bring up phlegm or mucus from his/ her chest? (Do not count phlegm or mucus from the nose or throat)

1. [ ] Yes 2. [ ] No

A. If "Yes" to 48 or 49, he/ she brings up phlegm like this for about how many months each year? Check only one.

1. [ ] Less than 1 month
2. [ ] 1 to 2 months
3. [ ] 3 months or more

B. If "Yes" to 48 or 49, for how many years he/ she has brought up phlegm like this?

__________________ Years

50. Has this child's chest ever sounded wheezy or whistling? You may check more than one "Yes".

a. When he/ she has had a cold?

1. [ ] Yes 2. [ ] No

b. When he/ she does not have a cold?

1. [ ] Yes 2. [ ] No

c. On most days or most nights?

1. [ ] Yes 2. [ ] No

A. If "Yes" to question 50 a, b or c, please answer the followings.

a. For how many years has this child had wheezing or whistling in his chest?

____________________ Years

b. Has he/ she ever required medicine or treatment by a doctor for wheezing?

1. [ ] Yes   2. [ ] No

c. Has this child had wheezing in the past 12 months?

1. [ ] Yes   2. [ ] No

51. About how many respiratory colds has this child had in the past year? (Count only colds with cough. Please check only one answer)

1. [ ] No colds
2. [ ] 1 or 2 colds
3. [ ] 3 colds or more

52. This question refers only to medical doctors that have been diagnosed in the child by a doctor. For each disorder listed in the table below, please check whether a doctor has ever said that the child had the disorder, and whether the child has had the disorder within the past 12 months.

Illness	Has a doctor ever diagnosed this illness in the child? Check 'Yes' or 'No'.		Has the child had this illness in the past year? Check 'Yes' or 'No'.	
	Yes	No	Yes	No
Asthma				
Bronchitis				
Pneumonia				
Tuberculosis				

APPENDIX D

BUDGET

No	Activities	Unit Price (THB)	Quantity	Total (THB)
1	**Pretesting** Photocopy	20	30 sets	600
2	**Data collection** Photocopy Quest.	20	500 sets	10,000
	Interviewers per diem	200	10 x 10 D	20,000
	Transportation cost	12,000	1 trips	12,000
3	**Document printing** Paper + printing	4	900 pages	3,600
	Photocopy (exam + final submit)	0.5	12 x 400 pages	2,400
	Stationary	500	1 set	500
	Binding Paper (exam)	150	7 set	1,050
	Binding Paper (submit)	150	7 set	1,050
Total				**51,200**

APPENDIX E

TIME SCHEDULE

No	Activity	2011					2012					
		Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1.	Literature Review	■	■	■								
2.	Formulation of proposal				■							
3.	Ethical approval					■	■					
4.	Go to the field							■				
5.	Collection of data							■	■			
6.	Analysis of data								■	■		
7.	Thesis and report writing										■	■

VITAE

PERSONAL DETAILS

Full name: Moe Myint Theingi Tun

Address: Permanent: 35th street between 76th & 77th street, Mandalay, Myanmar
Local address: 521/3-4 Soi Sriayuthaya 2-4, Sriayuthaya Road,
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Mobile: +66(0)803152316

Email: moemyattheingihtun.cf@gmail.com

Nationality: Myanmar

Gender: Female

Date of Birth: August 14th, 1986

Marital status: Single

EDUCATION

- June 2011to date: Graduate student at College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand.
- 2002-2008: University of Medicine, Mandalay, Myanmar: M.B.,B.S

LANGUAGE:

Myanmar : Speaking, writing and understanding-Excellent

English : Speaking, writing and understanding-Good

EMPLOYMENT HISTORY

July 2009 – May 2011: Medical officer in private hospital in Mandalay, Myanmar