PREVALENCE AND FACTORS ASSOCIATED WITH RESPIRATORY SYMPTOMS AND PULMONARY FUNCTION AMONG SOLID WASTE COLLECTORS OF BANGKOK METROPOLITAN ADMINISTRATION

LADDAWAN DOKKAEW

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ABSTRACT

Solid waste collectors are potentially exposed to various health hazards, which might have an effect on the respiratory system. This cross-sectional study aimed to measure the prevalence and determine the factors associated with respiratory symptoms and pulmonary function among solid waste collectors of the Bangkok Metropolitan Administration (BMA) in the Pathumwan district of Bangkok, Thailand. Among 160 workers aged 19-59 years, who had worked at least 6 months, completed the interview-guided questionnaire and pulmonary function test from November to December, 2014.

Overall, the prevalence of respiratory symptoms among solid waste collectors was 40.0% and the prevalence of abnormal pulmonary function among solid waste collectors was 31.9%. The major health risk factors were that they did not use respiratory protective equipment, smoking, working every day, and working at night.

The study result indicated that three variables were significantly associated with respiratory symptoms: living conditions, past respiratory conditions, and cigarette smoking (p-value < 0.05). There was a significant association between the uses of respiratory protective equipment every day and respiratory symptoms (p-value near 0.05). Multivariate analysis indicated that after controlling the covariates effect, the risk for respiratory symptoms among workers who lived near industrial factory was 5.63 times of that workers did not live near industrial factory (Adjusted odds ratio = 5.63, 95% CI 1.42 - 22.35). Two variables were significantly associated with abnormal pulmonary function: duration of work and age (p-value < 0.05). There was a significant association between the living conditions and abnormal pulmonary function (p-value near 0.05). Multivariate analysis indicated that after controlling the covariates effect, the trend was that the risk for abnormal pulmonary function among workers who worked ≥ 20 years was 2.19 times of that solid waste collectors who worked less than 20 years (Adjusted odds ratio = 2.19, 95% CI 0.94 – 5.08).

Recommendations include that the BMA should provide personal protective equipment, health promotion, and improve the strategy of solid waste collection.

KEY WORDS: WASTE COLLECTOR / RESPIRATORY/ PULMONARY FUNCTION

144 pages

ความชุกและปัจจัยที่มีความสัมพันธ์กับอาการระบบทางเดินหายใจและสมรรถภาพปอดในกลุ่มพนักงานเก็บขนขยะของกรุงเทพมหานคร

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บทคัดย่อ

พนักงานเก็บขนขยะมีโอกาสสัมผัสกับสิ่งคุกคามสุขภาพหลากหลายซึ่งอาจมีผลกระทบต่อระบบทางเดินหายใจ การศึกษาภาคตัดขวางนี้มีวัตถุประสงค์เพื่อวัดความชุกและหาปัจจัยที่มีความสัมพันธ์กับอาการระบบทางเดินหายใจและสมรรถภาพปอดในกลุ่มพนักงานเก็บขนขยะของกรุงเทพมหานคร ในเขตปทุมวัน กรุงเทพมหานคร ประเทศไทย พนักงานทั้งหมด 160 คน อายุ 19 - 59 ปี ทำงานเก็บขนขยะมาแล้วอย่างน้อย 6 เดือน สัมภาษณ์ด้วยแบบสอบถามและตรวจสมรรถภาพปอดระหว่างเดือนพฤศจิกายน – ธันวาคม 2557

ผลการศึกษาพบว่า กลุ่มพนักงานเก็บขนขยะมีความชุกของอาการระบบทางเดินหายใจ ร้อยละ 40.0 และความชุกของผลการตรวจสมรรถภาพปอดผิดปกติ ร้อยละ 31.9 ปัจจัยเสี่ยงต่อสุขภาพที่สำคัญ ได้แก่ การไม่ใส่อุปกรณ์ป้องกันอันตรายส่วนบุคคลขณะปฏิบัติงาน การสูบบุหรี่ ทำงานทุกวัน และทำงานช่วงเวลากลางคืน

การวิเคราะห์ความสัมพันธ์พบว่า ปัจจัยที่มีความสัมพันธ์กับอาการระบบทางเดินหายใจอย่างมีนัยสำคัญทางสถิติ คือ สภาพแวดล้อมที่อยู่อาศัย การเจ็บป่วยเกี่ยวกับระบบทางเดินหายใจในอดีต และการสูบบุหรี่ การใช้อุปกรณ์ป้องกันอันตรายเป็นประจำมีแนวโน้มว่ามีความสัมพันธ์กับอาการระบบทางเดินหายใจ และเมื่อวิเคราะห์แบบพหุตัวแปรโดยควบคุมตัวแปรร่วมอื่นๆพบว่า สภาพแวดล้อมที่อยู่อาศัย ยังคงเป็นปัจจัยที่มีความสัมพันธ์กับอาการระบบทางเดินหายใจ (Adjusted odds ratio = 5.63, 95% CI 1.419-22.35) ปัจจัยที่มีความสัมพันธ์กับความผิดปกติของสมรรถภาพปอดอย่างมีนัยสำคัญทางสถิติ คือ อายุ และระยะเวลาการทำงาน สำหรับปัจจัยสภาพแวดล้อมที่อยู่อาศัยก็มีแนวโน้มว่าจะมีความสัมพันธ์กับความผิดปกติของสมรรถภาพปอด และเมื่อวิเคราะห์แบบพหุตัวแปรโดยควบคุมตัวแปรร่วมอื่นๆพบว่า ระยะเวลาการทำงานมีแนวโน้มว่ามีความสัมพันธ์กับความผิดปกติของสมรรถภาพปอด โดยกลุ่มที่ทำงานตั้งแต่ 20 ปีขึ้นไปมีโอกาสเสี่ยงต่อการเกิดความผิดปกติของสมรรถภาพปอด 2.19 เท่าเมื่อเทียบกับกลุ่มที่ทำงานน้อยกว่า 20 ปี (Adjusted odds ratio = 2.19, 95% CI 0.94-5.08)

ข้อเสนอแนะจากการศึกษาครั้งนี้คือ กรุงเทพมหานครควรจัดอุปกรณ์ป้องกันอันตรายส่วนบุคคลให้แก่พนักงานทุกคน จัดโปรแกรมส่งเสริมสุขภาพ รวมทั้งพิจารณาปรับกลยุทธ์ในการจัดเก็บขยะเพื่อความปลอดภัยและสุขภาพที่ดีของพนักงาน

144 หน้า

CONTENTS

CONTENTS(cont.)

LIST OF TABLES

LIST OF TABLES (cont.)

LIST OF FIGURES

CHAPTER I
INTRODUCTION

1.1 Background and Rationale

The growth of both the economy and industry, the expansion of the urban community, as well as the increase in population, cause environmental problem including waste problem increased, affect the quality of life and the environment, especially in urban areas such as Bangkok in Thailand. Bangkok is the capital city. It is the center of economy, transportation, industry, commerce and education. Bangkok has become an important source of environmental pollution. Bangkok has expanded continuously and Bangkok produces solid waste that the largest amount of municipal solid waste of the country. During 2007 - 2011, the Bangkok Metropolitan Administration (BMA) had collected stable at around 8,700-8,900 tons per day of municipal solid waste. In 2012, the amount of solid waste had increased to 9,700 tons per day because of the big flood that occurred in Bangkok at the end of 2011. In 2013, Bangkok produces equivalent to 16% of total waste of the country (1, 2). The amount of solid waste trended to increase as the rate of population increased and the growth of economy, adding to the problem of landfill which may be limited in the future, solid waste was the major environmental problem (3, 4).

In Bangkok, municipal solid waste is collected by the Bangkok Metropolitan Administration (BMA) from the receptacles in front of houses, buildings, or designated locations on the specific dates and times. BMA can efficiently collect the solid waste cover all 50 districts areas. BMA collected general waste and household hazardous waste. Solid waste composition in Bangkok was 3 types: 1) Waste for composting 2) Waste for recycling process and 3) Waste of landfill process. Municipal solid waste management of BMA used many resources: In 2007, number of employees consist 9,117 sweepers, 7,682 waste collectors and 2,636 truck drivers (1, 3).

The municipal solid waste generated by domestics, markets, businesses, shops, offices, institutions and other activities in the community, including construction and demolition debris, branched-leaves and other waste collected from community streets. Typically, the materials were discarded in the form of solid waste is a waste of both organic and inorganic waste. Some of these wastes can spoilage or digested by microorganisms in a short time, which can be composting, such as food waste, leaves, fruit peels. But some of it may be difficult or impossible to decompose biodegradable such as foam, plastic, etc., which mainly solid waste is contaminated and can't be used to advantage (5-7). If solid waste managed improperly, it affects public health and environment, in addition to waste had smell/bad odor, some type of waste may be had pathogens and chemical contaminants or residues, which could cause injury and illness from exposure its. The workers implemented solid waste collection, they risk to potential health hazard, due to often directly expose to the waste for a long time, and the most did not wear personal protective equipment. The waste to become hazardous to a worker's health, it must first contact the body and the waste must have some biological effect on the body. There are major routes: inhalation (breathing), skin contact, the digestive system (ingestion or eating). Breathing of contaminated air is the most common way. Some chemicals such as lead and pesticides, when contacted, can pass through the skin into the blood stream. Ingestion may be swallowed accidentally if food or cigarettes (or hands) are contaminated (8, 9).

The workers implemented solid waste collection that responsible to collected municipal solid waste from houses, resident buildings, markets, public places, commercial places, educational institutions, etc. The most of municipal solid waste was mixed wastes (unseparated waste at the sources) and management of hazardous waste remains ineffective as communities fail to cooperate on separation (3). The municipal solid waste collection was a hard job, the workers implemented solid waste collection every day both in the daytime and nighttime, which involves working on a truck that moves through traffic, the manual lifting and handing of heavy bins about 100 – 200 litters, including sorting the wastes. Municipal solid collectors expose to variety of risk factors or health hazards, both the hazards in wastes and environmental conditions include chemical hazards, biological hazards and physical hazard such as chemical from the waste itself and its decomposition, dust (organic and inorganic dust),

bioaerosols, pathogens (bacteria, viruses, fungi, etc.), toxic substances (beta-glucans and endotoxins), as well as fume and smoke generate from vehicles exhaust and noise. These hazards may have effect of the respiratory system or health problems such as respiratory symptoms (cough, phlegm, itching nose, wheeze, chest tightness and breathlessness), asthma and chronic bronchitis (10-14).

Several previous studies, the results suggested that the collection of solid and compostable waste were associated with biological hazards, exposed to bioaerosols such as airborne bacteria and fungi (11). The household waste collectors who collected compostable can be exposed to airborne (1→3)-β-D-glucan, especially during the warm season and there was association between exposure level of (1→3)-β-D-glucan and outdoor temperature (15). In addition, exposures to bioaerosols in environment of workplace are associated with health effects, with major public health impact including infectious diseases, allergies, acute toxic effects and cancer. The most widely studies were lung function impairment and respiratory symptoms and probably among the most important bioaerosol- associated health effects (16). The moderate exposure to fungal spore, (1→3)-β-D-glucan, and endotoxins during waste handling can induced upper airway inflammation dominated by swelling of nasal mucosa and neutrophil infiltration (17). The household waste collectors showed signs of increasing respiratory symptoms and upper airway inflammation compared with controls, the certain dust from household may cause airway inflammation and general respiratory symptoms, and the effects were associated with higher (1→3)-β-D-glucan levels, suggested that the household waste collectors were exposed to microbial agents (18, 19). The prevalence of respiratory symptoms and abnormal lung function were higher among municipal solid waste or garbage collectors than control/comparable groups (garden workers, office workers), these was likely to be attributed to the occupation exposure of solid waste collectors to workplace contaminant, dust, vehicle exhaust and bioaerosols (20-22).

There were studies of health status among municipal solid waste collectors in Thailand. The results indicated that solid waste collectors had occupational health problems include respiratory symptoms, musculoskeletal disorders and occupational injuries such as fever, influenza-like symptom and back pain, and there was association between health status and occupational factors and personal factors (23-26).

The report of studies in other countries indicated that solid waste or garbage collectors had exposure to occupational health hazards with health impact including respiratory problems. However, the degree of the problem in each country might have different (27).

There were few reports in Thailand that surveyed health status, health behaviors and occupational health effects among waste collectors, but there were not report in study especially respiratory symptoms and abnormality of pulmonary function among solid waste collectors. The study in differently areas might have differently prevalence of respiratory symptoms and abnormal pulmonary function, due to several factors including personal characteristic factors, occupational factors and environmental factors as well as ambient air pollution.

Especially in Bangkok, which is the city center with a diverse economy, education, tourism and transport have caused environmental problems. Air pollution was one of the major environmental issues in Bangkok due to rapid growth in number of vehicles. It causes direct environmental impacts and serious effects on public health. Air pollution consists of dust and hazardous gases which cause illness, including cancer, respiratory failure. Respiratory illnesses are caused by particulate matters of less than 10 microns in diameter (PM_{10}) from emission of vehicles with incomplete combustion, industrial factories or other establishments. Air pollution was more severe in roadside areas than other areas. Particulate matter and volatile organic compounds exceeded the standard in Bangkok continuously for 10 years (2003-2013). In 2013, particulate matter in other areas of country was declining, but increased in Bangkok due to the increasing number of vehicles and traffic jams. The Pathumwan district is one of Bangkok and this district was one of 5 areas that had the highest PM_{10} of the country, including high amount of solid waste (1, 2, 28).

Therefore, the researcher was interested to study of prevalence and factors associated with respiratory symptom and pulmonary function among solid waste collectors of the Bangkok Metropolitan Administration. The results of this study will be used to propose guideline for improve operation procedure of worker, prevention of respiratory illness, health surveillance, and health intervention programs, as well as providing occupational health care for the health and safety of employees further.

1.2 Research objectives

1.2.1 General objective

To study of prevalence and factors associated with respiratory symptom and pulmonary function among solid waste collectors of Bangkok Metropolitan Administration.

1.2.2 Specific objectives

1.2.2.1 To assess the general characteristics, occupational factors and health factors among solid waste collectors of the Bangkok Metropolitan Administration.

1.2.2.2 To measure the prevalence of respiratory symptom and pulmonary function among solid waste collectors of the Bangkok Metropolitan Administration.

1.2.2.3 To identify association between general characteristics, occupational factors, health factors, respiratory symptoms and pulmonary function among solid waste collectors of the Bangkok Metropolitan Administration.

1.3 Hypotheses

The hypotheses for this study were:

1.3.1 There are associations between general characteristics i.e. age, body mass index, living condition, family history and respiratory symptoms among solid waste collectors

1.3.2 There are associations between health factors i.e. past respiratory conditions, cigarette smoking, exercise, alcohol drinking, use of personal protective equipment and respiratory symptoms among solid waste collectors.

1.3.3 There are associations between occupational factors i.e. position, duration of work, working period, second job/occupation, previous occupation and respiratory symptoms among solid waste collectors.

1.3.4 There are associations between general characteristics i.e. age, body mass index, living condition, family history and pulmonary function among solid waste collectors

1.3.5 There are associations between health factors i.e. past respiratory conditions, cigarette smoking, exercise, alcohol drinking, use of personal protective equipment and pulmonary function among solid waste collectors.

1.3.6 There are associations between occupational factors i.e. position, duration of work, working period, second job/occupation, previous occupation and pulmonary function among solid waste collectors.

1.4 Variables

1.4.1 Independent variables

Independent variables for this study were:

1.4.1.1 General characteristics i.e. age, body mass index, living condition and family history

1.4.1.2 Health factors i.e. past respiratory conditions, cigarette smoking, exercise, alcohol drinking and use of personal protective equipment

1.4.1.3 Occupational factors i.e. position, duration of work, working period, second job/occupation and previous occupation

1.4.2 Dependent variables

Dependent variables for this study were:

1.4.2.1 Respiratory symptoms

1.4.2.2 Pulmonary function

1.5 Scope of this study

This study was a cross-sectional study, which study of prevalence and factors associated with respiratory symptom and pulmonary function among workers who implemented solid waste collection of the Bangkok Metropolitan Administration.

1.6 Initial agreement

The interpretation of pulmonary function test was comparisons of data measured with reference (predicted) values based on health subjects, predicted values are computed with Siriraj equation.

1.7 Conceptual framework

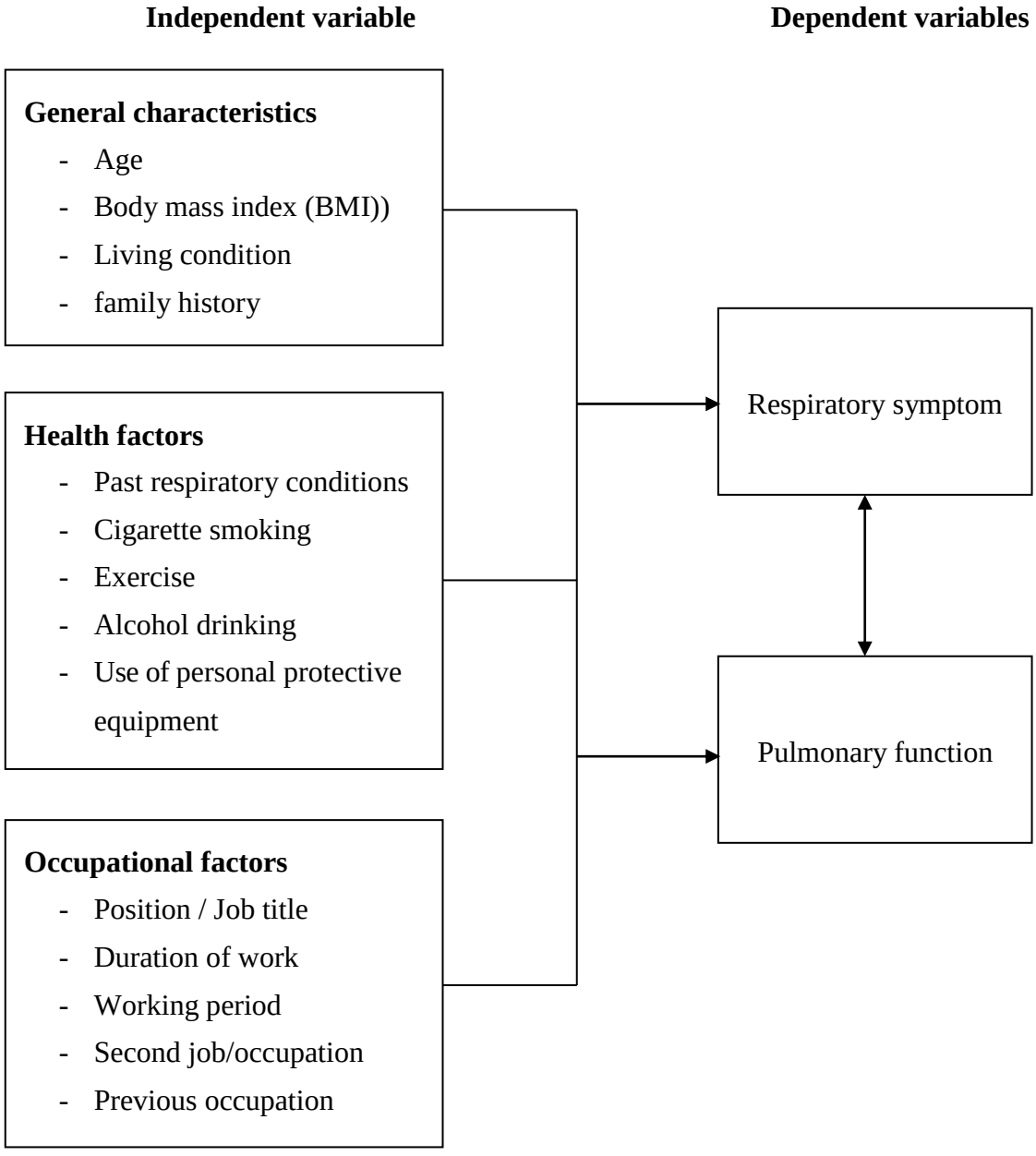


Figure 1-1 Conceptual framework of factors affecting respiratory and pulmonary function

Figure 1-1 shows the factors from literature, which appear to affect respiratory symptoms and pulmonary function including general characteristics, health factors and occupational factors. These factors are assumed to affect respiratory symptoms and pulmonary function.

1.8 Operational definitions

Solid waste collector means the workers or employees who implemented solid waste collection of the Bangkok Metropolitan Administration.

Bangkok Metropolitan Administration (BMA) is the local government organization to be responsible for the management of the city of Bangkok, Thailand.

Prevalence is computed from the number of cases divided by the number of workers in study.

General characteristics are age, body mass index, living condition and family history.

- **Age** refer to the age of an employee/worker

- **Body mass index (BMI)** is computed from information of weight (kilograms) and height (meters) as below formula:

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height}^2\ (\text{m}^2)}$$

- **Living condition** refers to house or resident place of workers near industrial factories or air pollution sources, or not.

- **Family history** refer to the natural parent have respiratory condition natural parents had respiratory diseases/chronic lung condition such as chronic bronchitis, asthma, allergy, other lung disease, or not.

Health factors are past respiratory conditions, cigarette smoking, exercise, alcohol drinking and use of personal protective equipment.

- **Past respiratory conditions** refer to workers had respiratory conditions such as bronchitis, asthma, pneumonia, allergy, etc., or not.

- **Cigarette smoking**: smoker is defined as a person who has smoked at least 1 cigarette per day for at least 1 year.

- **Exercise refer** to the physical exercise such as jogging, aerobic, walking that move the body at least 30 minutes for each time.

- **Alcohol drinking:** drinker is defined as a person who current drinker or former drinker.

- **Use of personal protective equipment** refers to use to personal protective measures such as used mask to respiratory protection ever day while working.

Occupational factors are position, duration of work, working period, second job/occupation, and previous occupation.

- **Position or Job title** refers to the current position or job title of workers who implemented solid waste collection of Bangkok Metropolitan Administration.

- **Duration of work** refer to period of work in current organization

- **Working period** refer to working according to schedules that set by employers or organization.

- **Second occupation** refer to second job in addition to major occupation (solid waste collection), worker has other occupation or part time job.

- **Previous occupation** refer to in the past, workers have ever worked in the industrial factories or other organization.

Respiratory symptoms were cough, phlegm, wheezing and breathlessness.

- **Present respiratory symptom** refers to have one or more than one symptom in these respiratory symptoms: cough, phlegm, wheezing and/or breathlessness).

- **Absent respiratory symptom** refers to absence any symptom in those respiratory symptoms.

Pulmonary function is the performance of the various organs in the respiratory system and breathing apparatus including the inhalation and exhalation, the main function is gas exchange. If there is abnormality of pulmonary function, it affects the respiratory system.

Abnormalities of pulmonary function are obstructive abnormalities, restrictive abnormalities and mixed abnormalities (the coexistence of obstruction and restriction).

- Abnormal pulmonary function means any abnormalities of pulmonary function (obstructive abnormalities or restrictive abnormalities or mixed abnormalities).

- Normal pulmonary function means to not any abnormalities of pulmonary function.

Pulmonary function test in this study is spirometry method: spirometry is a physiological test that measures how an individual inhales or exhales volumes of air as a function of time. The primary signal measured in spirometry may be volume or flow:

- Forced vital capacity (FVC) is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration, i.e. vital capacity performed with a maximally forced expiratory effort, expressed in liters at body temperature and ambient pressure saturated with water vapor (BTPS).

- Forced expiratory volume in 1 second (FEV_1) is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration, expressed in liters at BTPS.

- FEV_1/FVC ratio is computed from Forced expiratory volume in 1 second value divided Forced vital capacity value.

CHAPTER II
LITERATURE REVIEWS

This chapter reviews the literature covering the relevant issues as follows:

1. General information of solid waste
2. Solid waste management in Bangkok
3. Situation of air pollution in Bangkok
4. Concept of disease occurrence
5. Health effects among waste collectors
6. Respiratory system
7. Respiratory disorders
8. Respiratory evaluation
9. Measure of disease (health outcomes) occurrence
10. Reviews of relevant research

2.1 General information of solid waste

2.1.1 Solid waste situation in Thailand (1-6)

The solid waste is a major environmental problem in Thailand. Solid waste generated from a variety of sources that amount increased every year. Solid waste problems are likely more intense due to the amount of solid waste trended to increase as the rate of population increased as well as the growth economy and changes in consumer habits of the people, which affect the environment and public health. Particularly, in Bangkok and the city is the center of civilization in the region. In 2013, the nationwide survey by the Pollution Control Department (PCD), target groups were municipality and Pattaya city (2,273), Sub-district administrative organizations (5,508) and BMA. Total solid waste of the country had around 2 6 . 7 7 4 million tons that Bangkok produces equivalent to 16% of total solid waste of the country (Table 2-1)

Table 2-1 The amount of solid waste in Thailand, 2013 (4)

Organization	Amount of solid waste	
	million ton	percentage
Bangkok Metropolitan Administration (BMA)	4.137	16.0
Municipality and Pattaya city (n = 2,273)	10.241	38.0
Sub-district Administrative Organization(n = 5,508)	12.396	46.0
Total (7,782)	26.774	100.0

2.1.2 Definition (5-7, 30-31)

Human activities in communities generate waste materials that are often discarded because these materials are considered useless. These wastes are normally solid, and the word "waste" suggests that the material is useless and unwanted (29).

Solid waste is defined waste in solid form, which could be mixed with a certain amount of moisture. Solid waste generated from the industrial factories, residential buildings, markets, offices, etc. The amount and characteristics of solid waste may have different as each location. Typically, objects or materials are discarded in the form “waste”, there are both organic and inorganic wastes, and some of these can be decomposed by microorganisms in a short time such as food waste vegetable crops, but some of it may not yet be biodegradable such as plastics, etc.

Solid waste or Refuse may be defined as follows: garbage, rubbish, ashes, street refuse, bulky waste, abandoned vehicles, industrial solid waste, construction and demolition waste, sewage treatment residues, dead animals, animal and agricultural waste and hazardous waste

Municipal solid waste (MSW), which can be further defined as having the following components: mixed household waste, recyclables (which may not be limited to the following: newspapers, aluminum cans, milk cartons, plastic soft drink bottles, steel cans, corrugated cardboard, other materials collected by the community), household hazardous waste, commercial waste, yard or green waste, litter and waste from community trash cans, bulky items (refrigerators, rugs, etc.) and construction and demolition waste.

2.1.3 Health hazards in solid waste (8, 9, 24, 33)

In addition to the solid waste had smell, some of these waste contaminated with pathogens and residual chemical substances, which may cause illness from exposure to these the waste. Hazard in solid waste can summarized as follows:

1) Chemical hazards

The chemical hazards both organic chemicals and inorganic chemicals such as organic solvents, benzene, toluene, heavy metal, lead, mercury, pesticides, etc.

Mercury (Hg): the batteries, broken fluorescent bulbs, broken mirror, which containing mercury. Mercury has many toxic that causes health effect. Inhalation exposure of mercury vapor or exposure to inorganic mercury salts was associated with emotional instability, neuromuscular changes, insomnia, memory loss, and headaches.

Cadmium (Cd): household hazardous waste such as the watch charcoal pellets containing cadmium. Health effects from exposure to cadmium, long term occupational exposure to cadmium was associated with adverse effects on the lung and kidney, including a possible lung cancer risk and respiratory.

Lead (Pb): hazardous waste such as old batteries, printing ink, paint, which containing lead when exposure to lead causes health effect. Lead is a neurotoxin, impacts on peripheral nerve function and neurological function. The symptoms of lead poisoning include asthenia, weakness, irritability, nausea, anaemia and abdominal pain with constipation.

Manganese (Mn): most of the manganese was found near the refuse bunker. High levels of exposure are associated with irritation and inflammation of the lungs leading to cough, bronchitis, reduced lung function and pneumonitis.

Pesticides: such as exposure to pesticides from cans containing pesticides. Pesticides poisoning cause adverse health effects include diarrhea, paralysis, vomiting and nervous system damage.

Other chemicals: spray, dye fabric paint, nail polish, nail polish remover and herbicides. These chemical cause health effects include irritating to skin, mucous membranes, respiratory tract, shortness of breath and headache, etc.

These chemicals found in hazardous waste. If not managed properly, it affect to environment and public health. The workers implemented solid waste collection, they risk to potential health hazard, due to often directly expose to the waste for a long time, and the most do not wear personal protective equipment. The waste to become hazardous to a person's health, it must first contact the body and the waste must have some biological effect on the body. There are major routes: inhalation (breathing), skin contact, digestive system (ingestion or eating). Breathing of contaminated air is the most common way. Some chemicals such as lead and pesticides, when contacted, can pass through the skin into the blood stream. Ingestion may be swallowed accidentally if food or cigarettes (or hands) are contaminated

2) Biological hazards

Biological hazard such as pathogenic organisms: leptospirosis bacteria, avian influenza, hepatitis A, etc. Infection hazards that may be encountered in the collection and sorting of solid waste and recyclables include: faeces present in nappies, incontinence pads and stoma bags, dead animal carcasses and blood borne infectious material within used needles/syringes and used condoms, etc. Exposure to infectious agents can arise as a result of sharps injuries, skin contact, inhalation, and ingestion through hand to mouth contact (such as during smoking, drinking or eating) or contact with the mucous membranes of the eye. Specific agents include tetanus associated with sharp objects, toxocarsis associated with pet faeces, leptospirosis associated with water, hepatitis A associated with ingestion of faecal material, HIV and hepatitis B associated with blood, and salmonellosis associated with ingestion of faeces or contaminated foodstuffs. Solid waste workers had higher risk of infectious diseases than the general population

3) Sharp objects:

Sharp objects such as broken glass, knives branch, scrap metal, needle and skewers with meatballs, etc. These can cause harmful or injury or illness. Especially, if sharp object contaminated with pathogens such as tetanus, hepatitis.

2.1.4 Impacts of Solid waste (9, 31, 32)

Solid wastes increasingly become recognized for its impact on public health, the environment and land use as follow:

Environmental pollution

Dumping of solid waste into rivers and piles on the floor, the landfill is not sanitary, leachate from garbage or solid waste or rain falling on a pile of garbage, sewage could flow into water sources such as rivers or seep into groundwater, these were impacts on water quality, both surface water and groundwater, the potential problem are water pollution and soil quality. As well as air pollution, some types of solid waste such as organic wastes were source of food for microorganisms and insect or disease vectors. These are degradation and generated volatile organic compounds such as hydrogen sulfide include odor problem. If managed improperly solid waste has become air pollution.

Health risk

If solid waste was managed improperly that may directly or indirectly cause adverse public health effect in communities, which risk to illness such as respiratory illness, gastrointestinal diseases, parasitic diseases and irritation of the skin, nose and eyes. Solid waste to become hazardous to a person's health, when contact the body and the solid waste must have some biological effect on the body. The major routes including inhalation, ingestion or eating and skin contact. Breathing of contaminated air is the most common way, especially ambient air or environment of workplace that contaminated with bio-organisms or bio-aerosols.

Breeding Places

Garbage or solid waste was the source of microorganism or pathogenic agent that can spread into the environment. While, animals, insects or vectors such as flies, cockroaches and rats used garbage heaps to habitats for insect breeding. These vectors associated with the disease and public health.

Other impact

In addition, nuisance, accident risk and aesthetics were impact from solid waste was improperly managed according sanitation principle.

2.2 Solid waste management in Bangkok (1, 3, 28, 34 -37)

2.2.1 General situation (1, 3)

Bangkok produces 8,500 ton per day of municipal solid waste around 3.1 million ton per year, equivalent to 24% of total municipal solid waste of the country. During 1980-1997, the amount of solid waste increased by 10% but the figure dropped to 1.52% during 2003-2007 due to Bangkok Metropolitan Administration (BMA) successful campaigns on waste reduction and source separation. In 2010 BMA had collected 8,766 tons per day of municipal solid waste on average, which was about 21% of the country's solid waste amount. During 2007-2010 the amount of collected waste has been stable at around 8,700-8,900 tons per day. In 2011, BMA had collected 8,930 tons per day of municipal solid waste on average. In 2012, the amount of solid waste has increased to 9,700 tons per day because of the big flood that occurred in Bangkok at the end of 2011. In 2013, the amount of solid waste has still increased to near 10,000 tons per day (Table 2-2)

Municipal solid waste is collected by BMA from the receptacles in front of houses, buildings, or designated locations on the specific dates and times. The solid waste is transported to solid waste disposal centers at 3 locations which are On Nut, Nong Khaem and Sai Mia. BMA can efficiently collect the solid wastes cover all 50 districts areas. The most of solid wastes are disposed in sanitary landfills (88%) at Kampang Saen District, Nakorn Pathom Province and Phanomasarakam District, Chacheongsao Province. The rest of solid wastes are treated by composting at On Nut solid waste disposal center (12%).

Solid wastes in any city have different composition based on economy, behavior, and activities. Department of Environment has analyzed waste's physical and chemical composition on annual basis from randomly sampled wastes from the three solid waste disposal centers. Solid waste composition in Bangkok is 3 types, 1) Waste for composting 2) Waste for landfill and 3) Waste for recycling process, detail showed in Table 2-3. If the solid waste can actually be utilized, it will reduce BMA's costs in solid waste management as well as extending the lifetime of sanitary landfill.

Table 2-2 Solid waste collecting in Bangkok during 2007-2013 (1, 28)

Fiscal year	solid waste (tons)	solid waste (tons per day)
2007	3,182,435	8,719
2008	3,204,700	8,780
2009	3,207,620	8,788
2010	3,199,590	8,766
2011	3,264,195	8,943
2012	3,558,020	9,748
2013	3,636,595	9,963

Table 2-3 Composition of solid waste in Bangkok during 2008-2012 Fiscal year (1)

Type/Composition	Fiscal year				
	2551	2552	2553	2554	2555
Composting process	**50.02**	**50.01**	**54.87**	**50.07**	**48.70**
Food waste	41.92	44.34	48.41	44.67	42.72
Branched and leaves	8.07	5.67	6.46	5.26	5.99
Other	0.00	0.00	0.00	0.14	0.00
Landfill process	**40.05**	**39.70**	**34.49**	**38.95**	**39.45**
Non recycle paper	10.62	10.70	6.25	10.25	12.42
Non recycle plastic	20.00	19.18	21.43	20.56	21.35
Rubber	1.93	1.95	1.40	1.50	0.83
Fabric and textile	5.31	5.52	3.99	4.17	2.83
Rock and ceramic	0.99	0.81	0.65	0.59	0.53
Bone and shell	1.21	1.54	0.76	1.88	1.48
Recycling process	**9.93**	**10.29**	**10.64**	**10.98**	**11.85**
Recycled paper	0.35	1.19	1.42	1.80	2.76
Recycled plastic	3.86	3.25	3.40	3.44	3.66
Foam	1.22	1.44	1.55	1.43	1.57
Glass	2.55	2.70	2.56	2.77	2.70
Metal	1.95	1.71	1.72	1.54	1.15

2.2.2 Waste collection and transportation (1, 3, 28)

Waste collection

The implementation can be explained as follows:

1) Schedule for solid waste collection: BMA designates location, date and time for solid waste discarding by public and the district offices determine the details according to the areas, and the main criteria are:

a. The collection on main and secondary roads and markets are performed by setting up the time for the public to place the solid waste at designated location during 08.00 p.m. - 03.00 a.m., and the solid waste shall be completed collected by 06.00 a.m.

b. Communities, small roads and lanes must be cleaned every day, and where solid waste collection trucks cannot reach, the district offices shall seek volunteers to collect the solid waste to the designated locations for the solid waste collection trucks on daily basis.

2) Waste collection by types and increased frequency of collection

a. General waste: Daily or alternate days

b. Organic waste: Daily

c. Recyclable waste: Every Sunday

d. Household hazardous waste: On 1st and 15th of the month or designated day

3) Provision of sufficient number of waste collection trucks: The most of waste collection truck is the five ton compactor, which are used for household waste collection.

4) Implementation of information technology for solid waste collection: BMA record the weight of the waste's data and the program computer would calculate the exact amount of waste that would be disposal. Moreover, the route map was also applied with GPS (Global Position System) to improve the collection efficiency.

Collection of solid waste in river or canal: the district offices are responsible for solid waste collection from households located along the canals and Environmental Department is responsible for solid waste and water weed collection in Chao Phraya River.

The solid waste collecting in Bangkok, amount of solid waste had different in each area (50 districts of Bangkok). In 2013, the top 5 districts that the highest in amount of solid waste collecting include Chatachak district, Khlong Toei district, Bang Kapi district, Watthana district and Pathuwan district (Table 2-4).

Municipal solid waste management of BMA in each year used many resources: In 2007, number of employees consist 9,117 sweepers, 7,682 solid waste collectors and 2,636 truck drivers (Table 2-5).

Table 2-4 Solid waste collecting in top 5 districts of Bangkok, 2013 (28, 34)

Districts	Solid waste (tons)	Solid waste (tons per day)
Chatachak	134,495.20	368.48
Khlong Toei	125,154.42	342.89
Bang Kapi	120,588.63	330.38
Watthana	104,557.90	286.46
Pathuwan	104,978.92	285.97

Table 2-5 Solid waste management resources (3)

Types of resource	2003	2004	2005	2006	2007
Number of trucks	2,233	2,220	2,742	2,870	2,274
Number of employees					
Truck drivers	2,629	2,362	2,927	2,587	2,636
Solid waste collectors	7,942	7,689	7,736	7,591	7,682
Sweepers	8,967	8,985	8,825	9,042	9,117
Number of volunteers (solid waste collection)	237	246	256	252	257
Budget (million Baht)	2,129.46	2,263.54	1,949.06	3,295.28	4,189.29

The solid waste collection of district offices (35-37)

Base on the same solid waste collection in each district office, this study showed the solid waste collection of Pathumwan district due to the Pathumwan district had high amount of solid waste.

Pathumwan district is one of 50 district of Bangkok, Thailand. In 2013, Pathumwan district had collected of municipal solid waste around 289 tons per day. Pathumwan district is one inner city areas of Bangkok. This district is sub-divided into 4 sub-districts (Rong Mueang, Wang Mai Pathum Wan Lumphini), and these are center of shopping, commerce, transportation, education: 17 registered communities, 64 condominiums, 13 religious places (temples, mosques, churches), 19 schools or educational institutes, 6 markets, 16 supercenters/ department stores, 924 commercial places and 1,139 food establishment/convenience stores, including other place such as hospital and government offices

The implementation of solid waste collection can be explained as follows:

1) Schedule of discard and storage of solid waste and public relations campaign in the service area to get to know the date and time on the solid waste collection.

2) Assign of route map cover service Pathumwan district areas, 58 routes and period of implementation as follow:

- Shift of normal implementation 9 pm – 5 am
- Shift of rapid implementation 5 am – 1 pm
- Shift of rapid implementation 1 pm – 9 pm

Rapid implementation referred to solid waste collection in addition from normal schedule in the main street and alley by implementation during 05.00 - 21.00 hours, which was divided into two periods. The solid waste collection of Pathumwan district office used 49 vehicles/trucks; the most of trucks were compression type 5 tons (71%).

2.2.3 Solid waste treatment and disposal (1)

The solid waste disposal process of Bangkok Metropolitan Administration (BMA) was as follows:

Municipal Solid Wastes:

1) Nongkhame waste disposal Center

The BMA has contracted a private company to transport at least 2,000 tons per day of solid waste from the Nongkhame waste disposal center to a sanitary landfill at Kamphaeng Saen district, Nakhon Pathom province. The amount of solid waste is around 3,600 tons per day. The BMA has contracted a private company to dispose of solid waste at an incinerator with a capacity of 300 tons per day at the Nongkhame waste disposal center.

2) Saimai waste disposal Center (Tha-raeng site)

The BMA has contracted the private company to transport solid waste from Tha-raeng disposal center to a sanitary landfill at Kamphaeng Saen district, Nakhon Pathom province. The amount of solid waste was around 2,300 tons per day.

3) On-nut waste disposal center.

There are two methods of waste disposal, compost and landfill. The BMA has contracted the private company to transport at least 1,800 tons per day of solid waste from the On-nut waste disposal center to a sanitary landfill at Phanom Sarakham district, Chachoengsao Province. Solid waste was wrapped in a special film that allows it to be used as sanitary landfill. The amount of solid waste was around 2,600 tons/day.

Household Hazardous Waste:

The BMA also operates a service for handling household hazardous waste such as batteries, fluorescent lamps, oil paint, drain cleaners, cosmetics, motor oil, pesticides, cleaning chemicals, etc. The BMA has a campaign to encourage people to separate household hazardous waste. On the 1^{st} and 5^{th} of the month (or any other days agreed to by district office) garbage collectors collect and transport waste to the disposal sites in Nongkhame, Saimai and On-nut. The waste is stored there and a contracted private company by the department of industrial works disposes of the waste properly.

2.3 Situation of air pollution in Bangkok (1, 2, 34)

Bangkok, which is the city center with a diverse economy, education, tourism and transport have caused environmental problems. Air pollution was one of the major environmental issues in Bangkok due to rapid growth in number of vehicles. It causes direct environmental impacts and serious effects on public health.

Air pollution consists of dust, black smoke and hazardous gases which cause illness, including lung cancer, bronchial inflammation, allergies, respiratory symptoms or disorders of respiratory system. Respiratory illnesses are caused by particulate matters of less than 10 microns in diameter (PM_{10}) from emission of vehicles with incomplete combustion, industrial factories or other establishments. In particular, particulate matters of less than 10 microns in diameter (PM_{10}) was caused by the emission of black smoke from diesel exhaust and lack of engine maintenance by the drivers.

In 2012, Bangkok has 21 automated air quality and noise level monitoring for 4 stations which are under the supervision of BMA and under the supervision of The Pollution Control Department (PCD). The analysis results from these stations showed that small particulate matter (PM10) is the major problem in Bangkok every year. The relatively minor problem of ozone exceeds the standard in some areas, total suspended particulate (TSP) occasionally exceeds the standard in some areas.

The particulate matter of less than 10 microns in diameter (PM_{10}) was the major problem in Bangkok every year, especially in the roadside areas such as:
1) Vibhavadi Rangsit Road, Chatuchak district 2) Rama 4 and Sukhumvit Road, Klong Toey district 3) Ramkhamhaeng Road, Bangkapi district 4) Rama 1 Road and Rama 4 Road, Pathumwan district, and 5) Phaholyothin Road, Bang Khen district

In 2013, the monitoring by PCD reported that particulate matter in other areas of country was declining, but increased in Bangkok. The five areas that the highest of PM_{10} of the country include 1) Saraburi Province 2) Phaholyothin Road, Chatuchak, Bangkok 3) Rama 6 Road, Ratchathewi, Bangkok 4) Mae Moh district, Lumbang Province, and 5) Rama 4 Road, Pathumwan, Bangkok.

Particulate matter and volatile organic compounds exceeded the standard in Bangkok continuously for 10 years (2003-2013).

2.4 Concept of disease occurrence

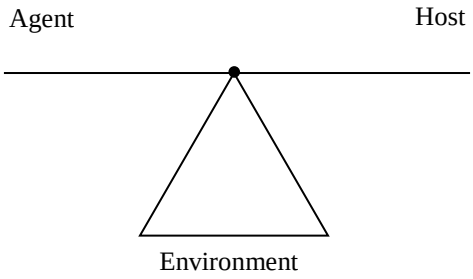
2.4.1 The epidemiological triad of cause factor

The epidemiological triad of cause factor referred to three epidemiological factors which influence associated with the disease and distribution of the disease. These three factors consist: Agent, Host and Environment.

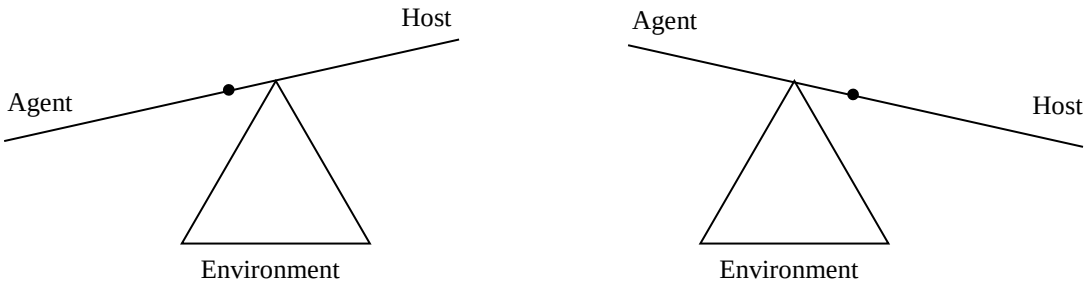
These three factors are interrelated. In normal conditions, there is balance of these three factors, it not have outbreak of disease in the community. But if there is imbalance of the three factors may due to environment, agent, or host changed, it cause of disease occurrence or outbreak of disease in the community.

Dr. John Gordon has compared the relationship among three factors; host, agent and environment as playing a fulcrum board. Host and agent in the different side of environment is the fulcrum in the center of fulcrum board. Their relationship is dividing into two types as follow:

1) In balance status of these three factors, it not have outbreak of disease in the community.



2) At imbalance status of the three factors may due to environment, agent, or host changed, it cause of disease occurrence or outbreak of disease in community.



Agent referred to factor or cause of disease, it may is “living” agent or “non-living” agent which, if found to have too much or too little, it can cause disease.

Agent originally referred to an infectious microorganism or pathogen such as bacterium, parasite, virus, other microorganism. Generally, the agent must be present for disease to occur. However, presence of that agent alone is not always sufficient to cause diseases. A variety of factors influence whether exposure to organisms will result in diseases.

Biological agent referred to organisms cause disease in human (host) such as bacteria, fungi, viruses and parasites.

Chemical agent referred to any chemicals that may be toxic to health of human (host) or cause disease such as dust, solvents, gases and vapors.

Physical agent referred to any physical causes of diseases such as heat, light, noise, vibration and radiation.

Psychosocial Agent referred to the agent caused of disease/health problem due to psychological and social factors and economic problems

Absence or insufficiency of a factor necessary to health referred to certain factors or certain nutrients necessary for survival. If those substances absent or insufficiency, it may cause disease.

Host refers to the human who can get the disease. A variety of factors intrinsic to the host, sometimes called “risk factors”, can influence an individual's exposure, susceptibility or response to a causative agent. Opportunities for exposure are often influenced by behaviors such as hygiene, sexual practices, and other personal characteristics as well as by race, age and gender. Susceptibility and response to an agent are influenced by factors include genetic composition, nutritional status and immunologic status, and anatomic structure, presence of disease or medications.

Environment refers to everything that around host (human) relationships and affect the well-being of humans, extrinsic factors that affect the agent and the opportunity for exposure. Environmental factors include biologic environment such as insects that transmit the agent, physical environment such as geology and climate, and socioeconomic environment such as crowding, sanitation, and the availability of health services.

The prevention and control diseases such as infectious diseases and non-infectious diseases, the basic knowledge about causes the disease and environment were used for disease control and prevention showed in Figure 2-1. The general principles of disease control and prevention as follow:

1) Health promotion, health education, nutrition and specific immunity to host (human)

2) Originally diagnosed and treated promptly, finding and treating disease vectors and infection source control

3) Environmental control

Prevention and control of diseases, measures and action were related with three factors include the host, agent and environment follow the example figure 2-1 to eliminate risk factors or inappropriate factor or health hazard and encourage them to have the healthy

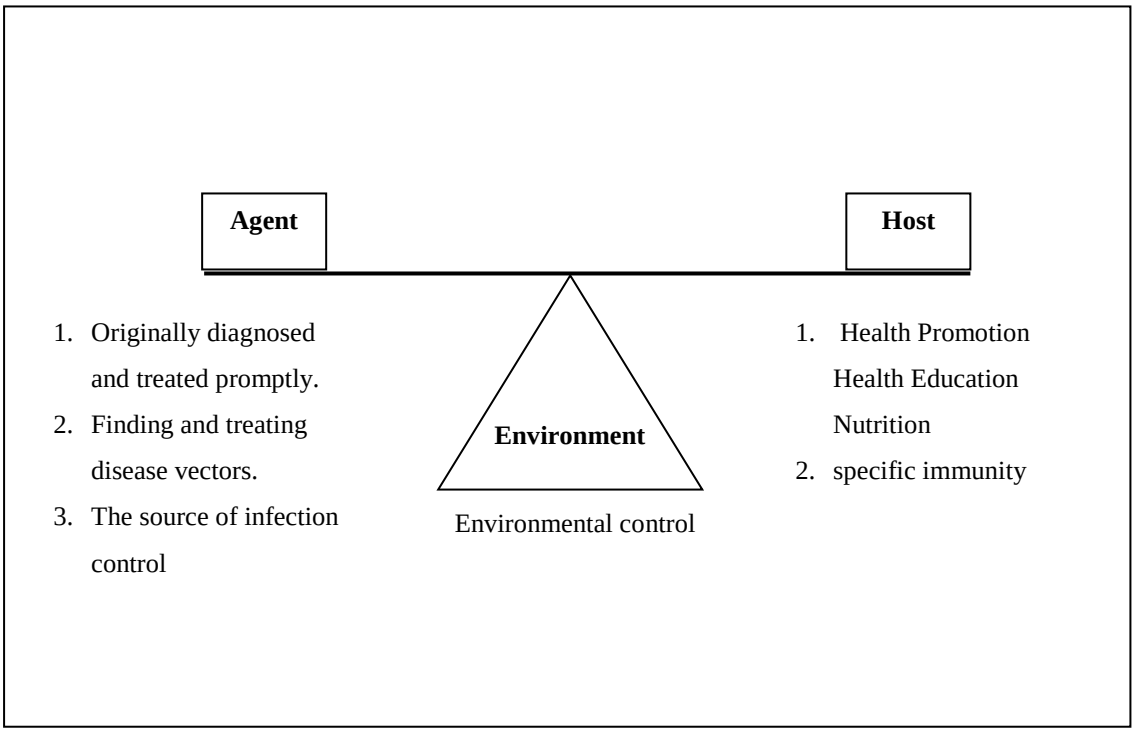


Figure 2-1 Principles of disease control and prevention

2.4.2 Cause factors of occupational disease (38-40)

Occupational disease referred to a disease or disorder that is caused by the work or working conditions or ergonomic conditions. Symptoms of disease or disorder might occur during working, after working or after the resignation or leave work.

The cause factors of occupational disease include:

Physical hazards: There are high exposure to physical hazards that were cause factor of adverse health effect such as exposure to noise, vibration, heat/extreme temperature, extreme pressure and radiation.

Chemical hazards: exposures to chemical hazards in environment of workplace, which can cause adverse health effect of workers by inhalation or contact directly to skin. Chemical hazards such as dust, solvent, fume, smoke, gases, vapors and chemical mists.

Biological hazards: biological hazards can cause illness/disease in general population as well as among workers. Biological hazards have more two hundred types include microorganism (i.e. bacteria, viruses and fungi, which cause infectious disease), arthropod, toxin, allergen and parasites.

Ergonomic hazards: ergonomic hazards are physical factors within the environment that harms to the musculoskeletal system. Ergonomic hazards include repetitive movement, manual handling, workplace, job task, work design and uncomfortable workstation height and poor body positioning.

Other factors: personal characteristics such as gender, age, health status, duration of work and individual sensitivity to disease, social and economic factors relating to person or thing that involve to disease or illness of the worker include employers, organization, colleagues, income and living condition.

2.5 Health effects among waste collectors

2.5.1 Solid waste collector (1, 10, 14)

Solid waste collection was an occupation with hard work to responsible for the collections of solid waste in communities include houses, shops, factories, markets, commercial place, institutes and public place.

The solid waste collectors may worked in daytimes and nighttime, they performed as follow a schedule of waste collection that assigned by their organization. The solid waste collector collected solid waste from the bins or receptacles in front of houses, buildings, designated locations and public place on the specific times. Then, solid waste was transported to the solid waste disposal centers.

The majority of solid waste collection consists two - four persons in one vehicle. Most of solid waste vehicle was compacter trucks.

The task of solid waste collectors are included moving or pulling or lifting solid waste bins/receptacles (around 100-200 liters) and driving the truck as route map of solid waste collection. The solid waste collection is occupation that involves vehicle which moves through traffic. In addition to, they also do the sorting the wastes.

Figure 2-2 The solid waste bins or receptacles

Figure 2-3 The solid waste collectors – lifting the bins or receptacles

Figure 2-4 The solid waste collectors –pulling the bins or receptacles

Figure 2-5 The solid waste collectors are sorting the wastes

Figure 2-6 The truck moves through traffic

2.5.2 Health hazards in the solid waste collection (10-14, 23, 33, 41, 42)

The workers who implemented solid waste collection are exposed to occupational health hazard, the risk occur at every step in process. Health hazards, which result in environmental or occupational illness, including the following:

a) Chemical health hazards, such as dust, smoke and fume arising from automobile exhaust, volatile organic substance, heavy metal and hazardous chemical. Exposure to chemical health hazards can arise as a result of skin contact, inhalation and ingestion.

b) Biological health hazards, such as pathogens (bacteria, viruses and fungi), fecal including toxic substance (endotoxin and beta-glucan) and parasites. Infection hazards that may be encountered in the collection and sorting of solid waste and recyclables include: faces present in nappies, incontinence pads and stoma bags, dead animal carcasses and blood borne infectious material within used needles or syringes and used condoms, etc. Exposure to infectious agents can arise as a result of sharps injuries, skin contact, inhalation, ingestion (during smoking, drinking or eating) or contact with the mucous membranes of the eye.

c) Physical health hazards, such as excessive noise from vehicles. Working in a noisy environment from vehicles-automobiles, long term exposure to noise can cause hearing loss. In addition, noise exposure resulted in changes to the body also cause interference speaking or communication and may cause occupational injury.

d) Ergonomics, the solid waste collection was a repetitive work such as moving, pulling and lifting the garbage containers/bags/ receptacles around 100-200 liters cause of the musculoskeletal disorders and fatigue from work. In addition, unsafe operation procedure such as the movement of workers (running, climbing over).

e) Other, such as unsafe condition, equipment and tool are defective, hazardous household waste, mental condition of workers (lack of occupational health and safety awareness), and stress from work. Including, occupational injury due to involve vehicle that move through traffic and sharp objects.

2.5.3 Health effects among waste collectors

The solid waste collection involved various waste such as organic waste, hazardous waste, compostable waste, etc. Most of solid waste was mixed waste, these waste may contaminated with pathogen, infectious and chemical substance cause various health disorder as well as occupational injuries and accident, including the following:

2.5.3.1 Occupational injuries

During 1989 to 1992, the incidence of occupational accidents was 95 per 1000 employees per year among workers in the Danish waste collection and 17 per 1000 employees per year of total work force and the relative risk of occupational accident among Danish waste collectors with as compared to Denmark's total work force was about 5.6, indicated that among waste collectors had high the incidence of occupational accidents. The accident among Danish waste collectors include fractures, sprains, wounds, soft tissue accidents and chemical burns. In 1993, the study among 159 urban Brazilian waste collectors reported the incidence rate of occupational accidents was about 700 per 1000 waste collectors per year (332 accidents in three years). Each waste collector (on average) lost 9.5 working days per year because of occupational accidents. The causes of occupational accident, such as working at a high speed (may influence the number of accidents), other factors include noise, insufficient illumination and thermal stress, especially working with high speed and muscle fatigue to produce high incidence rate of accidents (12). In 1998, the U.S. Department of Labor reported that solid waste collectors had the 7th most dangerous job in the USA. The risk for the fatality among solid waste collectors was 10 times of that other workers (relative risk = 10) that 81% of mortalities resulted from vehicular accidents. The fatality rate among solid waste collectors was 48.8 per 100,000 (based on 1996 nationwide statistics). During 1992 to1996, the waste collector 111 persons died in the USA. The U.S. National Traumatic Occupational Fatalities Surveillance System indicated that 36% of fatalities occurred when the collection worker slipped and fell from waste truck or run over on the truck, during 1980 to 1992 (41). And in 2011, the study of health status among municipal solid waste collectors at Nakorn Pathom Province in Thailand, found that the solid waste collector occurred from vehicles, including injuries from sharp objects and insect bites (24).

2.5.3.2 Musculoskeletal problems

In general, the solid waste collection was repetitive work, which the task of solid waste collectors included moving, pulling, lifting heavy solid waste bins/ receptacles as well as pulling-pushing container/carts. All these activities were occupational risk factors of low back pain or musculoskeletal disorders. In addition, the solid waste collection may contain work above shoulder level, often exertion of force, static contractions, and extreme joint positions which were occupational risk factors for musculoskeletal disorders of the shoulders, arms and neck (12).

In Iran, municipal solid waste was collected manually and the collection of household waste was repetitive heavy physical activity such as lifting, carrying, pulling and pushing. Mehrdad, et al. (2008) studied of musculoskeletal disorders among municipal solid waste workers. 65% of participants reported that they had been troubled with musculoskeletal symptoms in one or more of the 9 defined body regions during the last 12 months. Prevalence of symptoms in low back, knees, shoulders, upper back and neck were 45, 29, 24, 23 and 22% respectively (13).

In Thailand, Juntratep (2011) studied of ergonomic factors and prevalence of low back pain among solid waste collectors in Nong Bua Lam Phu Province. The prevalence of low back pain during the last 7 day and last 12 month period were 62.50 % and 77.50%, respectively. The related risk factors to low back pain were no regularly exercise, work duration, work 7 days per week, no breaks during work, number of lifting per day > 150 times, weight of lifting > 50 kg, wrong handling trash can and hang on the vehicle (23). Chomchey (2013) studied of refuse collectors in one district office of Bangkok Metropolitan Administration during February 2012 to March 2012 by using a set of self-administered questionnaires. The study population was exclusively male with an average age of 42.1 years, 66.9% of study participants completed only primary level education. The most common illnesses or injuries reported were muscular pain 94.6% and fatigue 89.5% (26).

2.5.2.3 Respiratory-pulmonary problems

In addition to occupational accidents and musculoskeletal disorders, the workers who implemented waste collection may have elevated incidence rates of work-related pulmonary problems compared to the total labor. The cause of health problem among solid waste collectors was exposure to various health hazards, including exposure to bioaerosols or volatile compounds (bioaerosols refer to aerosols containing biologically agents i.e. microorganisms and its metabolites or toxins). The risk factor of respiratory problem may have several factors include poor weather, vehicle exhaust and aerosols containing biologically agents generated by household waste (12). Breathing dust containing microorganisms into body may cause damage to the respiratory system compare breathing only dust and microbes into only one (45). Exposure to bioaerosols among solid waste collector may associate with various factors such as types of waste, types of vehicle and seasons (46). Past studies in Geneva showed that the probability of chronic bronchitis occurred 2.5 fold more among waste collectors than reference group of male workers (12). In 2001, study of adverse health effect among household waste collectors in Taiwan, showed that household waste collectors risk for development of chronic respiratory symptoms such as cough, phlegm, wheezing, and chronic bronchitis (14). In 2003, Heldal, et al. study of upper airway inflammation in waste handlers exposed to bioaerosols. The study result indicated that solid waste collectors had moderately exposure to spore of fungi, endotoxin and beta (1-3)-glucan during collected waste cause upper airway inflammation (17). A similar study was Wouters, et al. (2002) study of upper airway inflammation and respiratory symptoms among domestic waste collectors in four large Dutch cities. The waste collectors showed signs of increasing respiratory symptoms and upper airway inflammation compared with among controls. Exposure to organic dust probably underlies the inflammation mediated by neutrophils that result of respiratory symptoms (18). Several past studies indicate that among solid waste collector had higher respiratory symptoms and impaired lung function than among other workers. Athanasiou, et al. (2010) studied of respiratory health of municipal solid waste workers in the municipality of Keratsini, Greece showed that prevalence of each respiratory symptoms, including, breathlessness, cough in the morning, cough during the day, phlegm in the morning, phlegm during the day and coughing on

exertion was 50%, 29%, 16%, 28%, 26% and 25%, respectively. Prevalence of all respiratory symptoms was higher in among municipal solid waste workers than among office workers. Among municipal solid waste workers had reduced mean forced vital capacity (% predicted FVC) and forced expiratory volume in 1 second (% predicted FEV_1) compared with office workers (21). Neghab, et al. (2013) studied of respiratory symptoms and lung functional impairments among garbage collectors in Fars Province, south of Iran. The result of study indicate that the prevalence of respiratory symptoms and impaired lung function were more common among garbage collectors than in other workers. In addition, there was the relationship between occupation and the prevalence of respiratory symptoms. Similarly and there was significantly association between garbage collector occupation and impaired lung function (20). Hansen, et al. (1997) studied of respiratory symptoms among Danish waste collectors. The prevalence of respiratory symptoms among waste collectors was found cough 27.8%, wheeze 23%, phlegm 14.6% and itching nose 11.5%. The prevalence of respiratory symptoms was compared with park workers, significantly increased PPRs appeared for cough (PPR = 1.3), wheeze (PPR = 1.4) and itching nose (PPR = 1.9, p-value = 0.04). This study showed that waste collectors have moderately higher the prevalence of several respiratory problems than park workers. The causes are maybe exposure to vehicle exhaust and aerosols containing microorganisms (22). Djoharnis, et al. (2012) studied of respiratory symptoms and lung functions among domestic waste collectors in the Kota Bharu Municipal Council, Kelantan, Malaysia. The prevalence of respiratory symptoms, the most frequency of respiratory symptoms among domestic waste collectors was shortness of breath 42.1%, chest tightness 36.8%, morning phlegm 32.6% and morning cough 20%. The respiratory symptoms include morning cough, morning phlegm and shortness of breath were higher among domestic waste collectors compared than among office workers. Prevalence of abnormal lung function among domestic waste collectors was 12.6%, type of abnormality of lung function test found that the most of abnormality was restrictive abnormality 75% (27).

2.5.2.4 Gastrointestinal problem

In addition, solid waste collector had exposure to bioaerosols by inhalation, including exposure by ingestion and skin contact. Several countries, the solid waste collection by manual handling and waste collectors often have not opportunity for washing during working hours, there was reported that workers' hands were contaminated by Streptococci, and other microorganisms (12). Gastrointestinal problem such as diarrhea and nausea, these problems were well known in occupations that exposed to Gram-negative bacteria in the air at high volume, especially the worker and employees in the wastewater treatment plant and composting plant. There was study reported that gastrointestinal symptoms were associated with the work of waste collector and moreover the symptoms predominantly occurred in the summer (47). There was reported that high exposure to endotoxins was associated with nausea and the risk of reporting nausea decreased with decreasing exposure that workers with low exposure had the fewest reports in the comparison with the unexposed group. High exposure to endotoxins was also associated with diarrhea. , pattern existed for exposure to fungi. An exposure-response relationship was found between nausea and endotoxin exposure and between diarrhea and exposure to both endotoxins and viable fungi (48).

2.5.2.5 Injuries and other problem

In general, the solid waste collection was heavy work and work in poor environment that have various health hazards such as dust, bioaerosols, fume of chemical substances, insect and vectors, parasites, bacteria, fungi, pathogens, which harmful to health. Hazard both from environment and the composition of waste cause health problem such as respiratory, musculoskeletal, gastrointestinal problem.

In addition, there was reported that solid waste management was associated with health problem of workers, especially heavy traffic jam area; such as skin problem, eye irritation, eye and nose inflammation, infectious nail, allergy, insect bites and injuries from chemical and sharp objects (12, 49). The parts of body injured include back, knees, arms and legs. The most frequently reported injuries back part (50).

2.6 Respiratory system

2.6.1 Structure of the respiratory system (51-57)

The respiratory system consists of a pair of lung within the thoracic cage. Its main function is gas exchange, but other role includes speech, filtration of microthrombi arriving from systemic veins and metabolic activities. The structure of the respiratory system, lung and airway showed in Figure 2-7.

Structure of the respiratory system

Respiratory system may classify by structure is the following:

1) Upper respiratory tract consists of nose, pharynx and larynx
2) Lower respiratory tract consists of trachea, bronchi and a pair of lung

Respiratory system may classify by function is the following:

1) Air Passage: nose, mouth, pharynx, larynx, trachea, bronchus down to terminal bronchiole
2) Respiratory Unit: respiratory bronchiole down to alveolus

Anatomy of lung

The right lung is divided by transverse and oblique fissures into tree lobed: upper, middle and lower. The left lung has an oblique fissure and two lobes. Vessels, nerves and lymphatic enter the lung on their medial surfaces at the lung root or hilum. Each lobe is divided into a number of wedge-shaped bronchopulmonary segments with their apices at the hilum and base at the lung surface. Each bronchopulmonary segment is supplied by its own segmental bronchus, artery and vein and can removed surgically with bleeding or air leakage from remain lung.

The lung' main function is exchange gas between air and blood, in relation to the body's varying oxygen (O_2) needs.

A total lung capacity, the lung fills the entire chest cavity and can reach a volume, in the adult human, of some 5-6 liters, largely depending on body size. At the end of a deep breath, about 80% of lung volume is air, 10% is blood, and only the remaining is tissue. Important quantitative aspects of respiratory function are the changes in volume with inspiration and expiration and absolute volume of air that the lung hold at various times during the respiratory cycle.

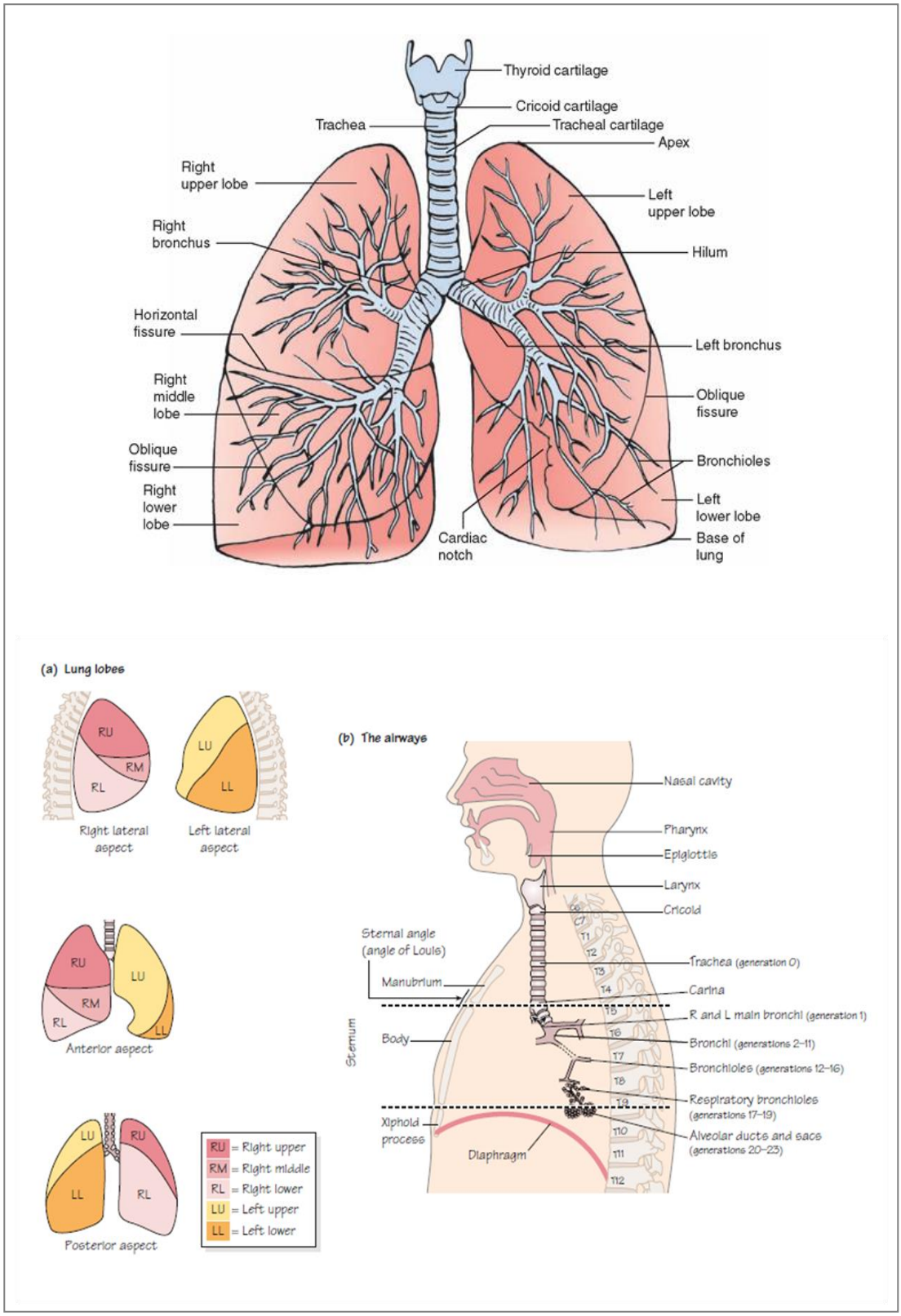


Figure 2-7 Structure of the respiratory system, Lung and Airway

Airway

Trachea is one part of the lower respiratory tract, between larynx and main bronchus that in front of the esophagus, through the neck into the chest cavity and into the left and right lung, by bronchus spilt to dichotomous into lung. The entrance to the lung's airway is the trachea, a single tube; the gas-exchange elements where air and blood are brought into close contact are contained in several million unit.

Airway divided repeatedly, with each successive generation approximately doubling in number. The trachea and main bronchi have U-shaped cartilage, linked posteriorly by smooth muscle. In the human lung the airway are built as dichotomous trees. This is the result of lung morphogenesis where end bud of each airway tube give rise to two daughter branches, in the human lung this goes on for 23 generations. The last nine generations of these airways are conducted to tightly packed alveoli, air chambers in which gas exchange take place. The respiratory bronchioles are the first generation to have alveoli. (Figure 2-8)

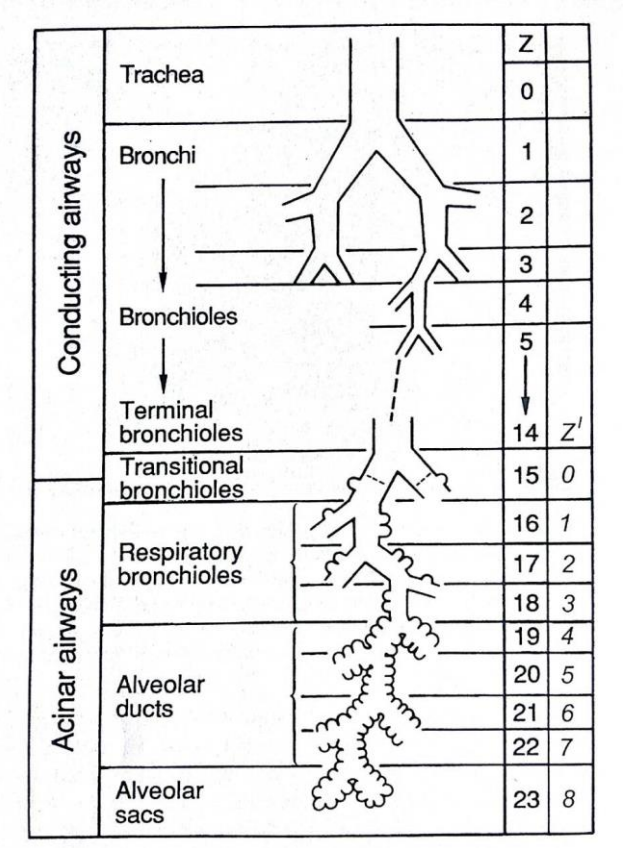


Figure 2-8 Model of airway branching in human

2.6.2 Respiratory pathology (58)

Pathology of the lower respiratory tract, most occur at bronchial and lung. The trachea structures have consecutive channels to air bags and airbags were advertised throughout the wall. When breath hazard agent especially pathogen may be occur various pathological positions such as trachea bronchi and small air sacs or agents spread through the air bag can cause infections throughout the lobes. The pathology occurs in different positions have different effects on pulmonary function.

Chronic pulmonary disease includes obstruction and restriction. Cause of pulmonary disorder is the following:

- Physical agent
- Biological agent
- Chemical agent
- Hypoxia
- Immunological reaction
- Genetic abnormality
- Nutritional imbalance and deficiency state

The bronchial and alveolar were constantly exposed to air, the probability of exposure to various health hazards such as virus, bacteria, fungi and air pollutants, which affect to health/illness such as occupation lung disease.

Diseases of the airways: such as chronic obstructive pulmonary disease and Bronchillitis.

Chronic obstructive pulmonary disease include chronic bronchitis, small airway disease or chronic obstructive bronchiolitis and emphysema, which bronchial pathology occur different position or main pathology occur at alveoli, but the end result is an obstructive airways as well. Such as:

1) Chronic bronchitis: pathology occurs at bronchus, bronchial wall thickening, cause sputum and obstructive bronchitis.

2) Small airway disease: pathology occurs at small airways, bronchial wall thickening and inflammation, including has peribronchiolar fibrosis

3) Emphysema: pathology was destruction of the alveoli walls, which cause elastic recoil of lung decreased and has premature closure of airway

2.7 Respiratory disorders

The most common respiratory compliant for which a person seek medical help is either shortness of breath or cough. Less frequent are hemoptysis, thoracic pain, cyanosis, and an abnormal breathing pattern. An in the case of any medical evaluation, the paramount diagnostic mainstay are history and physical examination (57).

2.7.1 Respiratory symptom (57, 59-61)

Cough

Cough is one of the most frequent causes of visit to doctor's office. Patients are frequently anxious about the possibility of a serious malady as the cause. They may also be troubles by the complications of cough, including chest pain from intercostals muscle strain or even a fractures rib in patient with bone disease. They may be embarrassed by cough-induced incontinence of the bladder or stool. Embarrassment and even social isolation may also arise from the frequent fear of other that the patient' cough is infectious and communicable.

A cough is an explosive expiration that protects the lung against aspiration and promotes the movement of secretions and other airway constituents upward toward the mouth. It is a critical element in the self-cleansing and protective mechanisms of the lung – a reflex act that usually, but not invariably, arise from stimulation of the bronchial mucosa somewhere between larynx and second-order bronchi.

A cough may be voluntary, involuntary, or a combination of the two if the subject attempts to control an involuntary cough. Three categories of stimuli are commonly at work in producing an involuntary cough: mechanical, inflammatory, and psychogenic. Mechanical and chemical causes range from inhalation of irritant, such as smoke or dust, to distortions of the airway produced by pulmonary fibrosis or atelectasis. Most often, coughs are due to tracheobronchial inflammation. The smoker is particularly vulnerable to exacerbation of cough by inhaled particles and fumes because of underlying chronic pharyngitis, laryngitis, and tracheobronchitis. Causes of cough classify as characteristics such as; acute cough refer to cough for less 3 weeks, cough for 3 weeks or more than define chronic cough. Some cause and characteristics of cough showed in Table 2-6

Table 2-6 Some cause and characteristics of cough

Cause	Characteristics
Sinusitis or nasopharygnitis	Cough following an upper respiratory syndrome or sinus symptoms: sensation of a need to clear the throat: postnasal drip
Acute infections of lungs	
Tracheobronchitis	Cough associated with sore throat, running nose and eyes
Lobar pneumonia	Cough often preceded by symptoms of upper respiratory infection: cough dry, painful at first: later becomes productive
Bronchopneumonia	Cough dry or productive, usually begins as acute bronchitis
Mycoplasma and viral pneumonia	Paroxysmal cough, productive of mucoid or blood-stained sputum associated with flulike syndrome
Exacerbation of chronic bronchitis	Cough productive of mucoid sputum becomes purulent
Chronic infections of lungs	
Bronchitis	Cough productive of sputum on most days for more than 3 consecutive months and for Sputum mucoid until acute exacerbation, when it becomes mucopurulent
Bronchiectasis	Cough copious, foul, purulent, often since childhood: forms layers upon standing
Tuberculosis or fungus	Persistent cough for weeks to months, often with blood-tinged sputum
Parenchymal inflammatory processes	
Interstitial fibrosis and infiltrations	Cough nonproductive, persistent, depends on origin.
Smoking	Cough usually associated with injected pharynx: persistent, most marked in morning usually only slightly productive unless succeeded by chronic bronchitis

Table 2-6 Some cause and characteristics of cough (cont.)

Cause	Characteristics
Tumors	
Bronchogenic carcinoma	Cough nonproductive to productive for weeks to months; recurrent small hemoptysis common.
Alveolar cell carcinoma	Cough similar to that with bronchogenic carcinoma except in occasional instances, when large quantities of watery: mucoid sputum are produced
Benign tumors in airways	Cough nonproductive: occasional hemoptysis.
Mediastinal tumors	Cough often breathlessness, caused by compression of trachea and bronchi
Aortic aneurysm	Brassy cough
Gastrointestinal	
Gastrioesophageal reflux (GERD)	Nonproductive cough often following meals or with recumbancy; may (or may not) be accompanied by other symptoms of GERD (e.g., heartburn, a bitter oral taste, belching)
foreign body	
Immediate, while still in upper airway	Cough associated with progressive evidence of asphyxiation
Later, when lodged in lower airway	Nonproductive cough, persistent, associated with localizing wheeze
Cardiovascular	
Left ventricular failure	Cough intensifies while supine, along with aggravation of dyspnea
Pulmonary infarction	Cough associated with hemoptysis, usually with pleural effusion
Medication-induced	
Angiotensin-converting enzyme (ACE)	Nonproductive cough, more common in women, may occur at any time inhibitors (following soon after drug initiation or with years of use)

Wheezing

Wheezing is more occur during forced expiration, which further narrows airway, they may occur during both inspiration and expiration in asthma. Wheezes presumably originate through a combination of limitation to airflow and vibrations in the walls of the airways. Wheezing is a sign that air is trying to flow through a narrow passage and it may indicate that the lungs are getting out of control. Airway narrowing can occur from spasms, swelling or mucus accumulating in the airways. Sometimes, when a person with chronic obstructive pulmonary disease (COPD) develops an infection in their lungs, wheezing may occur. Several investigation have shown that there was a relationship between wheeze and pulmonary function

Phlegm

Phlegm or sputum production, also called mucus production, can also be a symptom of COPD. Sometimes, people may be confusing sputum with the mucus that coming from their nose, which has drained from their sinuses. Sinus drainage from the nose may drip down the back of the throat to the trachea, where it may "mix" with mucus coming from the lungs. Sputum production usually refers to coming from the lungs, not your sinuses. It is normal for the airways to produce several ounces of sputum a day. This mucus is needed to keep the breathing passages moist. When the lungs are bothered by irritants, they try to protect themselves by producing additional mucus to trap any inhaled particles from entering the lungs. Constant attack by irritants, such as smoke, however, makes these glands enlarge and produce two to three times the normal amount of mucus. Chronic irritation also causes a problem with the natural cleaning system in the airways provided by the cilia. Cilia are destroyed by smoking. Smoking also causes any surviving cilia to become paralyzed for at least 20 minutes following inhalation of cigarette smoke. The result is a poorly working sweeping system that doesn’t clear the air passages very well. It is possible that sputum that is allowed to accumulate in the lungs may "grow" bacteria, which can cause acute bronchitis or pneumonia.

Breathlessness

Breathlessness or shortness of breath, the medical term for breathlessness is dyspnea. For the patient, breathlessness involves an experience of discomfort in breathing. It is alarming to most patients and can arouse great concern about a potential dire cause, making it one of the most frequent complaints that prompt patients to seek medical evaluation. Breathlessness of dyspnea may be acute or chronic. Cause of breathlessness; such as asthma, injury to chest wall and intrathroracic structures, pneumonia, anemia and chronic obstructive pulmonary disease (COPD), etc. Cause of acute and chronic dyspnea showed in Table 2-7.

Table 2-7 Cause of acute and chronic dyspnea

Cause of dyspnea	
Acute	**Chronic**
Pulmonary edema	chronic obstructive pulmonary disease
Asthma	Asthma
Spontaneous pneumothorax	Pulmonary thromboembolic disease
Pulmonary embolism	Left ventricular failure
Pneumonia	Diffuse interstitial fibrosis
Adult respiratory distress syndrome	Pulmonary vascular disease
Pleural effusion	Psychogenic dyspnea
Pulmonary hemorrhage	Pleural effusion
Injury to chest wall and intrathroracic structures	Anemia, severe
	Postintubation tracheal stenosis
	Hypersensitivity disorders

2.7.2 Respiratory disease

The Policy and Strategy Department of Public Health Ministry, Thailand reported that the common frequently diseases and are the top order of every year including; respiratory disease, digestive system-oral diseases, and musculoskeletal system. The highest frequently disease was respiratory disease in every year (61). In here, respiratory will focus on chronic obstructive pulmonary disease and asthma.

Factors associated with respiratory disease (55)

1) Smoking: Tobacco smoke contains many potentially toxic gases including carbon monoxide, detected as carboxyhaemoglobin in the blood, and polycyclic aromatic hydrocarbons which cause gene mutations frequently found in primary lung cancers. Cigarette smoke accelerates normal age-related loss of lung function and is the principal cause of COPD. It also impairs epithelial ciliary function and mucociliry transport, and stimulates goblet cell hyperplasia which contribute to the characteristic morning cough and excessive sputum expectoration experienced by regular smokers.

2) Environmental and social factors: Air pollution, living condition and poor sanitation increase susceptibility to acute infective disease, asthma and hypersen-sitivity pneumonitis.

3) Working condition: Protections against inhalation of mineral and organic dust and chemicals have reduced susceptibility to occupational lung disease, work-related asthma and hypersen-sitivity pneumonitis.

Chronic obstructive pulmonary disease (62-65)

Chronic obstructive lung disease (COPD) describes a group of lung conditions (diseases) that make it difficult to empty the air out of the lungs. This difficulty can lead to shortness of breath (also called breathlessness) or the feeling of being tired. COPD is a word that can be used to describe a person with chronic bronchitis, emphysema or a combination of these. COPD is a different condition from asthma, but it can be difficult to distinguish between COPD and chronic asthma.

Pathology: Chronic obstructive pulmonary disease comprises pathological changes in four different compartments of the lungs include central airways, peripheral airways, lung parenchyma and pulmonary vasculature, which are variably present in individuals with the disease.

Pathogenesis: Cigarettes smoking is the main risk factor for COPD, although other inhaled noxious particles and gases may contribute. This causes an inflammatory response in the lungs, which is exaggerated in some smokers, and leads to the characteristic pathological lesions of COPD. In addition to inflammation, an imbalance of proteinases and antiproteinases in the lungs, and oxidative stress are also important in the pathogenesis of COPD.

Pathophysiology: The different pathogenic mechanisms produce the pathological changes which, in turn, give rise to the physiological abnormalities in COPD: mucous hypersecretion and cilliary dysfunction, airflow limitation and hyperinflation, gas exchange abnormalities, pulmonary hypertension, and systemic effects.

Symptoms: Cough, sputum (mucus or phlegm) and breathlessness**.**

Risk factors: COPD cause various factors as follow; Genetic factor and Environmental factors such as smoke, air pollutants at workplace, public places and home or living condition.

Occupational exposures may be a much more important contributor to the development of chronic obstructive pulmonary disease than previously recognized. 20% of cases of COPD can be attributed to occupational exposures to various vapors, gases, dusts, and fumes. Some workplace factors may even double the risk of COPD.

Chronic bronchitis was probably the most frequent chronic respiratory response to external agents. A clinical diagnosis must satisfy the following American Thoracic Society (ATS) criteria: recurrent productive cough, occurring four to six times a day, at least 4 days of the week, for at least 3 months during the year, for at least 2 consecutive years. The definition of simple bronchitis; the production of phlegm on most days for as much as 3 months of the year, can be used to identify individuals with the most important symptoms. The excess mucus production associated with bronchitis often causes airflow obstruction. Chronic bronchitis is frequently superimposed on other respiratory diseases due to cigarette smoke and/or occupational hazards, organic dusts irritants. Emphysema is a disease that involves the alveoli (air sacs) of the lung

Asthma (55, 62, 66)

Asthma is a chronic inflammatory disorder of airway or a condition of chronic swelling of the airways. Chronically inflamed airways are hyperresponsive; they become obstructed and airflow is limited by bronchoconstriction, mucus plugs, and increased inflammation when airways are exposed to various risk factors. These airways are sensitive to stimulation by a number of things, such as cigarette smoke, respiratory infections, cold air, exercise, pollens, allergens, occupational irritants, etc. The swelling may produce an obstruction of the airways, similar to COPD. Some people with COPD also have asthma. Asthma can often be diagnosed on the basis of medical history and symptom. History of any of the following: Cough, wheeze, chest tightness and difficult breathing. Symptoms occur or worse at night or early in the morning, seasonal pattern,, when was the stimulus such as allergens, infections, stress, toxic smoke and other pollutants, often associated with allergies such as allergic rhinitis, allergic dermatitis and allergic conjunctivitis, history of family members such as parents or siblings suffer from asthma, including asthma occurs after exercise.

The major characteristics of asthma are:

1) Narrowing of the airway and impeded airflow, commonly reversible spontaneously of following treatment.

2) Increased mucosal inflammation and recruitment of inflammatory cells to the airway.

3) Non-specific airway hyperresponsiveness to a range of normally innocuous stimuli (such as cold air, irritants and pollutants) and airway spasmogens leading to bronchoconstriction.

Causes of asthma include allergies, tobacco smoke, environmental factors, obesity and stress. Almost all asthma sufferers have allergies. People who have hay fever or allergic rhinitis also develop asthma. Allergic reactions triggered by antibodies in the blood often lead to the airway inflammation. Tobacco smoke has been related to a higher risk of asthma as well as a higher risk of death due to asthma, wheezing, and respiratory infections. In addition, people who exposed to second-hand smoke have a higher risk of asthma prevalence. Smoking has also been associated with increases in asthma risk. Asthma symptoms are often the result of air pollution, symptoms such as wheezing, breathlessness, hay fever and asthma attacks.

2.8 Respiratory evaluation

Evaluations of respiratory response to occupational and environmental exposures should include the following:

(a) A complete history, including tobacco use, environmental exposures, occupational exposures and respiratory symptoms

(b) A physical examination, with special attention to breath sounds

(c) A chest X-ray, with attention to parenchymal and pleural opacities

(d) Pulmonary function tests.

In here, we focus only history (including personal characteristics, medical history, occupational factors, family history, etc) and pulmonary function tests.

2.8.1 History (54, 55, 63, 67)

A comprehensive history exploring the time course, nature and severity of symptom is the most important factor in establishing the cause of respiratory disease. A systematic logical approach is outlined below and ensures a through, complete enquiry.

1) General factors: age, gender, race, education and marital status

2) Presenting complaint: list the main symptom, usually chest pain, cough, breathlessness.

3) History of the presenting complaint: explore the specify features of main symptoms and associated systemic manifestations (e.g. night sweats, weight loss, fever, rigors, arthritis, lymphadenopathy and rashes)

4) Past medical history: enquire about previous respiratory conditions.

5) Medications: review current and previous medication, including inhalers.

6) Family history: family history of atopy, tuberculosis, COPD, etc.

7) Smoking history including duration and amount, Alcohol abuse.

8) Occupational and environment factors

Review of symptoms should include questions on chronic cough, chronic sputum production, shortness of breath (dyspnea), wheezing unrelated to respiratory infections, chest tightness, and chest pain. Shortness of breath and cough often occur at night, in occupational asthma and pulmonary edema, symptoms may peak 8 to 16 hours after exposure, Understanding symptom periodicity and timing is important.

Respiratory symptoms during the work week that improve on weekends or holidays strongly suggest an occupational disease. Recognizing the temporal relationships of symptoms with non-occupational exposures may be more difficult, since these exposures may be occurring daily in the home environment. Use of the American Thoracic Society (ATS) Respiratory Symptom Questionnaire has been helpful in systematically obtaining information on respiratory symptoms.

Breathlessness: occurs at rest, on exercise. Determine rate of onset such as sudden or gradual, when it occurs, exercise tolerance i.e. when walking, running or climbing stairs, and associated with symptoms e.g. hay fever, wheeze, etc.

Cough: in the morning indicates chronic bronchitis or smoker's cough, at night suggests asthma of may be persistent after viral respiratory tract infections with bronchial hyper-responsiveness. Cough may be dry or productive of sputum.

Sputum or phlegm: if morning cough and sputum production for three months a year for more than one year define chronic bronchitis. Sputum or phlegm characteristics, yellow or green – mucopurulent sputum occur in chest infection and when copious and foul smelling may indicate bronchiectasis, pink frothy phlegm is typical of pulmonary edema.

2.8.2 Pulmonary function test (57, 68 - 76)

Pulmonary function tests (PFT) can provide important clinical information. There are designed to identify and quantify defects and abnormalities in the function of respiratory system. The most frequently performed pulmonary function test is spirometry. Spirometry is a physiological test that measures how an individual exhales or inhales volume of air as a function of time, the primary signal measured in spirometry may be flow or volume. Spirometry is invaluable as a screening test of general respiratory health. The most important aspects of pulmonary function test (spirometry) are the forced vital capacity: FVC, which is the volume delivered during an expiration made as forcefully and completely as possible starting from full inspiration and the forced expiratory volume in one second: FEV_1, which is the volume delivered in the first second of an FVC manoeuvre.

In this study, spirometry parameters include FVC, FEV_1 and FEV_1/FVC. The spirograms were shown in form (A) volume-time curve and (B) flow-volume curve (Figure 2-9).

FVC is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration, expressed in litres at body temperature and ambient pressure saturated with water vapor (BTPS)

FEV_1 is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration, expressed in litres at body temperature and ambient pressure saturated with water vapor (BTPS)

FEV_1/FVC ratio is generally expressed as percentage (%).

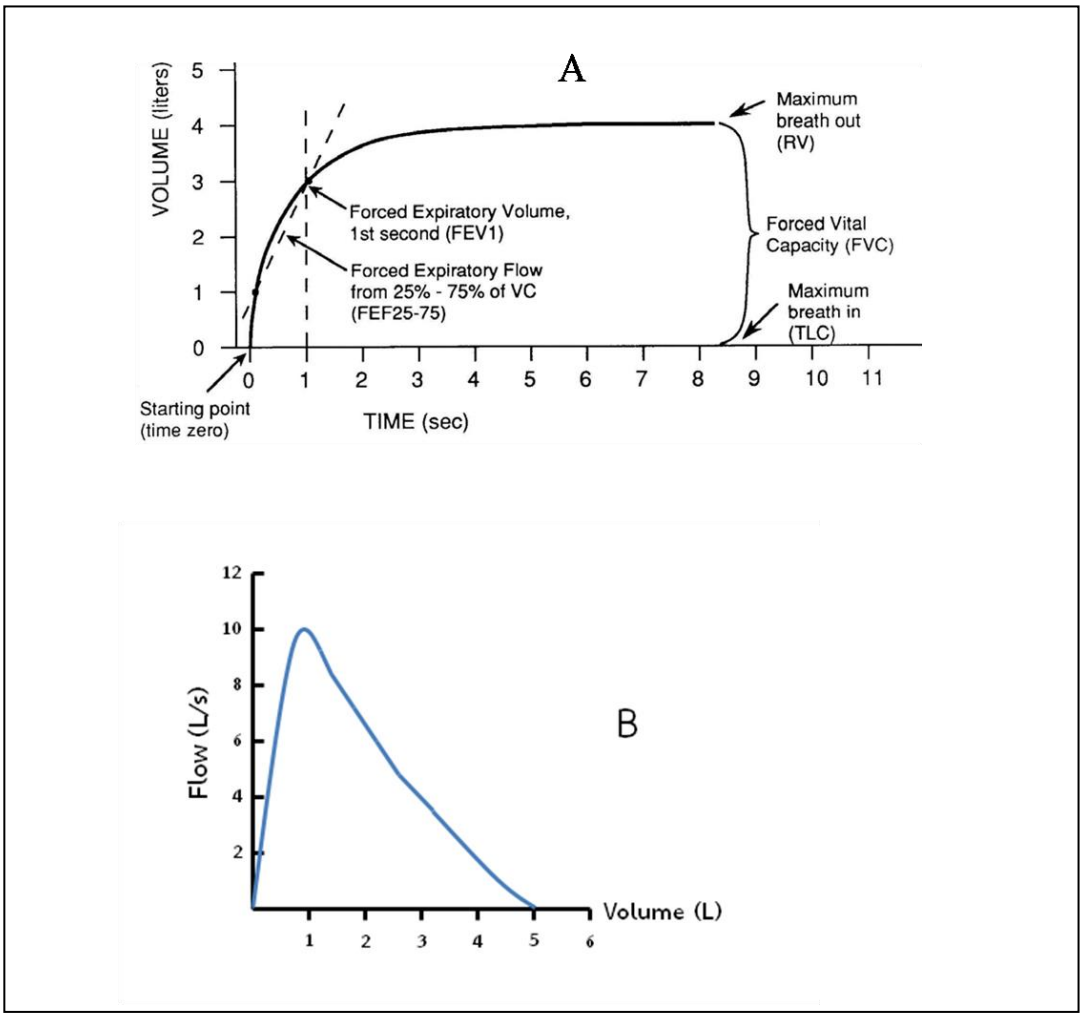


Figure 2-9 Spirograms during forced expiration from total lung capacity

(1) Standardisation of pulmonary function test

Subject preparation

The subject preparation for pulmonary function test, measured weight and height, and the subjects should avoid the activities such as smoking, drink alcohol exercise, etc. Activities that should **avoided** prior to lung function testing as follow:

- Smoking within at least one hour of testing
- Consuming alcohol within four hours of testing
- Eating a large meal within two hours of testing
- Performing vigorous exercise within 30 minutes of testing
- Wearing clothing that substantially restricts full chest and abdominal expansion

Hygiene and infection control

The goal of infection control is to prevent the transmission of infection to the subjects and staff during pulmonary function testing. Infection can be transmitted by direct contact or by indirect. Preventions are the following:

- The prevention of infection transmission to technicians or staff exposed to contaminated spirometer surfaces can be accomplished through hand washing and use of barrier devices such as hygiene face mask, suitable gloves. To avoid exposure and cross-contamination, hands should be washed immediately after direct handling of mouthpieces, or interior spirometer surfaces. Gloves should be worn when handling potentially contaminated equipment.
- To avoid cross-contamination, mouthpieces (reusable), breathing tubes, valves and manifolds should be disinfected or sterilized regularly. Equipments such as nose clips, mouthpieces, and any other equipment that comes into direct contact with mucosal surfaces should be disinfected, sterilized or discarded after each use. The mouthpiece should be changing between each the subject.

Personnel qualifications

Recommendations for personnel conducting pulmonary function tests suggest that completion of secondary education and at least two years of college education would be required to understand and fulfill the complete range of tasks undertaken by a pulmonary function technician.

Equipment quality control

Calibration is an important part of good practice, with regard to volume accuracy, calibration checks of spirometer prior to process of pulmonary function test as follows:

- Calibration checks must be undertaken at least daily, at least one time per day, calibrated one time every four hours if the spirometer was used continuously.
- If there was changed location that may be change temperature, pressure and humidity, check the spirometer calibration must be repeat before testing of pulmonary function.

Test procedure; procedures for recording forced vital capacity

- Check the spirometer calibration
- Explain the pulmonary function test
- Prepare the subject such as ask about recent illness, smoking, age and measure weight and height without shoes, for uses in the calculation of reference values
- Instruct and demonstrate the test to the subject, to include: Correct posture with head slightly elevated, Inhale rapidly and completely, Position of the mouthpiece (open circuit), Exhale with maximal force
- Perform the test (closed circuit method):

Have subject assume the correct posture, attach nose clip, place mouthpiece in mouth and close lips around the mouthpiece, inhale completely and rapidly, exhale maximally until no more air can be expelled, repeat instructions as necessary, repeat for a minimum of three times; but no more than eight are usually required and check test repeatability and perform more as necessary

Acceptability criteria

- Individual spirograms are ‘‘acceptable’’ if they are free from artifacts: cough during the first second of exhalation, glottis closure that influences the measurement, early termination or cut-off, effort that is not maximal throughout, leak or obstructed mouthpiece.
- They have good starts (extrapolated volume, 5% of FVC or 0.15 litters, whichever is greater
- They showed satisfactory exhalation (duration of 6 seconds or a plateau in the volume-time curve if the subject cannot or should not continue to exhale)

Reproducibility criteria

After acceptable spirograms have been obtained, apply the following tests

- The two largest values of FVC must differ not more than 0.20 liters and the two largest values of FEV_1 must differ not more than 0.20 liters.
- The best spirogram was considered from the largest FVC value and the largest FEV_1 value for interpretation of spirometry test.

Test result selection

FVC and FEV_1 measured from a series of at least three forced expiratory curves that have an acceptable start of spirometry test and are free from artifact, such as a cough or early termination. The largest FVC and the largest FEV_1 recorded after examining the data from all of the usable curves, even if they do not come from the same curve.

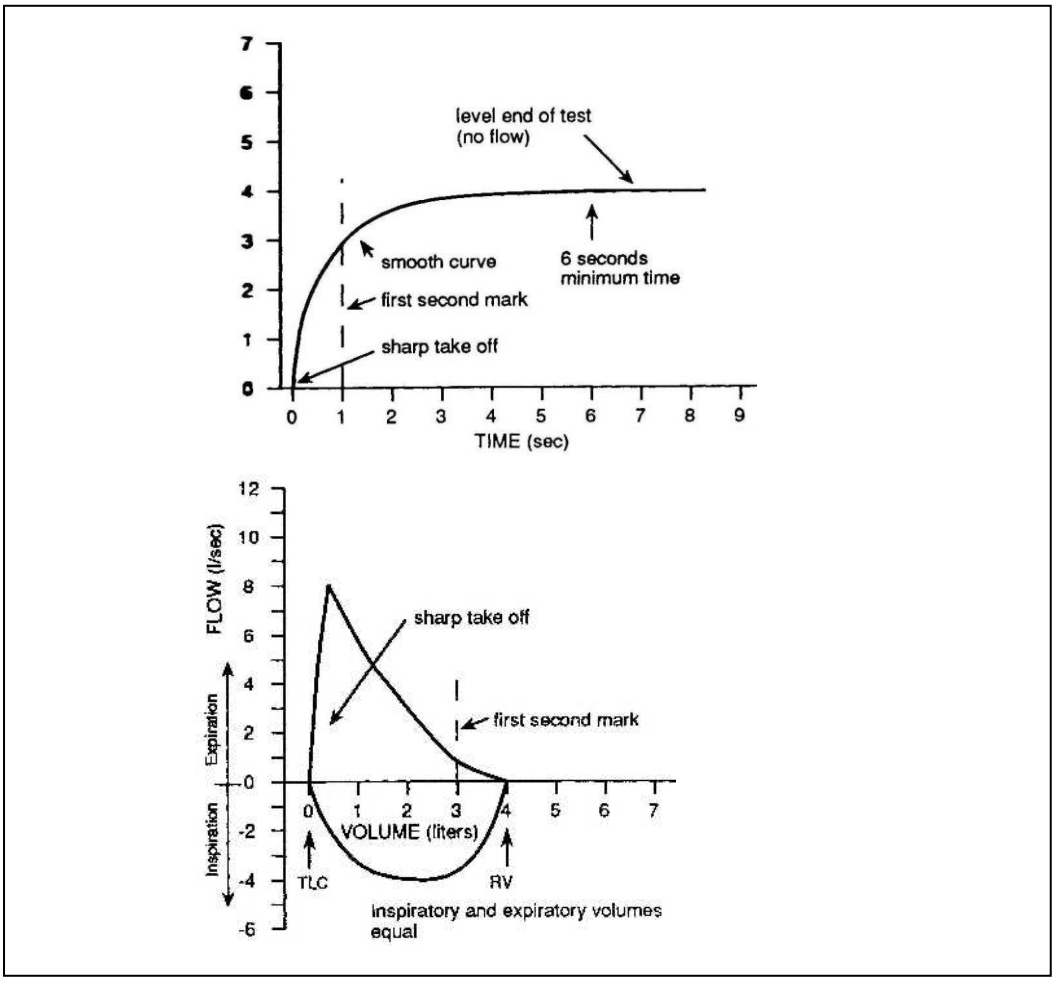


Figure 2-10 Example of acceptable curve

(2) Interpretation for pulmonary function test

The interpretation of pulmonary function test was comparisons of data measured with reference values base on health subjects.

Types of abnormalities of pulmonary function

- Obstructive abnormalities
- Restrictive abnormalities
- Mixed abnormalities (the coexistence of obstruction and restriction)

One thing to keep in mind about the result of restrictive abnormality, which spirometry by FVC Maneuver, the purpose was to screening. The result of abnormality suggested that "possible restrictive abnormality" only, not confirm that there is not the restrictive disorder because the maximum volume from spirometry by FVC Maneuver which is actually less than the total air volume of the lungs (Total lung capacity; TLC)

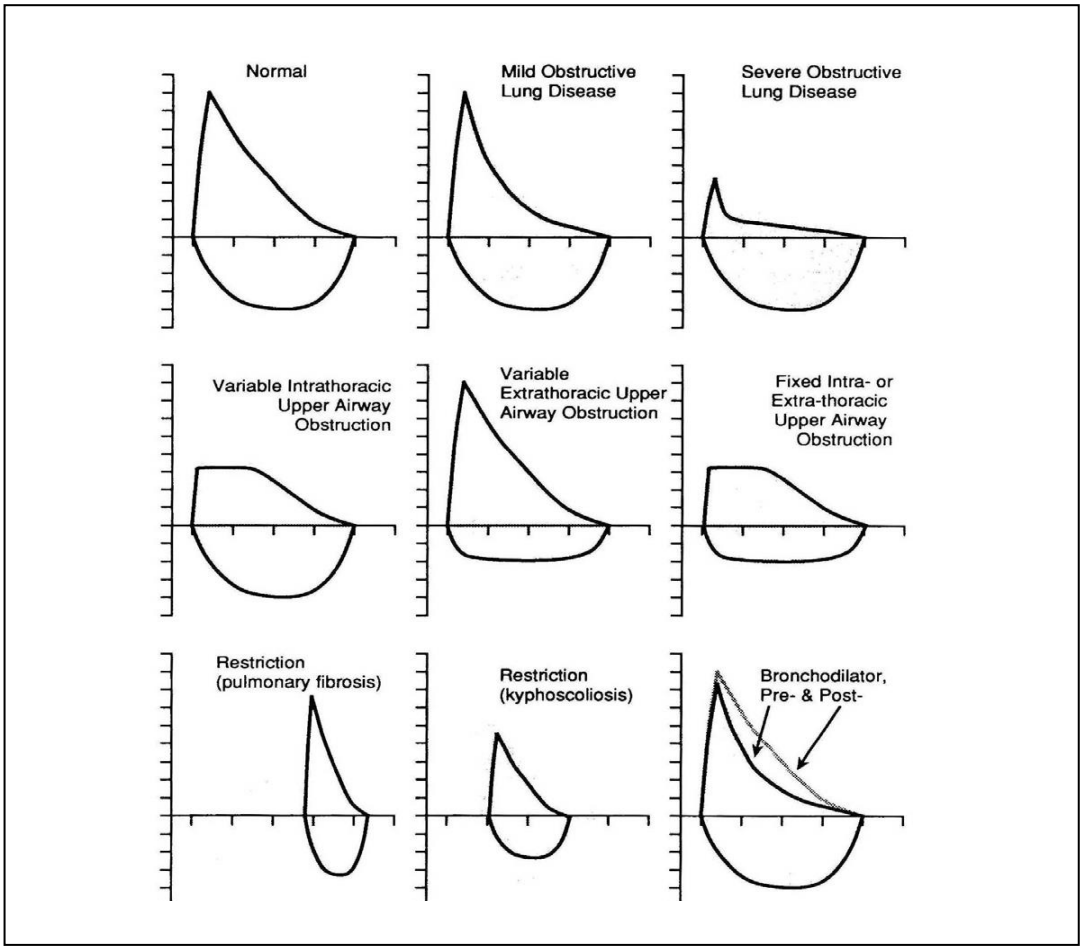


Figure 2-11 Examples of flow-volume curves in normal, obstruction and restriction

Reference equation

Reference value or predicted values should be obtained from studies of ‘‘normal’’ or ‘‘healthy’’ subjects with the same anthropometric (e.g. sex, age and height). Reference values are calculated with equations derived from measurements observed in a representative sample of healthy subjects in a general population.

In Thailand, “Siriraj” equation was recommended for calculation of reference value or predicted values in the study that subjects were Thai (Table 2-8). And fifth percentile criteria for spirometry interpretation in Thai showed in Table 2-9.

Table 2-8 Reference spirometric values in Thailand, Siriraj equation (75)

Parameters		Equation
FEV_1 (liters)	Male	-7.697+0.123A+0.067H-0.00034A2-0.0007AH
	Female	-10.603+0.085A+0.12H-0.00019A2-0.00022H2-0.00056AH
FVC (liters)	Male	-2.601+0.122A-0.00046A2+0.00023H2-0.00061AH
	Female	-5.914+0.088A+0.056H-0.0003A2-0.0005AH
FEV1/FVC (%)	Male	19.362+0.49A+0.829H-0.0023H2-0.0041AH
	Female	83.126+0.243A+0.08H+0.002A2-0.0036AH

Remark: A = age (years), H = height (centimeters)

Table 2-9 Fifth percentile criteria for spirometry interpretation in Thai (76)

Parameters		Equation
FEV_1 (liters)	Male	-8.843+0.113A+0.083H-0.00023A2-0.00007H2-0.0007AH
	Female	-7.578+0.082A+0.08H-0.0002A2-0.00011H2-0.00053AH
FVC (liters)	Male	-2.136+0.11A-0.006H-0.00034A2+0.00023H2-0.00061AH
	Female	-5.831+0.084A+0.056H-0.00029A2-0.00002H2-0.00048AH
FEV1/FVC (%)	Male	-34.124+0.531A+1.389H-0.00065A2-0.00409H2-0.00408AH
	Female	127.931+0.655A-0.676H+0.00144A2+0.00277H2-0.00641AH

Remark: A = age (years), H = height (centimeters)

Guideline for spirometry interpretation

Guideline for interpretation of abnormalities pulmonary function test, may considered from The Thailand Thoracic Society recommendations: Guidelines for spirometry and the American College of Occupational and Environmental Medicine (ACOEM): ACOEM guidance statement, Spirometry in the Occupational Health Setting (2011)

Pulmonary function test by spirometry was used to evaluate abnormality of individual lung function**.** Measured parameters include FVC, FEV_1 and FEV_1/FVC%.

Spirometry interpretation often used two methods include specified ratio and Lower limits of normal (LLN)

A lower limit of normal (LLN) or 5th percentile criteria is new method. Principle was comparisons of data measured with reference values (predicted value), lower limit of normal (LLN) is cut-off point that is used to define abnormality for spirometry (To separate normal from abnormal test result).

Specified ratio or fixed ratio: this is old method, principle was comparisons of data measured with reference values (predicted value), expressed in % predicted value. Cut-off point is used to define abnormality for spirometry. Fixed cut-off points for abnormality of spirometry showed in Table 2-10.

Interpretation algorithm

a. To separate normal from abnormal test results, first examine FEV_1/FVC value to determine whether obstructive abnormality is present, and then evaluate the FVC value to determine whether restrictive abnormality may exist. The FEV_1 is examined if the FEV_1/FVC indicates possible obstructive abnormality, as shown in Figure 2-12

b. All three indices of pulmonary function are considered abnormal if they fall below the fifth percentile lower limits of normal (LLN). Fixed cutoff points for abnormality such as 80% of the predicted value or an observed FEV_1/FVC ratio less than 0.70 (70%).

c. FEV1/FVC that is barely abnormal, in the presence of FEV_1 and FVC more than 100% of predicted, may indicate a normal physiologic variant pattern. However, if such healthy workers are exposed to respiratory hazards, clinical judgment may is needed to evaluate the possibility of early airways obstruction.

Table 2-10 Fixed cut-off points for abnormality of spirometry

Parameters	Normal level
FEV_1/FVC	≥ 70 % *
FEV_1	≥ 80 % predicted
FVC	≥ 80 % predicted

Note: * 75 if subject age less than 50 years old

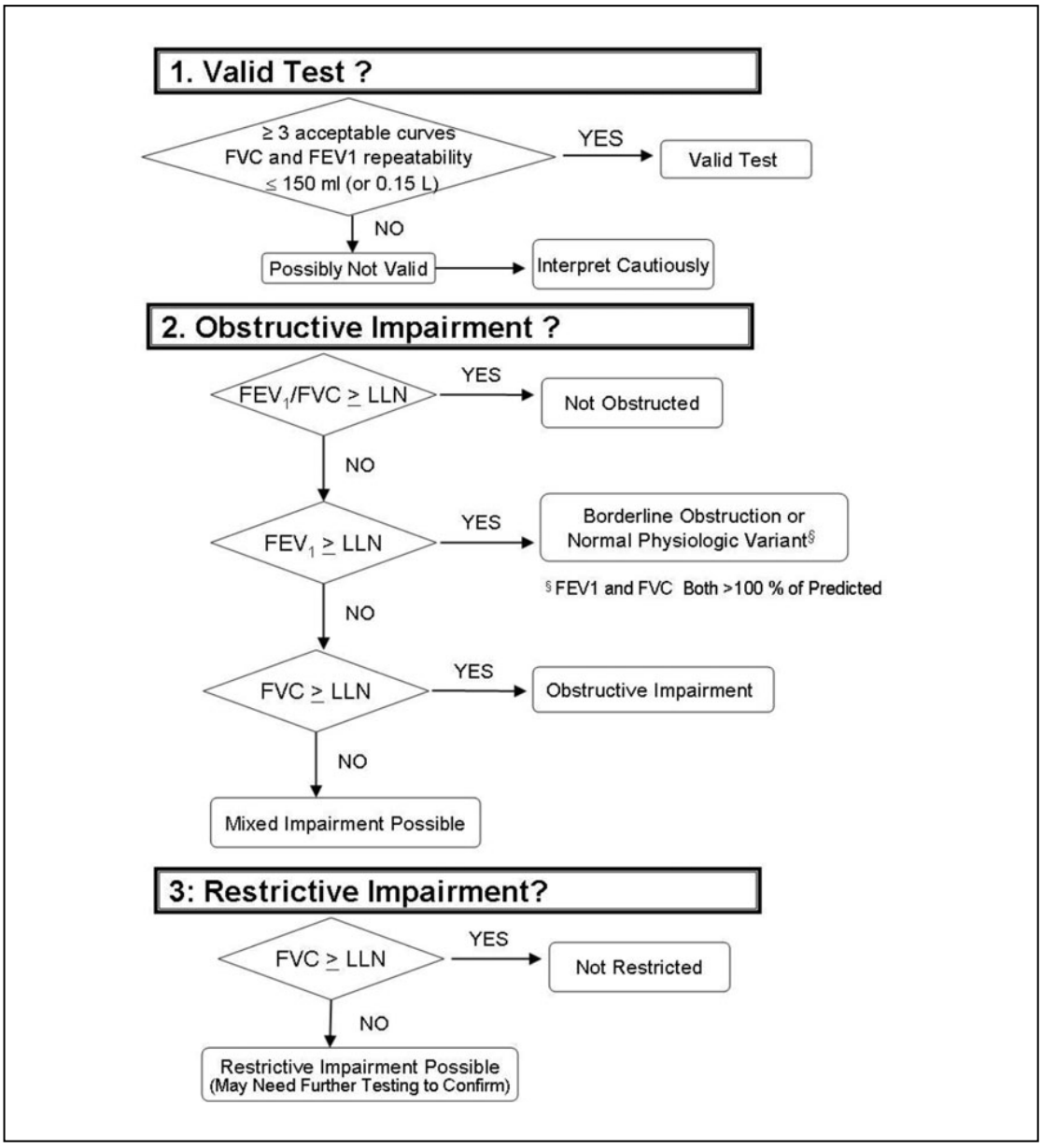


Figure 2-12 Spirometry interpretation- indicates lower limit of normal by ACOEM

2.9 Measure of disease (health outcomes) occurrence

The field of environmental and occupational epidemiological research focuses on finding patterns and understanding relationships between environmental or occupational exposures and health consequences. Environmental epidemiology is the study of the health consequences of exposures to hazards in the general environment, both outdoor and indoor, through the environmental media of air, water, soil, or food. The related field of occupational epidemiology is the study of the health consequences of hazardous exposures in the workplace (63).

In general, studies in epidemiology fall into two categories: (*a*) Disease-focused investigations seeking to identify risk factors for related diseases or health outcomes, such as in infectious disease or cardiovascular epidemiology. (*b*) Exposure-focused investigations seeking to identify relationships between exposure factors and diseases or health outcomes, such as in environmental and occupational epidemiology.

Measures of health outcomes frequency (63, 77, 78)

Incidence and prevalence, two epidemiological measures used to quantify disease occurrence, are standard variables used to measure disease frequencies.

Incidence Rate

Incidence measures the occurrence of new cases of disease (health outcomes) over a specified time period. The term risk is used to describe an individual's probability of developing a disease. On a population level, average risk in a group for a specific disease is referred to as the incidence proportion, or cumulative incidence, based on the number of new cases occurring during a specified period of time:

$$\text{Incidence proportion} = \frac{\text{Number of new cases}}{\text{Total population at risk during the specified time period}}$$

The incidence rate uses the same numerator as the incidence proportion, but a different denominator. The denominator incorporates the concept of person-time, usually expressed in units of person-years. This denominator takes into account not only the number of at-risk persons, but also the length of time during which they were at risk for development of the specific disease.

$$\text{Incidence rate} = \frac{\text{Number of new cases}}{\text{Sum of person-time at risk}}$$

Prevalence

Prevalence refers to the proportion of participants with a risk or disease at a particular point in time. Prevalence is the simplest quantity, known as point prevalence, is the ratio between the number of cases present and the size of the population at risk at a single point in time:

$$\text{Point prevalence} = \frac{\text{Number of persons with disease}}{\text{Number of persons with at risk (base line)}}$$

Unlike incidence, which is based on new cases during a given time period, point prevalence is based on the number of cases at one point in time. Prevalence is useful for service planning and cause. Further exploration of prevalence can be done by expressing it for subgroup of the population base on difference denominator data such as age or gender.

The goal of environmental and occupational epidemiology is most often to estimate the effect of the exposure of interest by comparing the occurrence of health effect in an exposed group and non-exposed group. Qualitative estimate for comparison include rate ratio and risk ration. Derivation of risk ratio and risk difference showed in Table 2-11.

Table 2-11 Derivation of risk ratio and risk difference*

Disease	Exposure		Total
	Present	Absent	
Present	a	c	a + c
Absent	b	d	b + d
Total	a + b	c + d	a + c + b + d

* Calculation

Exposed disease prevalence = a / (a + b)

Non-exposed disease prevalence = c / (c + d)

Risk ratio (prevalence rate) = a / (a + b) ÷ c / (c + d)

Risk difference (prevalence difference) = a / (a + b) - c / (c + d)

2.10 Reviews of relevant research

Yang, at el. (2001) studied of adverse health effects among household waste collectors in Taiwan. The object of this study was to assess whether there is an excess of adverse health outcomes among household waste collectors. The subjects were all current employees of the Household Waste Collection Department in the County of Kaohsiung, Taiwan. 52.7% of household waste collectors were male. The majority of household waste collectors (75.8%) aged equal or more 40 years old, duration of employment ≥ 8 years 59.4%. The result indicated that the collection of household waste presents a risk for the development of chronic respiratory symptoms (such as cough 17.3%, phlegm 14.3%, wheezing 15.4%, and dyspnea 11.1%), musculoskeletal symptoms (such as low back pain and elbow-wrist pain), and injuries caused by sharp objects. (14)

Neghab, et al. (2013) studied of assessment of respiratory symptoms and lung functional impairments among garbage collectors. This study was carried out in Fars Province, south of Iran. A mean age of 105 garbage collectors was around 44 years old (44.01 ± 7.34). A mean of duration of employment was around 15 years (15.07 ± 6.76). 60% of garbage collectors were smokers. The frequency of respiratory symptoms among garbage collectors, including, cough 7 persons (6.7%), phlegm 11 persons (10.5%), wheezing 19 persons (18.1%) and breathlessness 41 persons (39.0%). The result of study indicate that the prevalence of respiratory symptoms and impaired lung function were more common among garbage collectors than in other workers. In addition, there was the significantly relationship between occupation and the prevalence of respiratory symptoms. Similarly and there was significantly association between garbage collector occupation and impaired lung function. (20)

Athanasiou, et al. (2010) studied of respiratory health of municipal solid waste workers. The aim of this study was to evaluate the respiratory health of municipal solid waste workers. This study was performed in the municipality of Keratsini, the port city of Piraeus in Greece, during March 2009 – May 2009. By randomly selected 104 municipal solid waste workers. The demographic characteristics of the study municipal solid waste workers showed that 68% were males and 67 % were smoker with current smokers 54% and Ex-smoker 13%. Disease history found that municipal solid waste workers have ever had diseases that involved respiratory system and chest

injuries such as bronchitis 21%, pneumonia 8%, heart disease 10%, asthma 8% and chest injury 6%. Prevalence of each respiratory symptoms, including, breathlessness, cough in the morning, cough during the day, phlegm in the morning, phlegm during the day and coughing on exertion was 50%, 29%, 16%, 28%, 26% and 25%, respectively. Prevalence of all respiratory symptoms was higher in among municipal solid waste workers than in among office workers. Multiple logistic regression was used to adjust for confounders (smoking status, education level, age and sex). After the adjustment of confounders, there was association between municipal solid waste occupation and the prevalence of coughing in the morning increased at p-value < 0.05. The result of spirometry, among municipal solid waste workers had reduced mean forced vital capacity (% predicted FVC) and forced expiratory volume in 1 second (% predicted FEV_1) compared with office workers. After adjustment for smoking status, only the decline in FVC was statistically significant at p-value < 0.05. (21)

Hansen, et al. (1997) studied of respiratory symptoms among Danish waste collectors. This nationwide survey among waste collectors evaluates self-reported respiratory symptoms with focus on chronic bronchitis. Altogether waste collectors (76% male) and park workers (comparison group) completed a questionnaire on work conditions and health problems. An exposure matrix, measurements of airborne microorganisms among waste collectors based on with different working conditions. The characteristics of waste collectors mean age was 39.4 years old and period of employment was 9.4 years. The majority of waste collectors were smokers, current smokers 53% and former smokers 18%. The prevalence of respiratory symptoms among waste collectors was found cough 27.8%, wheeze 23%, phlegm 14.6% and itching nose 11.5%. The prevalence of respiratory symptoms was compared with park workers, significantly increased PPRs appeared for cough (PPR = 1.3, p-value = 0.04), wheeze (PPR = 1.4, p-value 0.03) and itching nose (PPR = 1.9, p-value = 0.04), but not significant differences in prevalence appeared between different working conditions among the waste collectors. In conclusion, this cross-sectional study showed that waste collectors have moderately higher the prevalence of several respiratory problems than park workers. The causes are maybe exposure to vehicle exhaust and aerosols containing microorganisms. (22)

Djoharnis, et al. (2012) studied of respiratory symptoms and lung functions among domestic waste collectors. The object of study was to determine the prevalence of respiratory symptoms and lung function status among domestic waste collectors in the Kota Bharu Municipal Council, Kelantan, Malaysia. This cross sectional study was carried out for two months period starting from September 2008. The respondents were 191 workers include 95 waste workers and 96 office workers (comparison group). The age of the respondents ranged from 24 to 56 years old. The mean age of waste collectors was 39.9 years old (39.9 ± 9.14). The majority of waste collectors were smokers (65.3%). The majority of domestic waste collectors graduate secondary school (79%). The occupational characteristics, 97.9% of among domestic waste collectors practiced overtime job. The prevalence of respiratory symptoms, the most frequency of respiratory symptoms among domestic waste collectors was shortness of breath 42.1%, followed by chest tightness 36.8%, morning phlegm 32.6% and morning cough 20%. The respiratory symptoms include morning cough, morning phlegm and shortness of breath were significantly higher among domestic waste collectors compared than among office workers, but no significant difference in chest tightness symptom. The spirometry result showed that prevalence of abnormal lung function among 95 domestic waste collectors was 12 (12.6%), type of abnormality of lung function test found that the most of abnormality was restrictive abnormality (75%) and obstructive abnormality had 25%. This study indicated that the waste collectors showed higher prevalence of respiratory symptoms as compared to the office workers. (27)

Sanjay (2009) study of occupational health problems among door to door solid waste handlers, in Surat city, Gujarat. The object to study the prevalence of occupational related morbidities and factors related to them among door to door waste collectors. The result indicated that major risk factors were untrained workers, manual handlers, unhygienic sorting of waste, not use of protective equipments, part time job, not following protocol for waste handling and workers collecting household waste less than three tons per day. The morbidity among 300 waste collectors with respiratory complaints was 187 (62.3%) such as cough with phlegm, chest tightness, wheeze, etc. Association of respiratory complaints and risk factors found that sorting material from the waste, living condition (industrial factory near home), use of mask were associated with respiratory disorders among waste collectors. (42)

Abou-ElWafa, et al. (2014) studied of respiratory disorders among municipal solid waste collectors in Mansoura, Egypt. This research assessed the prevalence of respiratory complaints and occupational factors among municipal solid waste collectors. A comparative study was conducted among municipal solid waste collectors in Western Municipality of Mansoura. The study was conducted during January 2011 to August 2011. The demographic characteristics, the majority of solid waste collectors aged equal of more 40 years old (78.3%), mean age was 47.4 years old, most of the solid waste collectors were illiterate (89.2%) and were current smoker 55.0%. The solid waste collectors were employed for long period (median 15 years, min 1 year and max 36 years). A minority of solid waste collectors wore face masks (0.8%), the main reason for noncompliance was unavailability of personal protective measures (90%), and the percentage of obesity was 16.7% among solid waste collectors. 25% of solid waste collectors had respiratory disorders such as chronic bronchitis, bronchial asthma and upper respiratory tract infections. Prevalence of each respiratory complaint such as shortness of breath was 21.0%, cough and phlegm 16.7% and sneezing 8.3%. The result of this study suggested that the prevalence of respiratory complaints during the past 12 months was higher among solid waste collectors than the service workers. The variables include older age, cigarette smoking, and duration of employment was associated with pulmonary function (impaired FEV1). In addition, older age group of collectors was associated with impaired FVC, including, duration of employment was associated with impaired FEV1/ FVC. (43)

Markalio (2008) studied of occupational injuries respiratory health problem and related factors among refuse handlers at Tanga city, Tanzania. The cross-sectional study was carried out where 135 refuse handlers and 113 other workers were involved. The result indicated that prevalence of injuries and respiratory problems were higher among refuse collectors than in other workers. Overall prevalence of acute respiratory problem was 65.9%, coughing in the morning 19.3%, and cough in day or night 26.7%. On the use of PPE most respondent know that PPE are important but they don’t use because they are not provide which mean not available. The study finding it is concluded that refuse collectors are highly affected by injuries and acute respiratory symptoms compared to other worker. (79)

van Eerd (1997) studied of occupational health aspects of waste collection and recycling an inventory study in India. The study regards the health of the waste pickers as compared to the control group. Prevalence of respiratory disease among waste pickers was 71% and control group was 34%. It was concluded that prevalence of respiratory disease higher among waste pickers than the control group. (80)

Conclusion, from literature review, many study suggested that the workers who implemented waste collection had respiratory health problem. The cause of respiratory health problem may from exposure to organic dust, bioaerosols, and vehicle exhaust from occupational environment. In general, smoking was cause respiratory health problem and age was associated with respiratory system. Base on information of past study, the factors were association with respiratory health problem include general factors, health factors and environmental factors such as age, living condition, cigarette smoking, behavior of health protection, working condition, type of occupation and duration of work. However, the degree of the health problem in each country might have different due to several factors that different condition.

CHAPTER III
MATERIALS AND METHODS

3.1 Study design

This study was a cross sectional study. General research objective one to study the prevalence and factors associated with respiratory symptom and pulmonary function among workers who implemented solid waste collection of the Bangkok Metropolitan Administration (BMA).

3.2 Study area

This cross sectional study was conducted at the Pathumwan district of Bangkok, Thailand. Base on data in 2013 that Pathumwan district was one of the districts that had high particulate matters of less than 10 microns in diameter (PM_{10}), including high amount of solid waste (2, 28)

3.3 Population and sample

3.3.1 Population

The population was workers who implemented solid waste collection in the Pathumwan district of the Bangkok Metropolitan Administration, both truck driver and solid waste collector. Number of workers around 242 person (Public cleansing and public park section of the Pathumwan district; 2013)

3.3.2 Sample size and sampling

The method of sample size determination for workers who implemented solid waste collection of the Bangkok Metropolitan Administration in the Pathumwan district was computed from 242 workers by Daniel’s formula (81).

The Daniel's formula as follow:

$$n = \frac{Nz^2pq}{d^2(N-1) + z^2pq}$$

When n = Sample size

N = Population size

α The level of statistical significance was set at 0.05

z = The value from normal distribution with 95% confidence interval

Thus, $z_{\alpha/2} = 1.96$

p = Unknown population proportion (%)

In study of Djoharnis, et al. (2012) found that respiratory symptom prevalence with cough was 20% among household waste collectors in Malaysia. Thus, estimating proportion = 0.20

q = 1 – p = 0.80

d = 95% confidence interval is desired with *d* = 0.05

Then, we computed sample size when: N = 242, $z_{\alpha/2} = 1.96$, *p* = 0.20, *q* = 0.80, *d* = 0.05

$$n = \frac{242(1.96)^2(0.20)(0.80)}{(0.05)^2(242\text{-}1) + (1.96)^2(0.20)(0.80)}$$

$$= \frac{148.7468}{0.6025 + 0.6147}$$

$$= 122.2$$

$$\approx 123$$

When we considered 30% of non-participant, we required 160 participants. A simple random sampling was used to collected data.

3.4 Sample selection

The sample selection was done through a simple random sampling and the sample selection was done by considering both inclusion criteria and exclusion criteria as follow:

3.4.1 Inclusion criteria

The inclusion criteria of this study include:

(1) The worker who implemented solid waste collection for at least 6 months.

(2) Volunteering and willing to participate in this research, which were informed on details of this research and volunteers sign their consent.

3.4.2 Exclusion criteria

The exclusion criteria of this study include:

(1) There was illness that might affect pulmonary function test (spirometry) such as hemoptysis, nausea and vomiting.

(2) There was condition of pneumothorax that had not been treated.

(3) There was condition of abnormal cardiovascular system such as hypertension.

(4) There was infection of respiratory system such as pulmonary Tuberculosis (inflectional phase)

(5) There was eye surgery, cataract surgery, thoracic surgery or abdominal surgery in last 3 months.

(6) Pregnancy during research

(7) The volunteer cancel participation during research

3.5 Research instrument

The research instruments for this study were questionnaire and pulmonary function test that was used measurement of study variables as follow:

3.5.1 Interview-guided questionnaire

The questionnaire divided into 5 parts:

Part I : General characteristics and health behaviors i.e. gender, race, education, age, weight, height, living conditions, exercise, cigarette smoking and alcohol drinking.

Part II : Occupational history i.e. position, duration of work, number of days that work in the week, working period, job rotation, second job/occupation and previous occupation.

Part III : Health preventive behaviors i.e. use of respiratory protective equipment, type of respiratory protective equipment and the reasons for not using.

Part IV : Past illness history and family history i.e. past respiratory conditions, other illness, medication and parent respiratory illness.

Part V : Respiratory symptoms

This questionnaire adjusted from the recommended respiratory disease questionnaire (ATS-DLD-78) by the American Thoracic Society. The content validity was assessed by the experts. Then items with unclear wording were revised. The revised questionnaire was approved by the expert before collecting data.

3.5.2 Pulmonary function test

The most frequently performed pulmonary function test is spirometry. Spirometry is a physiological test; it is the cornerstone of occupational respiratory evaluation programs that used for both screening and clinical evaluations. In this study, pulmonary function was measured by a calibrated digital spirometer: Minispir SN A23 T01859, turbine flow meters by the Medical International Research (MIR, Italy) that comply with the American Thoracic Society/European Respiratory Society Task Force (ATS/ERS) standards. Measured parameters include FVC, FEV_1 and FEV_1/FVC% and performed following the Thailand Thoracic Society recommendations: Guidelines for spirometry.

3.6 Duration of data collection

This research had started collecting data during November 2014 up to December 2014. Each participating workers was interviewed to about demographic/ general characteristics, health factors, occupational factors and respiratory symptoms. Then, pulmonary function test with spirometry method. For each participant was taken about 20-30 minutes to complete data collection.

The researcher had started process to collecting data after this project have been reviewed and approved by the Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University.

3.7 Process of data collection

Process of data collection by the following steps:

3.7.1 Cooperation

The researcher coordinated with the Pathumwan district office of BMA for cooperation in data collection, objectives clarification, project implementation and request for permission to collect information in area.

3.7.2 Preparation

The researcher prepared the research instruments and equipment. As well as prepared the research assistant to clarify the detailed content of the questionnaire and interviews. The research assistants are public health officers, person through lung function test training that had experience and expertise in lung function test.

3.7.3 Interview-guided questionnaire

The workers (participants) were clarified research objectives and methods. Then, the workers signed their consent to participate in this research.

The Interview-guided questionnaire base on general characteristics, health factors, occupational factors and information of respiratory symptom was used to gather information from the workers (participants).

3.7.4 Preparation of the subject

3.7.4.1 The preparation of workers before the test as follow:

- Do not exercise at least 30 minutes
- Avoid to smoking at least one hour
- Do not wear any clothes which tight chest / abdomen
- Avoid to large meals at least two hours
- Avoid to alcohol drinking at least four hours.
- Avoid to drinks tea, coffee and any beverages which containing caffeine at least two hours

3.7.4.2 Measure blood pressure of the workers (participants) by using the automatic blood pressure monitor for screening to hypertension due to affects to pulmonary function test.

3.7.5 Pulmonary function test

The spirometry method was used to evaluate abnormality of individual pulmonary function. The participants were explained the procedure and prepare before pulmonary function test. Process of pulmonary function test as follow:

3.7.5.1 Equipment quality control

Calibration is an important part of good practice, calibration checks of spirometer before start to process of pulmonary function test as follows:

- Calibration checks daily, at least 1 time per day or calibrated 1 time every 4 hours if the spirometer was used continuously.
- If there was changed location that may be change temperature, pressure and humidity, check the spirometer calibration must be repeat before testing of pulmonary function.

3.7.5.2 Demonstration of spirometry test

The research and research assistant demonstrated techniques and the procedure of spirometry test as follow:

- Explain the pulmonary function test
- prepare data of the subject: ask about smoking, recent illness, medication use, measure weight and height without shoes. Age, height and weight are recorded for uses in the calculation of reference/predicted values.

- Instruct and demonstrate the test: correct posture with head slightly elevated, inhale rapidly and completely, position of the mouthpiece (open circuit) and exhale with maximal force

- Perform the spirometry test: subject assume the correct posture, attach nose clip, inhale completely and rapidly, place mouthpiece in mouth and close lips around the mouthpiece and then, exhale maximally until no more air can be expelled. Repeat instructions as necessary, repeat no more than eight are usually required.

Acceptability criteria:

- Individual spirograms are ‘‘acceptable’’ if they are free from artifacts: cough during the first second of exhalation, glottis closure that influences the measurement, early termination or cut-off, effort that is not maximal throughout, leak or obstructed mouthpiece.

- They have good starts (extrapolated volume, 5% of FVC or 0.15 litters, whichever is greater

- They showed satisfactory exhalation (duration of 6 seconds or a plateau in the volume-time curve if the subject cannot or should not continue to exhale)

Reproducibility criteria:

After acceptable spirograms have been obtained, apply the following tests

- The two largest values of FVC must differ not more than 0.20 liters and the two largest values of FEV_1 must differ not more than 0.20 liters.

- The best spirogram was considered from the largest FVC value and the largest FEV_1 value for interpretation of spirometry test.

Test result selection:

FVC and FEV_1 measured from a series of at least three forced expiratory curves that have an acceptable start of spirometry test and are free from artifact, such as a cough or early termination. The largest FVC and the largest FEV_1 recorded after examining the data from all of the usable curves, even if they do not come from the same curve.

3.8 Data analysis

3.8.1 Interpretation of respiratory symptoms data

Respiratory symptoms in this study were cough, phlegm, wheezing and breathlessness.

- Cough refer to usually have cough, cough as much as 4-6 times a day- 4 or more days out of the week, cough in the morning, cough during the day or at night, cough most days for 3 consecutive months. (These, if was one or more than one condition, it means had cough symptom)

- Phlegm refer to usually bring up phlegm from the chest, usually had phlegm as much as 4-6 times a day- 4 or more days out of the week, phlegm in the morning, phlegm during the day or at night, phlegm most days for 3 consecutive months. (These, if was one or more than one condition, it means had phlegm symptom)

- Wheezing refer to the chest ever sound wheezy or whistling

- Breathlessness refers to shortness of breath when hurrying on the level or walking up a slight hill, walks slow on the level because of breathlessness, ever have stop for breath when walking about 100 meters or after a few minutes on the level, too breathless to leave the house or breathless on dressing. (These, if was one or more than one condition, it means had breathlessness symptom)

Interpretation of respiratory symptoms data as follow:

- Present respiratory symptom refers to have one or more than one symptom in these respiratory symptoms: cough, phlegm, wheezing and/or breathlessness.

- Absent respiratory symptom refers to absence any symptom in those respiratory symptoms.

3.8.2 Interpretation of pulmonary function test

Pulmonary function test by spirometry was used to evaluate abnormality of individual lung function**.** Measured parameters include FVC, FEV_1 and FEV_1/FVC%. Fixed cut-off points for abnormality of spirometry base on FVC, FEV_1 and FEV_1/FVC% value, that is, 80% of the predicted for FVC and FEV_1, and 70% for FEV_1/FVC%* (* 75 for FEV_1/FVC%, if subject age less than 50 years old)

Fixed cut-off points for abnormality of spirometry

Parameters	Normal level
FEV_1/FVC	≥ 70 % *
FEV_1	≥ 80 % predicted
FVC	≥ 80 % predicted

Note: * 75 if subject age less than 50 years old

- Forced vital capacity (FVC) is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration, expressed in liters

- Forced expiratory volume in 1 second (FE_{V1}) is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration, expressed in liters.

- FEV_1/FVC ratio is computed from Forced expiratory volume in 1 second value divided Forced vital capacity value.

Interpretation of pulmonary function test

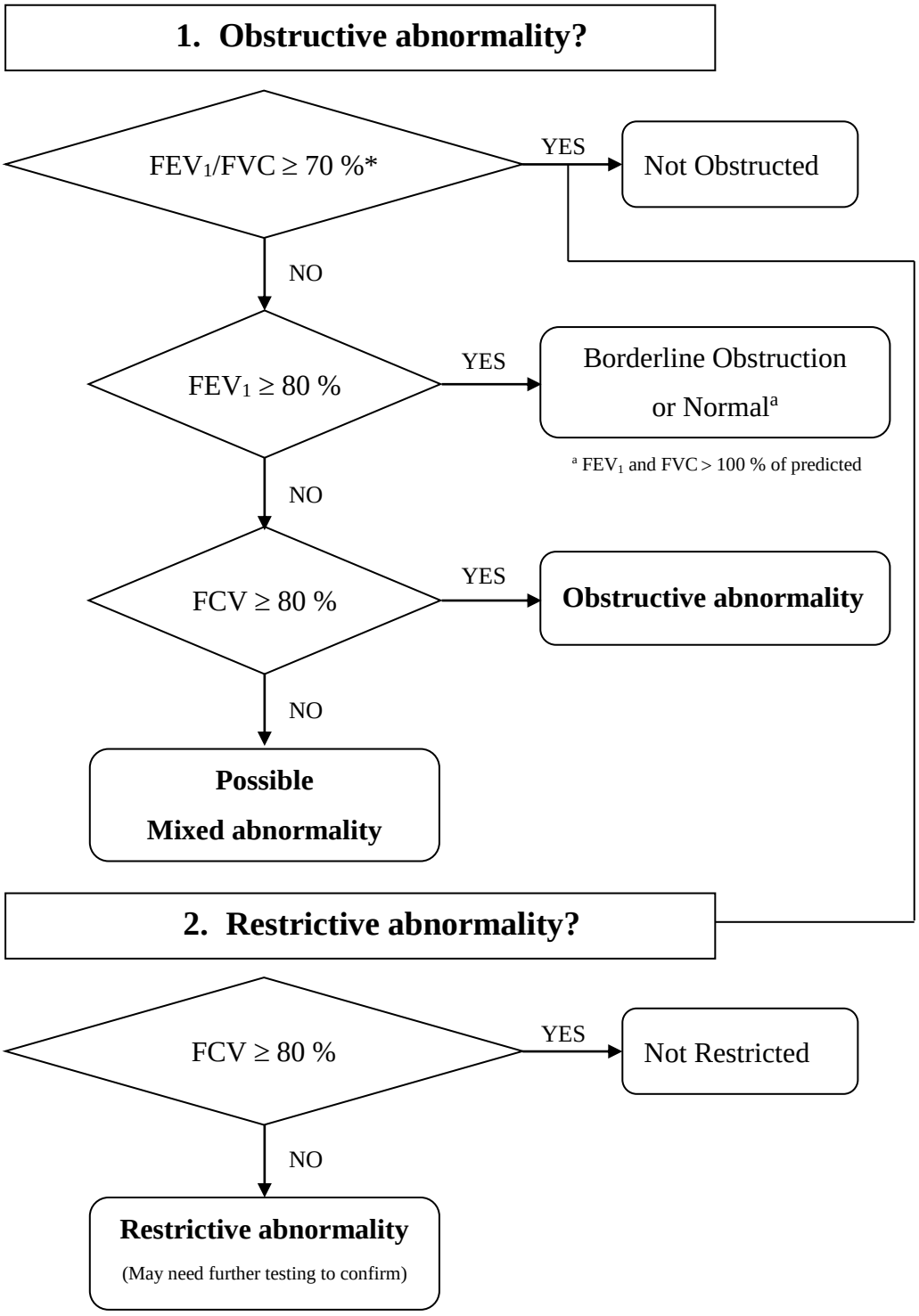
The interpretation of pulmonary function test was comparisons of data measured with reference values base on health subjects, predicted value are computed with Siriraj equation.

Abnormalities of pulmonary function are obstructive abnormalities, restrictive abnormalities and mixed abnormalities (the coexistence of obstruction and restriction).

- Abnormal pulmonary function means any abnormalities of pulmonary function (obstructive, restrictive or mixed abnormalities).

- Normal pulmonary function means to not any abnormalities of pulmonary function.

Guideline for interpretation of abnormalities pulmonary function test, considered from The Thailand Thoracic Society recommendations: Guidelines for spirometry and the American College of Occupational and Environmental Medicine (ACOEM): ACOEM guidance statement, Spirometry in the Occupational Health Setting (2011)



Spirometry interpretation; Adjusted from Guidelines for spirometry by ACOEM

3.8.3 Statistical analysis

Descriptive statistics such as mean, min, max, frequency and percentage were used to describe all study variables.

Independent variables for this study were:

- General characteristics i.e. age, body mass index, living conditions and family history
- Health factors i.e. past respiratory conditions, cigarette smoking, exercise, alcohol drinking and use of personal protective equipment
- Occupational factors i.e. position, duration of work, working period, second job/occupation and previous occupation

Dependent variables for this study were:

- Respiratory symptoms
- Pulmonary function

Prevalence of respiratory symptoms was computed from the number of cases that present respiratory symptoms divided by the number of workers in study. As well as, the prevalence of abnormal pulmonary function was computed from the number of cases that had abnormality from pulmonary function test result divided by the number of workers in study. The chi-square test was used to compare the different between two proportions. The chi-square test for trend was used to explore the trend when there were more than two levels.

Analysis of the association was analyzed as two sections: 1) bivariate analysis by simple logistic regression was used to explore associations between one dependent variable and one independent variable and then 2) multivariate analysis by multiple logistic regression was used to explore associations between one dependent variable and two or more independent variables, the purpose of the multiple logistic regressions is to isolate the relationship between the independent variables and dependent variable from the effects of one or more other variables (called covariates or confounders). In analysis of the association, variables were re-coded into dichotomous variable. The level of statistical significant was set at 0.05.

3.9 Ethical consideration

This research protocol was reviewed and approved by the Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University. Permission to carry out was obtained data collection from director of the Pathumwan district office, Bangkok Metropolitan Administration. Written consent for participating in this project. The collected data were used only purpose of this study. All information obtained in the study was kept confidential, used for research only and destroyed when the research is completed. The research presentation was showed in overall. Researcher was conducted strictly according of ethical human research principles.

CHAPTER IV
RESULTS

Study of prevalence and factors associated with respiratory symptoms and pulmonary function among solid waste collectors of the Bangkok Metropolitan Administration (BMA), data was collected by interview and pulmonary function test, from sample of 160 with complete data collected 100.0%, present the results of a study as the following.

1. General characteristics, health and occupational history.
2. Prevalence of respiratory symptoms and pulmonary function.
3. Factors associated with respiratory symptoms and pulmonary function.

4.1 General characteristics, health and occupational history

4.1.1 Demographic characteristics of solid waste collectors

The demographic characteristics of workers were collected among 160 workers who involved solid waste collection shows in Table 4-1.

All solid waste collectors were male. The highest grade completed in school among solid waste collectors was primary school level (63.8%). The age of solid waste collectors ranged from 19 – 59 years old , mean age was 42.18 years old (42.18 ± 9.96). The height and weight of solid waste collectors ranged from 150 – 188 centimeters, 47 – 150 kilograms, mean height and weight of solid waste collectors was 167.18 centimeters (167.18 ± 6.90), 68.71 kilograms (68.71 ± 14.24). The body mass index (BMI) of solid waste collectors ranged from 16.07 – 46.30 kg/m^2, mean BMI of solid waste collectors was 24.52 kg/m^2 (24.52 ± 4.37), 55.0% of solid waste collectors were normal weight (BMI 18.5 – 24.9 kg/m^2).

Table 4-1 Demographic characteristics of solid waste collectors

Characteristics	Workers (n = 160)	
	Number	**Percentage (%)**
Gender : Male	160	100.0
Race : Thai	160	100.0
Highest level of education		
Primary school	102	63.8
Secondary school	56	35.0
Junior secondary school	33	
Senior secondary/High school	23	
Tertiary education	2	1.2
Age (years)		
< 30	22	13.8
30-39	41	25.6
40-49	55	34.4
≥ 50	42	26.2
Mean = 42.18 SD = 9.96		
Min = 19 Max = 59		
Height (centimeters)		
< 160	13	8.1
160 - 169	90	56.3
≥ 170	57	35.6
Mean = 167.18 SD = 6.90		
Min = 150.0 Max = 188.0		
Weight (kilograms)		
< 60	45	28.1
60 - 69	45	28.1
70 - 79	37	23.1
≥ 80	33	20.6
Mean = 68.71 SD = 14.24		
Min = 47.0 Max = 150.0		

Table 4-1 Demographic characteristics of solid waste collectors (cont.)

Characteristics	Workers (n = 160)	
	Number	Percentage (%)
Body mass index: BMI (kg/m^2)		
Under weight (BMI <18.5)	6	3.8
Normal weight (BMI 18.5 – 24.9)	88	55.0
Over weight (BMI 25.0 – 29.9)	48	30.0
Obesity (BMI ≥ 30)	18	11.2
Mean = 24.52 SD = 4.37		
Min = 16.07 Max = 46.30		

Table 4-2 Family history and environmental factor of solid waste collectors

Factors	Workers (n = 160)	
	Number	Percentage (%)
Living conditions		
Living near factory or sources of air pollution:		
No	147	91.9
Yes	13	8.1
Family history		
Biological parents ever told by a doctor that they had a chronic lung conditions:		
No	145	90.6
Yes	15	9.4
Chronic bronchitis	1	
Asthma	6	
Allergy	2	
Other lung disease	6	

4.1.2 Family history and environmental factor

The environmental factor and family history of workers were collected among 160 workers who involved solid waste collection shows in Table 4-2.

Living conditions: 8.1% of solid waste collectors lived near factory or sources of air pollution.

Family history: 9.4% of solid waste collectors who biological parents had respiratory diseases/chronic lung conditions such as chronic bronchitis, asthma, allergy, other lung disease, etc.

4.1.3 Health behaviors

The cigarette smoking, exercise and alcohol drinking behaviors of workers were collected among workers who involved solid waste collection shows in Table 4-3

The majority of solid waste collectors have ever smoked cigarettes (70.6%), with more than half of smokers were current smokers (79.6%) and 20.4% of smokers were former smokers. Among smoking workers, 48.7% smoked 1-9 cigarettes per day, 43.3% smoked 10-19 cigarettes per day and 8.0% smoked ≥ 20 cigarettes per day. Smoking duration ranged from 1 – 47 years, 54.0% smoked for ≥ 20 years.

The majority of solid waste collectors have never exercised before or after working (68.1%). Alcohol drinking, 51.3% of solid waste collectors were drinkers, with more than half of drinkers were current drinkers (81.7%) and 18.3% of drinkers were former drinkers.

The health preventive behaviors of workers were collected among workers who involved solid waste collection shows in Table 4-4

The majority of solid waste collectors have never used Personal Protective Equipment (PPE) for respiratory protection while working (83.8%), 16.2% of solid waste collectors have ever used the respiratory protective equipment, with 8.7% used the respiratory protective equipment everyday while working. Type of respiratory protective equipment, 92.3% used general masks and 7.7% used hygienic face masks. The majority of solid waste collectors didn’t use the respiratory protective equipment because they believed not expose to hazards (5.5%), uncomfortable (74.0%) and other reasons (20.5%). If the organization supplies Personal Protective Equipment, 60.0% of solid waste collectors will use its.

Table 4-3 Health behaviors of solid waste collectors

Health behaviors	Workers (n = 160)	
	Number	Percentage (%)
Cigarette smoking		
Never smoke	47	29.4
Smoke	113	70.6
Former smoker (n = 113)	23	20.4
Current smoker (n = 113)	90	79.6
Number of cigarettes per day (n = 113)		
1 – 9	55	48.7
10 – 19	49	43.3
≥ 20	9	8.0
Mean = 8.99 SD = 6.52		
Min = 1 Max = 30		
Smoking duration: years (n = 113)		
1 – 9	16	14.1
10 – 19	36	31.9
≥ 20	61	54.0
Mean = 21.82 SD = 11.17		
Min = 1 Max = 47		
Exercise behavior (less than 30 minutes)		
Never exercise	109	68.1
Exercise	51	31.9
Alcohol drinking behavior		
Never drink	78	48.7
Drink	82	51.3
Former drinker (n = 82)	15	18.3
Current drinker (n = 82)	67	81.7

Table 4-4 Health preventive behaviors among solid waste collectors

Behaviors		Workers (n = 160)	
		Number	Percentage (%)
Use of respiratory protective equipment			
Never use		134	83.8
Ever use		26	16.2
Type of respiratory protective equipment			
General masks	n = 26	24	92.3
Hygienic face masks	n = 26	2	7.7
Behavior of using respiratory protective equipment (Use every day while working**)**			
No		146	91.3
Yes		14	8.7
The reasons for not using (n = 146)			
Believe that not exposed to hazards		8	5.5
Uncomfortable		108	74.0
Other reasons		30	20.5
If the organization will supply the protective equipment, will you use it?			
No		64	40.0
Yes		96	60.0

4.1.4 Past medical history and medication

The past medical histories of workers were collected among 160 workers who involved solid waste collection shows in Table 4-5.

Past respiratory conditions: 20.0% of solid waste collectors had respiratory conditions such as bronchitis, asthma, pneumonia, allergy, etc. and 17.5% of solid waste collectors had back - chest conditions such as chest injuries, chest operations, back injuries, etc., in addition to had other illnesses such as high blood pressure (8.1%), diabetes (3.8%).

Table 4-5 Past medical history of solid waste collectors

Illnesses	Workers (n = 160)	
	Number	Percentage (%)
Past respiratory conditions:		
Did you have respiratory conditions such as bronchitis, asthma, other lung disease?		
No	128	80.0
Yes	32*	20.0
Allergy	16	
Bronchitis	6	
Pneumonia	2	
Asthma	7	
Emphysema	1	
Tuberculosis	2	
Other lung disease or involve respiratory system	2	
Back - Chest conditions		
Did you have back or chest conditions such as injuries, operations?		
No	132	82.5
Yes	28*	17.5
Chest injuries	6	
Chest operations	3	
Ribs broken (injuries)	6	
Back injuries	15	
Other illnesses		
High blood pressure	13	8.1
Diabetes	6	3.8

* Some persons had more than one condition

The medications of workers were collected among workers who involved solid waste collection shows in Table 4-6.

Current and previous medications: the majority of solid waste collectors were not taking any medications (85.0%), only 15.0% of solid waste collectors were taking medications.

Among 24 solid waste collectors were taking medications, with 79.2% were taking one medication and 20.8% were taking more than one medication, type of medication such as high blood pressure medications, diabetes medications, cholesterol medications, etc.

Table 4-6 Current and previous medication

Medication	**Workers (n = 160)**	
	Number	**Percentage (%)**
Current and previous medication:		
Were you taking any medication or drug?		
No	136	85.0
Yes	24	15.0
Number of medications (n = 24)		
One medication	19	79.2
More than one medication	5	20.8
Type of medication (n=24)*		
High blood pressure medications	13	54.2
Diabetes medications	6	25.0
Cholesterol medications	2	8.3
Other medication	7	29.2

* Some persons were taking more than one medication

4.1.4 Occupational history

The current occupational characteristics of workers of workers were collected among 160 workers who involved solid waste collection shows in Table 4-7.

Position – Job title: 75.6% of workers among solid waste collection were solid waste collectors/garbage collectors and 24.4% were truck drivers.

Duration of work: the working duration of workers ranging from 1–37 years, the mean of working duration of workers was 12.75 years (12.75 ± 9.10), 40.0% worked 1–9 years, 37.5% worked 10–19 years, 22.5% worked ≥ 20 years. The majority of solid waste collectors worked every day in a week (96.2%).

Working period: the majority of solid waste collectors worked from 9 pm to 5 am (78.1%), 12.5% worked from 5 am to 1 pm, 9.4% worked from 1 pm to 9 pm.

Working conditions: the majority of solid waste collectors reported that they involved or exposed to waste, aerosol, dust or other occupational health hazards (90.6%).

Job rotation in current organization: the majority of solid waste collectors did not have job rotation (93.1%) but the minority of solid waste collectors had job rotation such as sweeper, garden worker.

Second job or occupation: the majority of solid waste collectors did not have a second job (76.2%), but the minority of solid waste collectors had second job such as taxi drivers, chauffeurs, motorcycle driver, general labor and other (23.8%).

Table 4-7 Current occupational characteristics of worker among solid waste collectors

Characteristics	Workers (n = 160)	
	Number	Percentage (%)
Position – Job title		
Garbage/Solid waste collector	121	75.6
Truck driver	39	24.4
Number of workdays in a week		
6 days	6	3.8
7 days (usually 6 days, over time 1 day)	154	96.2

Table 4-7 Current occupational characteristics of worker among solid waste collectors (cont.)

Characteristics	Workers (n = 160)	
	Number	Percentage (%)
Duration of work (years)		
1-9	64	40.0
10-19	60	37.5
≥ 20	36	22.5
Mean = 12.75 SD = 9.10		
Min = 1 Max = 37		
Working period		
9:00 pm - 5:00 am	125	78.1
5:00 am - 1:00 pm	20	12.5
1:00 pm - 9:00 pm	15	9.4
Working conditions (involved or exposed to waste, aerosol, dust, smoke, other health hazards)		
Did not involve/ expose	15	9.4
Involved/ exposed	145	90.6
Job rotation in current organization		
Did not have job rotation	149	93.1
Had job rotation	11	6.9
Second job/occupation		
Did not have second job	122	76.2
Had second job	38	23.8
Taxi drivers and Chauffeurs	5	
Motorcycle driver	8	
Retail store	14	
General labor and other	11	

The previous occupational characteristics of workers were collected 160 workers among solid waste collection shows in Table 4-8.

The previous occupation and past working conditions: more than half of solid waste collectors have ever worked in factories or other organization (58.8%), with 36.2% of them involved or exposed to health hazards at the previous occupation.

Table 4-8 Previous occupational characteristics

Characteristics	Workers (n = 160)	
	Number	Percentage (%)
Previous occupation (worked in factories or other organization)		
Never	66	41.2
Ever	94	58.8
Past working conditions (involved or exposed to waste, aerosol, dust, smoke, other health hazards)		
Did not involve/ expose	102	63.8
Involved/ exposed	58	36.2

4.2 Prevalence of respiratory symptoms and pulmonary function

4.2.1 Prevalence of respiratory symptoms

Among 160 solid waste collectors, 64 persons had respiratory symptoms, with 31 persons had one respiratory symptom and 33 persons had more than one respiratory symptom. The overall prevalence of respiratory symptom among solid waste collectors was 40.0%. Prevalence computed from the information display in Table 4-9.

The respiratory symptom among 64 solid waste collectors had respiratory symptoms with phlegm 57.8%, breathlessness 46.9%, cough 45.3%, and wheezing 21.9% as shown in Table 4-9.

Table 4-9 Respiratory symptoms among solid waste collectors

Variables	Workers	
	Number	Percentage (%)
Respiratory health status		
Did not have respiratory symptoms	96	60.0
Had respiratory symptoms	64*	40.0
one symptom	31	
more than one symptom	33	
Respiratory symptoms		
Cough	29	18.1 (45.3)
Phlegm	37	23.1 (57.8)
Wheezing	14	8.8 (21.9)
Breathlessness	30	18.8 (46.9)

Note: *some persons had more than one symptom, Percentage in ( ) is computed from among 64 workers who had respiratory symptoms

The prevalence of respiratory symptoms with general characteristic factors among solid waste collectors shows in Table 4-10.

Age:

Among 22 solid waste collectors aged < 30 years old, 10 persons had respiratory symptoms with prevalence 45.5%. Among 41 solid waste collectors aged ranging from 30-39 years old, 14 persons had respiratory symptoms with prevalence 34.1%. Among 55 solid waste collectors aged ranging from 40-49 years old, 20 persons had respiratory symptoms with prevalence 36.4%. Among 42 solid waste collectors aged ≥ 50 years old, 20 persons had respiratory symptoms with prevalence 47.6%. The prevalence of respiratory symptoms in each age group was not significantly different.

Body mass index (BMI):

Among 142 solid waste collectors had BMI < 30.0 kg/m^2, 56 persons had respiratory symptoms with prevalence 39.4% and among 18 solid waste collectors had BMI ≥ 30.0kg/m^2, 8 persons had respiratory symptoms with prevalence 44.4%. The prevalence of respiratory symptoms in both groups was not significantly different.

Living conditions:

Among 13 solid waste collectors lived near factory or air pollution sources, 10 persons had respiratory symptoms with prevalence 76.9%. Among 147 solid waste collectors did not live near factory or air pollution sources, 54 persons had respiratory symptoms with prevalence 36.7%. The prevalence of respiratory symptoms in both groups was significantly different (p-value = 0.005).

Family history:

Among 15 solid waste collectors who biological parents had chronic lung conditions, 8 persons had respiratory symptoms (prevalence 53.3%). Among 145 solid waste collectors who natural parents had chronic lung conditions, 56 persons had respiratory symptoms (prevalence 38.6%). The prevalence of respiratory symptoms in both groups was not significantly different.

Table 4-10 Prevalence of respiratory symptoms with general characteristic factors among solid waste collectors

Variables	n	Respiratory symptoms	Prevalence (%)	p-value
Age (years)				
< 30	22	10	45.5	0.606[a]
30-39	41	14	34.1	
40-49	55	20	36.4	
≥ 50	42	20	47.6	
Body mass index: BMI (kg/m^2)				
< 30.0	142	56	39.4	0.683
≥ 30.0 (Obesity)	18	8	44.4	
Living conditions				
Living near factory or sources of air pollution**:**				
No	147	54	36.7	0.005*
Yes	13	10	76.9	
Family history				
Biological parents ever told by a doctor that they had a chronic lung conditions:				
No	145	56	38.6	0.268
Yes	15	8	53.3	

Note: * Significant at p-value < 0.05, [a] Chi-square test for trend

The prevalence of respiratory symptoms with health factors among solid waste collectors shows in Table 4-11.

Past respiratory conditions:

Among 128 solid waste collectors did not have respiratory conditions in past medical history, 46 persons had respiratory symptoms with prevalence 35.9%. Among 32 solid waste collectors had respiratory conditions in past medical history (such as bronchitis, asthma, allergy, other lung disease), 18 persons had respiratory symptoms with prevalence 56.2%. The prevalence of respiratory symptoms in both groups was significantly different (p-value = 0.036)

Cigarette smoking behaviors:

Among 113 solid waste collectors who have ever smoked cigarettes, 52 persons had respiratory symptoms with prevalence 46.0%. Among 47 solid waste collectors have never smoked cigarettes, 12 persons had respiratory symptoms with prevalence 25.5%. The prevalence of respiratory symptoms in both groups was significantly different (p-value = 0.016).

Among 55 solid waste collectors smoked 1-9 cigarettes per day, 20 persons had respiratory symptoms with prevalence 36.4%. Among 49 solid waste collectors smoked 10-19 cigarettes per day, 26 persons had respiratory symptoms with prevalence 53.1%, and among 9 solid waste collectors smoked ≥ 20 cigarettes per day, 6 persons had respiratory symptoms with prevalence 66.7%. The prevalence of respiratory symptoms in each group was significantly different (p-value = 0.033), the prevalence trended to increase as cigarettes increased.

Among 16 solid waste collectors smoked for 1-9 years, 6 persons had respiratory symptoms with prevalence 37.5%, among 36 solid waste collectors smoked for 10-19 years, 10 persons had respiratory symptoms with the prevalence 27.8%, and among 61 solid waste collectors smoked for ≥ 20 years, 36 persons had respiratory symptoms with prevalence 59.0%. The prevalence of respiratory symptoms in each group was significantly different (p-value = 0.016), the group of smoked for ≥ 20 years had the highest prevalence.

Exercise:

There were no exercises for 43 persons among 109 solid waste collectors had respiratory symptoms with prevalence 39.4%. It also found exercises for 21 persons among 51 solid waste collectors had respiratory symptoms with prevalence 41.2%. The prevalence of respiratory symptoms in both groups was not significantly different.

Alcohol drinking:

Among 78 solid waste collectors who did not drink alcohol, 29 persons had respiratory symptoms with prevalence 37.2%. There were 35 drinker among 82 solid waste collectors had respiratory symptoms with prevalence 42.7%. The prevalence of respiratory symptoms in both groups was not significantly different.

Behavior of using respiratory protective equipment:

Among 14 solid waste collectors used PPE for respiratory protection every day while working; only 2 persons had respiratory symptoms with prevalence 14.3%. Among 146 solid waste collectors did not use PPE every day while working, 62 persons had respiratory symptoms with prevalence 42.5%. The prevalence of respiratory symptoms in both groups was significantly different (p-value = 0.040). The group of workers did not use PPE every day had higher the prevalence of respiratory symptoms than among workers use every day.

Table 4-11 Prevalence of respiratory symptoms with health factors among solid waste collectors

Variables	n	Respiratory symptoms	Prevalence (%)	p-value
Past respiratory conditions:				
Had respiratory conditions such as bronchitis, asthma, other lung disease, etc.				
No	128	46	35.9	0.036*
Yes	32	18	56.2	

Note: * Significant at p-value < 0.05

Table 4-11 Prevalence of respiratory symptoms with past respiratory conditions and health behavior factors among solid waste collectors (cont.)

Variables	n	Respiratory symptoms	Prevalence (%)	p-value
Cigarette smoking status				
Never smoke	47	12	25.5	0.016*
Smoke	113	52	46.0	
Number of cigarettes per day				
1 – 9	55	20	36.4	0.001*[a]
10 – 19	49	26	53.1	
≥ 20	9	6	66.7	
Smoking duration (years)				
1 – 9	16	6	37.5	0.001*[a]
10 – 19	36	10	27.8	
≥ 20	61	36	59.0	
Exercise				
Never exercise	109	43	39.4	0.835
Exercise	51	21	41.2	
Alcohol drinking				
Never drink	78	29	37.2	0.478
Drink	82	35	42.7	
Behavior of using respiratory protective equipment (Use every day while working**)**				
No	146	62	42.5	0.040*
Yes	14	2	14.3	

Note: * Significant at p-value < 0.05, [a] Chi-square test for trend

The prevalence of respiratory symptoms with occupational factors among solid waste collectors shows in Table 4-12.

Position – Job title:

Among 121 workers were waste collectors, 45 persons had respiratory symptoms with prevalence 37.2%. There were 39 truck driver, 19 persons had respiratory symptoms with prevalence 48.7%. The prevalence of respiratory symptoms in both groups was not significantly different.

Duration of work:

Among 64 workers had the working duration ranging from 1–9 years, 24 persons had respiratory symptoms with prevalence 37.5%, among 60 workers working for 10–19 years that 24 persons had respiratory symptoms with prevalence 40%, and among 36 workers who had worked ≥ 20 years, 16 persons had respiratory symptoms with prevalence 44.4%. The prevalence trended to increase as the working duration increased that among workers who had worked ≥ 20 years had the highest prevalence but there was not significant different.

Working period:

The prevalence of respiratory symptoms among workers working from 9 pm to 5 am was 40.8%, prevalence was 35.0% among workers working from 5 am to 1 pm, and prevalence was 40.0% among workers working from 1 pm to 9 pm. The prevalence of respiratory symptoms in different groups with working period was not significantly different.

Second job:

Among 122 workers, there were 51 persons had second job or part time job that had respiratory symptoms with prevalence 41.8%. Among 38 workers did not have second job or part time job, 13 persons had respiratory symptoms with prevalence 34.2%. The prevalence of respiratory symptoms in both groups was not significantly different.

Previous occupation:

The prevalence of respiratory symptom among workers never work at factories or other organization in the past was 40.9%, workers who have ever worked at factories or other organization in the past was 39.4%. The prevalence of respiratory symptoms in both groups was not significantly different.

Table 4-12 Prevalence of respiratory symptoms with occupational factors among solid waste collectors

Variables	n	Respiratory symptoms	Prevalence (%)	p-value
Position – Job title				
Solid waste collector	121	45	37.2	0.201
Truck driver	39	19	48.7	
Duration of work (years)				
1-9	64	24	37.5	0.504[a]
10-19	60	24	40.0	
≥ 20	36	16	44.4	
Working period				
9:00 pm - 5:00 am	125	51	40.8	0.886
5:00 am - 1:00 pm	20	7	35.0	
1:00 pm - 9:00 pm	15	6	40.0	
Second job/occupation				
Did you have any second job or part-time job?				
No	122	51	41.8	0.404
Yes	38	13	34.2	
Previous occupation				
Have you ever worked in factories or other organization?				
Never	66	27	40.9	0.844
Ever	94	37	39.4	

Note: [a] Chi-square test for trend

4.2.2 Prevalence of abnormal pulmonary function

The results of pulmonary function test of workers were tested among 160 workers that involved solid waste collection by spirometry test shows in Table 4-13.

The FEV_1 value ranging from 1.69 to 4.42 liters, mean FEV_1 value was 2.97 liters (2.97 ± 0.47).

The FVC value ranging from 2.15 to 4.65 liters, mean FVC value was 3.21 liters (3.21 ± 0.46).

The FEV_1/FVC value ranging from 69.50 to 100.00%, mean FEV_1/FVC value was 92.53% (92.53 ± 4.97).

Interpretation of pulmonary function test was comparisons of data measured in an individual subject with predicted values (reference values). In this study, predicted values were calculated with "Siriraj" equation that reference spirometric values for healthy lifetime nonsmoker in Thailand.

Overall, the percentage of predicted FEV_1 and percentage of predicted FVC value shows in Table 4-14.

The percentage of predicted FEV_1 value ranged from 66.00 to 121.00%, mean value was 94.97% (94.97 ± 11.18).

The percentage of predicted FVC value ranging from 67.00 to 115.00%, mean value was 83.78% (83.78 ± 8.14).

The classification of spirometry results among solid waste collectors based on FEV_1, FVC and FEV_1/FVC shows in Table 4-15.

The abnormal spirometry among solid waste collectors that prevalence of abnormal FEV_1 (%predicted) was 8.8%, abnormal FVC (%predicted) was 30.6% and abnormal FEV_1/FVC was 1.2%.

Information of interpretation to define subjects as "normal" or "abnormal" pulmonary function and define types of abnormalities display in Table 4-16

The overall prevalence of abnormal pulmonary function among solid waste collectors was 31.9%. Prevalence computed from among 160 solid waste collectors, 51 persons had abnormalities of pulmonary function. The majority of abnormal types were restrictive abnormality.

Table 4-13 Result of pulmonary function test among solid waste collectors

Parameters	Min	Max	Mean	SD
FEV_1 (liters)	1.69	4.42	2.97	0.47
FVC (liters)	2.15	4.65	3.21	0.46
FEV_1/FVC (%)	69.50	100.00	92.53	4.97

Table 4-14 Percentages of predicted FEV1 and FVC among solid waste collectors

Parameters	Min	Max	Mean	SD
FEV_1 (% of predicted)	66.00	121.00	94.97	11.18
FVC (% of predicted)	67.00	115.00	83.78	8.14

Table 4-15 Classification of spirometry result among solid waste collectors based on FEV_1, FVC and FEV_1/FVC

Parameters	Normal		Abnormal	
	Number	%	Number	%
% predicted FEV_1	146	91.2	14	8.8
% predicted FVC	111	69.4	49	30.6
%FEV_1/FVC	158	98.8	2	1.2

Note: Normal when % predicted FEV_1, % predicted FVC ≥ 80, % FEV_1/FVC ≥ 70* (* 75 if subject age less than 50 years old)

Table 4-16 Interpretation of pulmonary function test among solid waste collectors

Pulmonary function test	Workers (n = 160)	
	Number	Percentage (%)
Normal	109	68.1
Abnormal	51	31.9
Obstructive abnormality (n = 51)	2	3.9
Restrictive abnormality (n = 51)	49	96.1

Prevalence of abnormal pulmonary function with general characteristic factors among solid waste collectors shows in Table 4-17.

Age:

Among 22 solid waste collectors aged < 30 years old, 6 persons had abnormal pulmonary function with prevalence 27.3%. Among 41 solid waste collectors aged ranging from 30-39 years old, 7 persons had abnormal pulmonary function with prevalence 17.1%. Among 55 solid waste collectors aged ranging from 40-49 years old, 19 persons abnormal pulmonary function with the prevalence 34.5%. Among 42 solid waste collectors aged ≥ 50 years old, 19 persons had abnormal pulmonary function with prevalence 45.2%. The prevalence of abnormal pulmonary function significantly trended to increase if the age increased. (p-value = 0.020)

Body mass index (BMI):

Among 142 solid waste collectors had BMI < 30.0 kg/m^2, 44 persons had abnormal pulmonary function with prevalence 31.0% and among 18 solid waste collectors had BMI ≥ 30.0kg/m^2, 7 persons had abnormal pulmonary function with prevalence 38.9%. The prevalence of respiratory symptoms in both groups was not significantly different.

Living conditions:

Among 13 solid waste collectors lived near factory or air pollution sources, 7 persons had abnormal pulmonary function with prevalence 53.8% and among 147 solid waste collectors did not live near factory or air pollution sources, 44 persons had abnormal pulmonary function with prevalence 29.9%. The workers who lived near factory or air pollution sources trended to higher the prevalence of abnormal pulmonary function than another groups, p-value = 0.076

Family history:

Among 15 solid waste collectors who biological parents had chronic lung conditions, 5 persons had abnormal pulmonary function with prevalence 33.3%. Among 145 solid waste collectors who biological parents had chronic lung conditions, 46 persons had abnormal pulmonary function (prevalence 31.7%). The prevalence of abnormal pulmonary function in both groups was not significantly different.

Table 4-17 Prevalence of abnormal pulmonary function with general characteristic factors among solid waste collectors

Variables	n	Abnormal PF	Prevalence (%)	p-value
Age (years)				
< 30	22	6	27.3	0.020*[a]
30-39	41	7	17.1	
40-49	55	19	34.5	
≥ 50	42	19	45.2	
Body mass index: BMI (kg/m^2)				
< 30.0	142	44	31.0	0.498
≥ 30.0 (Obesity)	18	7	38.9	
Living conditions				
Living near industrial factory or sources of air pollution**:**				
No	147	44	29.9	0.076
Yes	13	7	53.8	
Family history				
Biological parents ever told by a doctor that they had a chronic lung conditions:				
No	145	46	31.7	0.899
Yes	15	5	33.3	

Note: PF, pulmonary function, *Significant at p-value < 0.05,

[a] Chi-square test for trend

The prevalence of abnormal pulmonary function with health factors among solid waste collectors shows in Table 4-18.

Past respiratory conditions:

Among 128 solid waste collectors did not have respiratory conditions in the past medical history, 37 persons had abnormal pulmonary function with prevalence 28.9%. Among 32 solid waste collectors had respiratory conditions in the past medical history, 14 persons had abnormal pulmonary function with prevalence 43.8%, the prevalence of abnormal pulmonary function in both groups was not significantly different.

Cigarette smoking behaviors:

Among 113 solid waste collectors have ever smoked cigarettes, 33 persons had abnormal pulmonary function with prevalence 29.2%, among 47 solid waste collectors have never smoked cigarettes, 18 persons had abnormal pulmonary function with prevalence 38.3%, the prevalence of abnormal pulmonary function in both groups was not significantly different.

Among 55 solid waste collectors smoked 1-9 cigarettes per day, 13 persons had abnormal pulmonary function with prevalence 23.6%, 49 solid waste collectors smoked 10-19 cigarettes per day, 15 persons had abnormal pulmonary function with prevalence 30.6%, and 9 solid waste collectors smoked ≥ 20 cigarettes per day, 6 persons had abnormal pulmonary function with prevalence 55.6%. The prevalence of abnormal pulmonary function trended to increase as cigarettes increased (p-value = 0.077).

Among 16 solid waste collectors smoked for 1-9 years, 4 persons had abnormal pulmonary function with prevalence 25.0%, 36 solid waste collectors smoked for 10-19 years, 7 persons had abnormal pulmonary function with prevalence 19.4%, and 61 solid waste collectors smoked for ≥ 20 years that 22 persons had abnormal pulmonary function with prevalence 36.1%. The prevalence of respiratory symptoms in each group was not significantly different.

Exercise:

Among 109 solid waste collectors did not exercise, 38 persons had abnormal pulmonary function with prevalence 34.9%, 51 solid waste collectors exercise, 13 persons had abnormal pulmonary function with prevalence 25.5%. However, the prevalence of abnormal pulmonary function in both groups was not significantly different.

Alcohol drinking:

Among 78 solid waste collectors did not drink alcohol, 27 persons had abnormal pulmonary function with prevalence 34.6%. Among 82 solid waste collectors were drinker, 24 persons had abnormal pulmonary function with prevalence 29.3%. The prevalence of abnormal pulmonary function in both groups was not significantly different.

Behavior of using respiratory protective equipment:

Among 14 solid waste collectors used PPE to respiratory protection every day while working, 3 persons had abnormal pulmonary function with prevalence 21.4%. Among 146 solid waste collectors did not use PPE every day while working, 48 persons had abnormal pulmonary function with prevalence 32.9%. The workers did not use PPE every day while working had higher the prevalence of abnormal pulmonary function than among used PPE every day. However, the prevalence of abnormal pulmonary function in both groups was not significantly different.

Table 4-18 Prevalence of abnormal pulmonary function with health factors among solid waste collectors

Variables	n	Abnormal PF	Prevalence (%)	p-value
Past respiratory conditions:				
Had respiratory conditions such as bronchitis, asthma, other lung disease, etc.				
No	128	37	28.9	0.107
Yes	32	14	43.8	

Table 4-18 Prevalence of abnormal pulmonary function with health factors among solid waste collectors (cont.)

Variables	n	Abnormal PF	Prevalence (%)	p-value
Health behavior factors				
Cigarette smoking status				
Never smoke	47	18	38.3	0.261
Smoke	113	33	29.2	
Number of cigarettes per day				
1 – 9	55	13	23.6	0.077*[a]
10 – 19	49	15	30.6	
≥ 20	9	5	55.6	
Smoking duration (years)				
1 – 9	16	4	25.0	0.166[a]
10 – 19	36	7	19.4	
≥ 20	61	22	36.1	
Exercise				
Never exercise	109	38	34.9	0.236
Exercise	51	13	25.5	
Alcohol drinking				
Never drink	78	27	34.6	0.468
Drink	82	24	29.3	
Behavior of using respiratory protective equipment (Use every day while working**)**				
No	146	48	32.9	0.380
Yes	14	3	21.4	

Note: PF, pulmonary function, *Significant at p-value < 0.1

[a] Chi-square test for trend

The prevalence of abnormal pulmonary function with occupational factors among solid waste collectors shows in Table 4-19.

Position – Job title:

Among 121 workers were waste collectors, 37 persons had abnormal pulmonary function with prevalence 30.6%. Among 39 workers were truck driver, 14 persons had abnormal pulmonary function with prevalence 35.9%. The prevalence of abnormal pulmonary function in both groups was not significantly different.

Duration of work:

Among 64 workers had the working duration ranging from 1–9 years, 14 persons had abnormal pulmonary function with prevalence 21.9%, among 60 workers worked 10–19 years, 19 persons had abnormal pulmonary function with prevalence 31.7%, and among 36 workers worked ≥ 20 years, 18 persons had abnormal pulmonary function with prevalence 50.0%. The prevalence of abnormal pulmonary function significantly trended to increase as working duration increased. (p-value = 0.005)

Working period:

The prevalence of abnormal pulmonary function among workers working from 9 pm to 5 am, from 5 am to 1 pm, from 1 pm to 9 pm were 30.4%, 35.0% and 40.0%, respectively, but the prevalence of abnormal pulmonary function in different groups with working period were not significantly different.

Second job/Part time job:

The prevalence of abnormal pulmonary function among workers who had second job or part time job and among did not have second job or part time job were 26.3%, 33.6%, respectively. The prevalence of abnormal pulmonary function in both groups was not significantly different.

Previous occupation:

The prevalence of abnormal pulmonary function among workers who have never worked at factories or other organization in the past was 37.9%, among them have ever worked at factories or other organization in the past was 27.7%, the prevalence was not significantly different.

Table 4-19 Prevalence of abnormal pulmonary function with occupational factors among solid waste collectors

Variables	n	Abnormal PF	Prevalence (%)	p-value
Position – Job title				
Solid waste collector	121	37	30.6	0.535
Truck driver	39	14	35.9	
Duration of work (years)				
1-9	64	14	21.9	0.005*[a]
10-19	60	19	31.7	
≥ 20	36	18	50.0	
Working period				
9:00 pm - 5:00 am	125	38	30.4	0.715
5:00 am - 1:00 pm	20	7	35.0	
1:00 pm - 9:00 pm	15	6	40.0	
Second job/occupation				
Did you have any second job or part-time job?				
No	122	41	33.6	0.400
Yes	38	10	26.3	
Previous occupation				
Have you ever worked in factories or other organization?				
Never	66	25	37.9	0.172
Ever	94	26	27.7	

Note: PF, pulmonary function, [a] Chi-square test for trend

4.3 Factors associated with respiratory symptoms and pulmonary function.

Analysis of the association was analyzed as two sections: 1) bivariate analysis by simple logistic regression was used to explore associations between one dependent variable and one independent variable and then 2) multivariate analysis by multiple logistic regression was used to explore associations between one dependent variable and two or more independent variables, the purpose of multiple logistic regressions is to isolate the relationship between the independent variables and dependent variable from the effects of one or more other variables (called covariates or confounders)

4.3.1 Factors associated with respiratory symptoms

Bivariate analysis was used to explore association between respiratory symptoms and other variables among solid waste collectors, the results show in Table 4-20. The independent variables, including living conditions (near factory or sources of air pollution), past respiratory conditions, and cigarette smoking were significantly associated with respiratory symptoms (p-value < 0.05). There was clear tendency to significant association between the use of respiratory protective equipment every day while working and respiratory symptoms (p-value near at 0.05)

The probability of developing respiratory symptoms among solid waste collectors who lived near factory or sources of air pollution was 5.74 times of that workers did not live near factory or sources of air pollution (OR = 5.741, 95% CI 1.514 - 21.773, p-value = 0.010). The likelihood to delivery respiratory symptoms for solid waste collectors experiencing past respiratory diseases was 2.3 times of that did not have past respiratory diseases (OR = 2.292, 95% CI 1.044 - 5.031, p-value = 0.039). The probability of developing respiratory symptoms among solid waste collectors who smoke cigarette was about 2.5 times of that non- smoking solid waste collectors (OR = 2.486, 95% CI 1.171 - 5.278, p-value = 0.018). The probability of developing respiratory symptoms among solid waste collectors who did not use PPE every day was about 4.4 times of that workers who used PPE ever day (OR = 4.429, 95% CI 0.957 - 20.503, p-value = 0.057).

Multivariate analysis by multiple logistic regressions was used to explore association between respiratory symptoms and two or more independent variables that associated significantly with respiratory symptoms at p-value < 0.05 or near 0.10 were included in each model. The results show in Table 4-21.

The results of multivariate analysis, both the living conditions (living near factory or sources of air pollution) and cigarette smoking were significantly associated with respiratory symptoms (p-value < 0.05), the past respiratory conditions and the use of PPE to respiratory protection every day while working tended toward significantly associated with respiratory symptoms (p-value near at 0.10)

There was a strong association between living near factory or sources of air pollution and respiratory symptoms in bivariate analysis (OR = 5.741). After controlling the covariates or confounders effect of past respiratory conditions and cigarette smoking, the risk for respiratory symptoms among solid waste collectors who lived near industrial factory or sources of air pollution was about 5.6 times of that workers who did not live near industrial factory or sources of air pollution (OR_{adj} = 5.630, 95% CI 1.419 - 22.346, p-value = 0.014).

In bivariate analysis, there was association between cigarette smoking and respiratory symptoms among solid waste collectors (OR = 2.486). After controlling the covariates or confounders effect of past respiratory conditions and living conditions, the probability of developing respiratory symptoms among solid waste collectors smoking cigarette was about 2.7 times of that non- smoking solid waste collectors (OR_{adj} = 2.688, 95% CI = 1.216 - 5.940, p-value = 0.015).

In addition, there was clear tendency to significant association between the use of PPE to respiratory protection every day while working and respiratory symptoms in bivariate analysis (OR = 4.429). After controlling the covariates effect of cigarette smoking, the trend of risk for respiratory symptoms among solid waste collectors who did not use PPE every day was about 3.8 times of that workers who used PPE ever day (OR_{adj} = 3.844, 95% CI = 0.815 – 18.128, p-value = 0.089)

Table 4-20 Association of respiratory symptoms and other variables among solid waste collectors by bivariate analysis

Variables	OR	95% CI		p-value
		Lower	Upper	
General characteristic factors				
Age (≥ 40 years)	1.140	0.596	2.184	0.692
Body mass index (Obesity, BMI ≥ 30.0 kg/m^2)	1.229	0.457	3.302	0.683
Living conditions (near industrial factory or sources of air pollution)	5.741	1.514	21.773	0.010
Family history (parents had a chronic lung conditions)	1.816	0.624	5.285	0.273
Health factors				
Past respiratory conditions*	2.292	1.044	5.031	0.036
Cigarette smoking	2.486	1.171	5.278	0.018
Exercise	1.074	0.546	2.115	0.835
Alcohol drinking	1.258	0.667	2.373	0.478
Use of PPE to respiratory protection (did not use PPE every day)	4.429	0.957	20.503	0.057
Occupational factors				
Position – Job title	0.623	0.301	1.291	0.203
Duration of work (≥ 20 years)	1.267	0.598	2.682	0.537
Working period	1.275	0.479	3.394	0.696
Second job / part-time job	0.724	0.338	1.549	0.405
Previous occupation (had ever worked in factories or other organization)	0.938	0.493	1.782	0.844

Note: * Past respiratory conditions such as bronchitis, asthma, pneumonia, allergy, etc.

Table 4-21 Association of respiratory symptoms and other variables among solid waste collectors by multivariate analysis

Variables	Adjusted OR	95% CI		p-value
		Lower	Upper	
Model 1				
Living conditions (near industrial factory or sources of air pollution)	5.127	1.292	20.352	0.020
Past respiratory conditions	2.065	0.897	4.752	0.088
Cigarette smoking	2.515	1.128	5.606	0.024
Use of PPE to respiratory protection (did not use PPE every day)	3.232	0.674	15.507	0.143
Model 2				
Living conditions (near industrial factory or sources of air pollution)	5.630	1.419	22.346	0.014
Past respiratory conditions	2.087	0.913	4.770	0.081
Cigarette smoking	2.688	1.216	5.940	0.015
Model 3				
Use of PPE to respiratory protection (did not use PPE every day)	3.844	0.815	18.128	0.089
Cigarette smoking	2.311	1.078	4.956	0.031
Model 4				
Living conditions (near industrial factory or sources of air pollution)	6.345	1.613	24.962	0.008
Cigarette smoking	2.667	1.218	5.840	0.014

Note: * Past respiratory conditions such as bronchitis, asthma, pneumonia, allergy, etc.

4.3.2 Factors associated with abnormal pulmonary function

Bivariate analysis was used to explore association between abnormal pulmonary function and other variables among solid waste collectors as shown in Table 4-22. Duration of work and age of workers were significantly associated with abnormal pulmonary function (p-value < 0.05), including the living conditions (near industrial factory or sources of air pollution) tended toward significantly associated with abnormal pulmonary function (p-value < 0.10).

The probability of developing abnormal pulmonary function among solid waste collectors who worked ≥ 20 years was 2.76 times of that solid waste collectors who worked less than 20 years (OR = 2.758, 95% CI 1.283 - 5.927, p-value = 0.009).

The likelihood to delivery abnormal pulmonary function for solid waste collectors 40 years or older was about 2.5 times of that for solid waste collectors less than 40 years (OR = 2.477, 95% CI 1.189 - 5.160, p-value = 0.015).

The probability of developing abnormal pulmonary function among solid waste collectors who lived near industrial factory or sources of air pollution was 2.73 times of that workers who did not live industrial factory or sources of air pollution (OR = 2.731, 95% CI 0.868 - 8.592, p-value = 0.086).

Multivariate analysis by multiple logistic regressions was used to explore association between abnormal pulmonary function and two or more independent variables that significantly associated with abnormal pulmonary function at p-value < 0.05 or near 0.10 were included in each model as shown in Table 4-23.

The results of multivariate analysis, after controlling the covariates effect of age and past respiratory diseases, the duration of work and living conditions were tended toward significantly associated with abnormal pulmonary function (p-value < 0.10)

There was a moderate association between working duration and abnormal pulmonary function in bivariate analysis (OR = 2.758), after controlling the covariate effect of age and the living condition factor, there was trend that the risk for abnormal pulmonary function among solid waste collectors who worked ≥ 20 years was about 2.19 times of that solid waste collectors who worked less than 20 years (OR_{adj} = 2.188, 95% CI 0.942 – 5.081, p-value = 0.069).

Table 4-22 Association of abnormal pulmonary function and other variables among solid waste collectors by bivariate analysis

Variables	OR	95% CI		p-value
		Lower	Upper	
General characteristic factors				
Age (≥ 40 years)	2.477	1.189	5.160	0.015
Body mass index (Obesity, BMI ≥ 30.0 kg/m^2)	1.417	0.515	3.900	0.499
Living conditions (near industrial factory or sources of air pollution)	2.731	0.868	8.592	0.086
Family history (parents had a chronic lung conditions)	1.076	0.348	3.328	0.899
Health factors				
Past respiratory conditions	1.913	0.863	4.241	0.110
Cigarette smoking	0.665	0.325	1.358	0.262
Exercise	0.639	0.304	1.344	0.238
Alcohol drinking	0.782	0.401	1.522	0.469
Use of PPE to respiratory protection (did not use PPE every day)	1.796	0.479	6.740	0.386
Occupational factors				
Position – Job title	0.787	0.368	1.682	0.536
Duration of work (≥ 20 years)	2.758	1.283	5.927	0.009
Working period	0.851	0.318	2.281	0.450
Second job / part-time job	0.706	0.313	1.592	0.401
Previous occupation (had ever worked in factories or other organization)	0.627	0.320	1.228	0.173

Note: * Past respiratory conditions such as bronchitis, asthma, pneumonia, allergy, etc.

Table 4-23 Association of abnormal pulmonary function and other variables among solid waste collectors by multivariate analysis

Variables	Adjusted OR	95% CI		p-value
		Lower	Upper	
Model 1				
Age (≥ 40 years)	1.928	0.851	4.369	0.116
Living conditions (near industrial factory or sources of air pollution)	2.981	0.887	10.023	0.077
Past respiratory conditions	1.761	0.760	4.081	0.187
Duration of work (≥ 20 years)	2.246	0.960	5.257	0.062
Model 2				
Age (≥ 40 years)	1.981	0.878	4.469	0.099
Living conditions (near industrial factory or sources of air pollution)	3.291	0.997	10.860	0.051
Duration of work (≥ 20 years)	2.188	0.942	5.081	0.069
Model 3				
Living conditions (near industrial factory or sources of air pollution)	3.118	0.965	10.079	0.057
Duration of work (≥ 20 years)	2.935	1.350	6.383	0.007

Note: * Past respiratory conditions such as bronchitis, asthma, pneumonia, allergy, etc.

4.3.3 Association of pulmonary function and respiratory symptoms

The chi-square test was used to determine association between respiratory symptoms and pulmonary function, the results show in Table 4-24.

The results showed that there were significant association between respiratory symptoms and abnormal pulmonary function among 160 solid waste collectors (χ^2 = 8.870, p-value = 0.003). The probability of the present respiratory symptoms give the abnormal pulmonary function was 56.9% (sensitivity of respiratory symptoms = 56.9%).

The variety of probability estimates of each respiratory symptom computed from the information display in Table 4-25, summary of sensitivity and specificity as shown in Table 4-26.

The sensitivity of each respiratory symptom include breathlessness, phlegm, cough, and wheezing were 58.6%, 55.2%, 41.4%, and 24.1%, respectively.

The breathlessness was the highest sensitivity, the probability of the present breathlessness symptom give the abnormal pulmonary function was 58.6% (sensitivity of breathlessness = 58.6%).

Table 4-24 Association of pulmonary function and respiratory symptoms

Respiratory symptoms	**Pulmonary function test**		**Total**	**χ^2**	**p-value**
	Abnormal	**Normal**			
Present	29	35	64	8.870	0.003
	56.9%	32.1%			
Absent	22	74	96		
	43.1%	67.9%			
Total	51	109	160		

Note: Significant at p-value < 0.05

Table 4-25 Number and percentage of abnormal pulmonary function in each respiratory symptom among respiratory symptom workers (n = 64)

Respiratory symptoms			Pulmonary function test	
			Abnormal	Normal
Cough	Present	Count	18	17
		% within cough	51.4%	48.6%
		% within Pulmonary function	51.4%	58.6%
	Absent	Count	17	12
		% within cough	58.6%	41.4%
		% within Pulmonary function	48.6%	41.4%
Phlegm	Present	Count	14	13
		% within phlegm	51.9%	48.1%
		% within Pulmonary function	40.0%	44.8%
	Absent	Count	21	16
		% within phlegm	56.8%	43.2%
		% within Pulmonary function	60.0%	55.2%
Wheezing	Present	Count	28	22
		% within wheezing	56.0%	44.0%
		% within Pulmonary function	80.0%	75.9%
	Absent	Count	7	7
		% within wheezing	50.0%	50.0%
		% within Pulmonary function	20.0%	24.1%
Breathlessness	Present	Count	22	12
		% within breathlessness	64.7%	35.3%
		% within Pulmonary function	62.9%	41.4%
	Absent	Count	13	17
		% within breathlessness	43.3%	56.7%
		% within Pulmonary function	37.1%	58.6%

Table 4-26 Summary of Sensitivity and specificity of each respiratory symptom with pulmonary function test result among respiratory symptom workers (n = 64)

Respiratory symptoms	Sensitivity	Specificity	Positive predictive value
Cough	41.4%	51.4%	41.4%
Phlegm	55.2%	40.0%	43.2%
Wheezing	24.1%	80.0%	50.0%
Breathlessness	58.6%	62.9%	56.7%

CHAPTER V
DISCUSSION

Solid waste collectors had exposure to various health hazards such as pathogens (fungi, viruses, bacteria and parasites), bio-aerosols, chemical (both from waste itself and waste composition), and smoke as well as air pollutants and vehicle exhaust (21). This cross-sectional study aimed to measure the prevalence and identify association between general characteristics, occupational factors, health factors, respiratory symptoms and pulmonary function among solid waste collectors of the Bangkok Metropolitan Administration. This chapter presents the discussion of research finding from the result in the chapter IV and compares the result with previous studies.

5.1 General characteristics among solid waste collectors

Among 160 solid waste collectors were male and aged 19 – 59 years old (mean 42.18). The highest grade completed in school among solid waste collectors was primary school level (63.8%). Similar to the study of Chomchey (2013) showed the study of refuse collectors in one district office of the Bangkok Metropolitan Administration, the study population was exclusively male with an average age of 42.1 years, and 66.9% completed only primary level education (26). The majority of solid waste collectors were smokers (70.6%). Similar to several studies, they found that most of waste collectors were smokers (20, 21, 42, 43). The duration of work among solid waste collectors ranged from 1–37 years (mean 12.75 years), 22.5% worked ≥ 20 years. Similar to Abou-ElWafa, et al. (2014), they found that the solid waste collectors were employed for long period, median 15 years, min 1 year and max 36 years (43). The majority of solid waste collectors worked every day of the week (overtime), 96.2%. Similar to Djoharnis, et al. (2012) 97.9% of among domestic waste collectors practiced overtime job (27). The possible reason explains were the human activities generated waste materials in communities every day (29).

5.2 Prevalence of respiratory symptoms and pulmonary function

There were several studies survey the prevalence and factors associated with respiratory symptom and pulmonary function. In this study, we compared to the study results with previous studies on similar population.

Prevalence of respiratory symptoms

Based on several previous studies indicated that waste collectors showed sign of increasing respiratory symptoms or respiratory problem compared with other workers (18, 20, 21, 22, 27, 79). In present study, the overall prevalence of respiratory symptoms among solid waste collectors was 40.0%. The distribution of each respiratory symptom was phlegm 23.1%, breathlessness 18.8%, cough 18.1%, and wheezing 8.8%. A possible explanation may be that the solid waste collectors exposed to organic dust, and bioaerosols or aerosolized fungi and bacteria (11, 15-18). In addition, most of solid waste collectors did not use personal protective equipment for respiratory protection. Previous study such as Yang, at el. (2001) indicated that household waste collectors presented a risk for the development of chronic respiratory symptoms such as cough 17.3%, wheezing 15.4%, phlegm 14.3%, and breathlessness 11.1%. Neghab, et al. (2013) indicated that the frequency of respiratory symptoms among garbage collectors included breathlessness 39.0%, wheezing 18.1%, phlegm 10.5%, and cough 6.7%. Athanasiou, et al. (2010) showed that the prevalence of respiratory symptoms include breathlessness, cough in the morning, cough during the day, phlegm in the morning, phlegm during the day, and coughing on exertion were 50%, 29%, 16%, 28%, 26% and 25%, respectively. Hansen, et al. (1997) The prevalence of respiratory symptoms among waste collectors were found; cough 27.8%, wheeze 23%, phlegm 14.6% and itching nose 11.5%. Djoharnis, et al. (2012) The most frequency of respiratory symptoms among waste collectors were shortness of breath 42.1%, morning phlegm 32.6% and morning cough 20%.

The prevalence of respiratory symptoms including characteristics of respiratory complaints may vary or differ from other countries. In present study, most of the workers complained of phlegm, followed by breathlessness, and cough. Among solid waste collectors who lived near industrial factory or air pollution sources present significantly higher of respiratory symptoms (76.9%) than among did not live near air pollution sources (36.7%). Among workers who have ever smoked cigarettes present

significantly the prevalence of respiratory symptoms (46.0%) higher than among workers who have never smoked cigarettes (25.5%). In addition to the prevalence of respiratory symptoms higher among workers who did not use PPE every day while working (42.5%) than among used PPE to respiratory protection every day (14.3%). The possible explanation may be that the job description of waste collectors may differ from other countries including personal factors may differ and environmental factor (such as air pollutants) may vary from other countries.

Prevalence of abnormal pulmonary function

The previous studies indicated that the natural of solid waste collection, job characteristics of waste collectors were exposed to various hazards from waste its and environment such as organic dust, chemical fume, and air pollutants as well as may have exposure to bioaerosols (20, 21) due to the solid waste collection involved working vehicle that moves through traffic throughout the year, the waste collectors were standing on the platform-behind the waste truck and near garbage, including they work without respiratory protection such as did not use mask while working.

In present study, the overall prevalence of abnormal pulmonary function among solid waste collectors was 31.9%. The interpretation results of pulmonary function showed that FVC (% predicted), FEV_1 (% predicted), and FEV_1/FVC (%) value among solid waste collectors which lower than normal level were 30.6%, 8.8%, and 1.2%, respectively. Most of pulmonary function interpretation results indicated that had possible restrictive abnormality. In general, lung volumes were related to body size, age, and standing height was the most important correlating variable (74). In present study showed that there was the probability of development to abnormal pulmonary function among solid waste collectors significantly trended to increase as age increased, and there was the probability of development to abnormal pulmonary function significantly trended to increase as working duration increased. But this study showed that among solid waste collectors who smoked cigarettes presenting the prevalence of abnormal pulmonary function was not significantly different in non-smokers group. Similar report of the study in Mansoura, Egypt by Abou-ElWafa HS, et al. (2014) indicated that the majority of municipal solid waste collectors with impaired respiratory function test were more than 40 years of age. The differences between solid waste collectors with normal and abnormal pulmonary function were

statistically significant regarding age and duration of employment. In present study showed that the majority of pulmonary function test result among solid waste collectors had possible restrictive abnormality, similar results of Djoharnis, et al. (2012), the most of pulmonary function test result was restrictive abnormality. However, there was different report in Neghab, et al. (2013) reported that the ventilatory abnormality found in spirometry of garbage collectors was consistent with obstructive pulmonary disease. The prevalence of abnormal pulmonary function including types of abnormality may vary or differ from other investigators. These differences could be explained by the difference of various factors including personal characteristic factor, occupational factors, health factors, environment factors and types of agents. It may relate as duration of exposure to cause agents and exposure dose, in addition, difference in the evaluation of lung function, using different types of equipment, reference equations and interpretation algorithm.

5.3 Factors associated with respiratory symptoms and pulmonary function.

There were few previous studies exploring the factors of associations between respiratory symptom, pulmonary function and other variable.

Factors associated with respiratory symptoms

In present study, the variables include living condition (near industrial or sources of air pollution), past respiratory conditions, and cigarette smoking were significantly associated with respiratory symptoms (p-value < 0.05). There was clear tendency to significant association between the use of respiratory protective equipment every day while working and respiratory symptoms (p-value near at 0.05). Multivariate analysis by multiple logistic regressions indicated that after controlling the covariates of past respiratory conditions and cigarette smoking, the risk for respiratory symptoms among solid waste collectors who lived near industrial or sources of air pollution was about 5.63 times of that workers did not near live industrial or sources of air pollution (Adjusted odds ratio = 5.630, 95% CI 1.419 - 22.346). There was tendency to significant association between the use of PPE to respiratory protection every day and respiratory symptoms after controlling the covariates effect of cigarette smoking,

the trend of risk for respiratory symptoms among solid waste collectors who did not use PPE every day was about 3.84 times of that workers who used PPE ever day (Adjusted odds ratio = 3.844, 95% CI 0.815 – 18.128). Neghab, et al. (2013) reported that there was significantly relationship between garbage collectors occupation and prevalence respiratory symptoms, the garbage collector increased the relative risk of productive cough, phlegm, wheezing, and shortness of breath by 9.22, 9.22, 2.84 and 2.06 fold, respectively compared with other group. In present study indicated that there was not association between the occupational factors and the respiratory symptoms. However, there was clear tendency to significant association between the uses of respiratory protective equipment every day while working. The possible explanation may be that the occupational factors was not significantly associated with respiratory symptoms due to the covariates or confounders effect such as past respiratory conditions and cigarette smoking, including living condition.

Factors associated with abnormal pulmonary function

In present study found that two variables; duration of work and age were significantly associated with abnormal pulmonary function (p-value < 0.05), living conditions tended toward significantly associated with abnormal pulmonary function (p-value < 0.10). After controlling the covariate effect of age and living conditions, there was trend that the risk for abnormal pulmonary function among solid waste collectors who work ≥ 20 years was about 2.18 times of that solid waste collectors work less than 20 years (Adjusted odds ratio = 2.188, 95% CI 0.942 – 5.081). Similar to Abou-ElWafa HS, et al. (2014) studied of respiratory disorders among municipal solid waste collectors in Mansoura, Egypt. The results indicated that older age and longer duration of employment were associated with impaired pulmonary function parameters. However, the risk level or severity may be differ by vary factors such as exposure dose, health factors, and individual factors (i.e. age, obesity).

Association of pulmonary function and respiratory symptoms

In general, indications for spirometry were to evaluate symptoms, screen individuals at risk of having pulmonary disease, etc. In this study showed that there was significant association between respiratory symptoms and pulmonary function test (p-value < 0.05). The probability of the present respiratory symptoms give the abnormal pulmonary function was 56.9% (sensitivity = 56.9%).

5.4 Limitation

1) Respiratory symptoms information obtained in this study, the interview-guided questionnaire (self-report) was used for data collection, which may be having the limits of self-report methods. However, this did not mean that all data were invalid, only that they cannot be trusted in all cases.

2) This study carried out a cross-sectional survey to estimate the prevalence; there was the limit to investigate causal relationships.

3) Spirometry was used lung function test to evaluate respiratory in this study. Spirometry can provide useful diagnostic and screening information. However, it had a limitations i.e. test results can show restrictive or obstructive abnormality patterns, but they were not specific disease. Such as spirogram may show a low FEV_1, but we may not be able to determine whether the cause was from emphysema, asthma, or other disease. Additional information, such as a physical examination, chest x-rays were needed to make a diagnosis.

CHAPTER VI
CONCLUSION AND RECOMMENDATION

This cross-sectional study aimed to measure the prevalence and identify association between general characteristics, occupational factors, health factors, respiratory symptoms and pulmonary function among solid waste collectors of the Bangkok Metropolitan Administration in the Pathumwan district, Thailand. Among 160 workers aged 1-59 years, who worked at least 6 months, completed pulmonary function test and interview-guided questionnaire from November to December, 2014. This questionnaire adjusted from the recommended respiratory disease questionnaire (ATS-DLD-78) by the American Thoracic Society. The content validity was assessed and approved by the experts before collecting data

6.1 Conclusion

Among 160 solid waste collectors who participated in this study were male and aged 19 – 59 years with the mean age was 42.18 years. The mean body mass index (BMI) of solid waste collectors was 24.52 kg/m^2 with 11.2 % were obesity (BMI equal or more than 30). The majority of workers have ever smoked cigarettes (70.6%), and 54.0% smoked for ≥ 20 years. The most of workers have never used personal protective equipment (PPE) to respiratory protection while working; only 8.7% used every day while working. Duration of work 1–37 years with the mean of 12.75 years and 22.5% worked ≥ 20 years. The majority of solid waste collectors (96.2%) worked every day of the week (overtime) from 9 pm to 5 am.

Overall, prevalence of respiratory symptom among solid waste collectors was 40.0% and the prevalence of abnormal pulmonary function among solid waste collectors was 31.9%. There was significant association between respiratory symptoms and pulmonary function .The probability of the present respiratory symptoms give the abnormal pulmonary function was 56.9% (sensitivity = 56.9%).

The major health risk factors were that they did not use respiratory protective equipment, smoking, working every day, and working at night.

Conclusion:

1) The prevalence of respiratory symptoms presented significantly higher among workers who lived near industrial or air pollution sources than among did not live near air pollution sources, among smoker presented significantly prevalence of respiratory symptoms higher than non-smoker, and among workers who did not use PPE every day presented significantly prevalence of respiratory symptoms than among workers who used PPE every day.

2) The major pulmonary function abnormality was that they had possible restrictive abnormality. The prevalence of abnormal pulmonary function significantly trended to increase as age increased and duration of work increased.

3) There was significant association between general characteristic and respiratory symptoms among solid waste collectors; which variable was living conditions.

4) There were significant associations between health factors and respiratory symptoms among solid waste collectors; which variables were the past respiratory conditions, and cigarette smoking. There was clear tendency association between use of respiratory protective equipment every day while working and respiratory symptoms.

5) There were not associations between occupational factors and respiratory symptoms among solid waste collectors.

6) There was significant association between general characteristic and pulmonary function among solid waste collectors, which variable was age. The trend was that living conditions associated with abnormal pulmonary function.

7) There were not associations between health factors and pulmonary function among solid waste collectors.

8) There was significant association between occupational factor and pulmonary function among solid waste collectors, which variable was duration of work.

Although, after controlling the covariates effect; living conditions was also significantly associated with respiratory symptoms and duration of work tended toward associated with abnormal pulmonary function. The level of statistical significant was set at 0.05.

6.2 Recommendation

6.2.1 Recommendation on the study findings

There was the moderately prevalence of respiratory symptoms and abnormality of pulmonary function. In addition, the majority of solid waste collectors had poor health behaviors include cigarettes smoking, alcohol drinking, not exercise, as well as they did not use of respiratory protective equipment while working, which these were the important health risk factors. Recommendations include:

1) The District offices and Health Department of Bangkok Metropolitan Administration should provide personal protective equipment necessary based on the risk of job characteristics, for the workers who implement solid waste collection such as mask and glove, etc.

2) Provide health promotion activities such as sport day, exercise, and reduction-quitting smoking.

3) Provide regular training-health education to raise awareness of personal hygiene, occupational health and safety as well as safety standard operating procedure.

4) Provide the annual health check program based on the risk of job record and collection to a health database, as well as the regular investigate health problem.

5) Improve properly implementation of solid waste collection for occupational health and safety of workers including strategy and policies

6.2.2 Recommendation for further research

1) This study carried out among 160 solid waste collectors in only one district. Future study should be carried out with large sample size and various areas.

2) Interventional study to provide the most reliable evidence in research including evaluating occurrence of respiratory problem with health program and improve properly implementation of solid waste collection, which the intervention study can generally be considered as either preventative.

3) A comparative study of dust exposure to acute-chronic respiratory symptoms and pulmonary function among solid waste collector and other workers.

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APPENDICES

APPENDIX A

แบบสัมภาษณ์

โครงการวิจัย ความชุกและปัจจัยที่มีความสัมพันธ์กับอาการระบบทางเดินหายใจและสมรรถภาพปอด ในกลุ่มพนักงานเก็บขนขยะของกรุงเทพมหานคร

หมวดที่ 1 ข้อมูลทั่วไป

1. เพศ ☐ ชาย ☐ หญิง
2. เชื้อชาติ.....
3. ระดับการศึกษาสูงสุด.....
4. อายุ.....ปี วันที่เกิด.....เดือน.....พ.ศ.....
5. น้ำหนัก.....กิโลกรัม ส่วนสูง.....เซนติเมตร
6. ท่านออกกำลังกายเป็นประจำ อย่างน้อยครั้งละ 30 นาที หรือไม่

   ☐ ไม่ออกกำลังกาย ☐ ออกกำลังกาย ความถี่.....วันต่อสัปดาห์
7. สภาพแวดล้อมบริเวณโดยรอบที่อยู่อาศัยของท่านมีโรงงานหรือแหล่งอื่นใดที่ก่อให้เกิดมลพิษทางอากาศ เช่น ฝุ่นละออง ควัน หรือไม่

   ☐ ไม่มี

   ☐ มี ระบุรายละเอียด ประเภทโรงงาน/แหล่งกำเนิดมลพิษ.....

   สิ่งคุกคามสุขภาพ.....
8. ประวัติการสูบบุหรี่

   ก. ท่านเคยสูบบุหรี่ หรือไม่ ☐ ไม่เคย ☐ เคย

   ถ้า **“เคยสูบบุหรี่”**

   ข. ปัจจุบันท่านสูบบุหรี่หรือไม่

   ☐ ไม่สูบ ท่านเลิกสูบบุหรี่เมื่ออายุ.....ปี

   ☐ สูบ จำนวนบุหรี่ที่สูบ.....มวนต่อวัน

   ค. ท่านเริ่มสูบบุหรี่ครั้งแรก เมื่ออายุเท่าใด.....ปี สูบมานานเท่าใด.....ปี

   ง. นับตั้งแต่ท่านเริ่มสูบบุหรี่ โดยเฉลี่ยท่านสูบบุรี่.....มวนต่อวัน

   จ. ท่านสูบบุหรี่ชนิดใด

   ☐ ก้นกรอง ☐ ไม่ใช่แบบก้นกรอง ☐ สูบทั้งสองแบบ

หมวดที่ 2 ข้อมูลการทำงาน

9. ท่านทำงานในหน่วยงานนี้ตั้งแต่ พ.ศ._____ ระยะเวลาการทำงาน (อายุงาน) _____ปี
10. ปัจจุบันท่านทำงานแผนก/กลุ่มงาน _____
11. ตำแหน่งงาน_____ลักษณะงาน_____
12. ท่านทำงานสัปดาห์ละ _____วัน วันละ _____ชั่วโมง
13. ท่านทำงานในช่วงเวลาใด
    - ☐ รอบดึก เวลา 21.00 – 05.00 น.
    - ☐ รอบเช้า เวลา 05.00 – 13.00 น.
    - ☐ รอบบ่าย เวลา 13.00 – 21.00 น.
14. การทำงานของท่านเกี่ยวข้องหรือสัมผัสกับสิ่งคุกคาม เช่น ขยะมูลฝอย ฝุ่นละออง ควัน ไอระเหย สารเคมี หรือไม่
    - ☐ ไม่เกี่ยวข้อง/สัมผัส
    - ☐ เกี่ยวข้อง/สัมผัส ระบุสิ่งคุกคาม_____
      ระยะเวลาการสัมผัส_____ชั่วโมงต่อวัน
      ความถี่ในการสัมผัส_____วันต่อสัปดาห์
15. ในหน่วยงานปัจจุบันนี้ ท่านเคยย้ายแผนกทำงานหรือไม่
    - ☐ ไม่เคย
    - ☐ เคย ระบุแผนก_____ลักษณะงาน _____
      ทำมานาน _____ปี
16. ก่อนทำงานในหน่วยงานนี้ ท่านเคยทำงานในโรงงานหรือหน่วยงานอื่น หรือไม่
    - ☐ ไม่เคย ☐ เคย

    ถ้า **"เคย"** ระบุรายละเอียด

    (1) ประเภทงาน/กิจการ_____ระยะเวลาทำงาน_____ปี
    ลักษณะงานที่ทำงาน_____
    การทำงานดังกล่าวสัมผัสฝุ่นละออง ควัน ไอระเหย สารเคมี หรือไม่
    ☐ ไม่สัมผัส ☐ สัมผัส ระบุ_____

    (2) ประเภทงาน/กิจการ_____ระยะเวลาทำงาน_____ปี
    ลักษณะงานที่ทำงาน_____
    การทำงานดังกล่าวสัมผัสฝุ่นละออง ควัน ไอระเหย สารเคมี หรือไม่
    ☐ ไม่สัมผัส ☐ สัมผัส ระบุ_____
17. ท่านมีอาชีพเสริม หรือไม่
    - ☐ ไม่มี ☐ มี ระบุ _____

หมวดที่ 3 ข้อมูลพฤติกรรมการป้องกันระบบทางเดินหายใจ

18. ขณะปฏิบัติงานท่านใช้อุปกรณ์ในการป้องกันฝุ่นละอองหรือป้องกันระบบทางเดินหายใจ หรือไม่

☐ ไม่ใช้

☐ ใช้

ถ้าตอบ **"ไม่ใช้"** ข้ามไปข้อ 20

19. ก. ท่านใช้อุปกรณ์ในการป้องกันฝุ่นละอองหรือป้องกันระบบทางเดินหายใจ ชนิดใด

☐ ผ้าปิดจมูก ใช้มานาน .....ปี

☐ หน้ากากป้องกันฝุ่นละออง ใช้มานาน .....ปี

☐ อื่นๆ ระบุ ..... ใช้มานาน .....ปี

ข. ท่านใช้อุปกรณ์ป้องกันดังกล่าวทุกวันที่ทำงาน หรือไม่

☐ ทุกวัน ☐ บางครั้ง (ระบุความถี่ .....)

ค. ท่านใช้อุปกรณ์ป้องกันดังกล่าวตลอดเวลาทำงาน หรือไม่

☐ ตลอดเวลาทำงาน ☐ มากกว่า 4 ชั่วโมง

☐ 2 – 4 ชั่วโมง ☐ น้อยกว่า 2 ชั่วโมง

20. ก. ถ้าหน่วยงานจัดอุปกรณ์ป้องกันให้ ท่านจะใช้หรือไม่

☐ ไม่ใช้ ☐ ใช้

ข. ถ้า "ไม่ใช้" เพราะเหตุใดท่านจึงไม่ใช้อุปกรณ์ในการป้องกัน

☐ คิดว่าไม่เป็นอันตราย ☐ อึดอัด รำคาญ

☐ อื่นๆ ระบุ .....

หมวดที่ 4 ประวัติการเจ็บป่วยในอดีต

21. ท่านเคยเจ็บป่วยหรือมีโรคประจำตัว หรือไม่ (ที่ได้รับการวินิจฉัยจากแพทย์)

การเจ็บป่วย	ไม่ป่วย/ไม่มีโรค	ป่วย/มีโรค	เดือน/ปีที่เริ่มป่วย	การรักษาโดยแพทย์		หมายเหตุ (ยังมีอาการอยู่หรือไม่)
				ไม่มี	มี	
กระดูกซี่โครงหัก						
อุบัติเหตุบริเวณทรวงอก						
อุบัติเหตุเกี่ยวกับร่างกายด้านหลัง						
ผ่าตัดบริเวณทรวงอก						
หลอดลมอักเสบ						

การเจ็บป่วย	ไม่ป่วย/ไม่มีโรค	ป่วย/มีโรค	เดือน/ปีที่เริ่มป่วย	การรักษาโดยแพทย์		หมายเหตุ (ยังมีอาการอยู่หรือไม่)
				ไม่มี	มี	
ปอดบวม ปอดอักเสบ						
หอบหืด						
ถุงลมโป่งพอง						
วัณโรคปอด						
โรคปอดอื่นๆ……						
เบาหวาน						
ลมชัก						
โรคหัวใจ						
ภูมิแพ้						
ความดันโลหิตสูง						

22. ท่านมีประวัติการกินยาหรือใช้ยาเป็นประจำ หรือไม่

☐ ไม่มี ☐ มี ระบุชื่อ/ชนิดยา .....

23. ประวัติครอบครัว บิดา หรือมารดา หรือบุคคลในครอบครัวของท่าน เคยได้รับการวินิจฉัยจากแพทย์ว่า **เป็นโรคระบบทางเดินหายใจ** ต่อไปนี้ หรือไม่

โรค	ไม่เป็น	เป็น	ระบุผู้ป่วย (บิดา มารดา หรืออื่นๆ)	ไม่ทราบ/ไม่แน่ใจ
ภูมิแพ้				
หลอดลมอักเสบ				
หอบหืด				
โรคเยื่อหุ้มปอดเป็นหนอง				
โรคมะเร็งปอด				
โรคปอดอื่นๆ				

หมวดที่ 5 ข้อมูลอาการระบบทางเดินหายใจ

อาการไอ

24. ก. ปกติท่านมีอาการไอบ่อยๆ หรือไม่

☐ ไม่มี (ข้ามไปข้อ 24 ค) ☐ มี

ข. ท่านมีอาการไอบ่อยมากกว่า 4-6 ครั้งต่อวัน ไอนาน 4 วันหรือมากกว่าต่อสัปดาห์ หรือไม่

☐ ไม่มี ☐ มี

ค. ท่านมีอาการไอ เมื่อตื่นนอนตอนเช้า หรือไม่

☐ ไม่มี ☐ มี

ง. ท่านมีอาการไอ ในเวลากลางคืน หรือในเวลาอื่นๆของวัน หรือไม่

☐ ไม่มี ☐ มี

ถ้าตอบ “ **มี** ” ในข้อหนึ่งข้อใดข้างต้น (ข้อ 24 ก, ข, ค, ง)

จ. ท่านมีอาการไอเช่นนี้ เป็นเกือบทุกวัน ติดต่อกันนาน 3 เดือนหรือมากกว่า หรือไม่

☐ ไม่มี ☐ มี เป็นมานาน.....ปี

อาการมีเสมหะ

25. ก. ปกติท่านมีเสมหะเป็นประจำ หรือไม่ (ไม่นับเสมหะที่ไหลจากจมูกลงคอ)

☐ ไม่มี (ข้ามไปข้อ 25 ค) ☐ มี

ข. ท่านมีเสมหะมากกว่า 2 ครั้งต่อวัน มีเสมหะ 4 วันหรือมากกว่าต่อสัปดาห์ หรือไม่

☐ ไม่มี ☐ มี

ค. ท่านมีเสมหะ ในช่วงตื่นนอนตอนเช้า หรือไม่

☐ ไม่มี ☐ มี

ง. ท่านมีเสมหะ ในเวลากลางคืน หรือในเวลาอื่นๆของวัน หรือไม่

☐ ไม่มี ☐ มี

ถ้าตอบ “ **มี** ” ในข้อหนึ่งข้อใดข้างต้น (ข้อ 25 ก, ข, ค, ง)

จ. ท่านมีเสมหะเช่นนี้ เป็นเกือบทุกวัน ติดต่อกันนาน 3 เดือนหรือมากกว่า หรือไม่

☐ ไม่มี ☐ มี เป็นมานาน.....ปี

อาการไอ ร่วมกับ การมีเสมหะ

26. ถ้าท่านเคยมีอาการไอ และหรือ มีเสมหะ

ท่านมีอาการไอร่วมกับการมีเสมหะ เป็นเวลา 3 สัปดาห์หรือมากกว่า หรือไม่

☐ ไม่มี

☐ มี (รายละเอียด เช่น เริ่มเป็นเมื่ออายุเท่าใด เป็นมานานกี่ปี และการรักษา)

.....

อาการหายใจมีเสียงดังหวีด

27. ท่านมีอาการหายใจเสียงดังหวีด หรือไม่

☐ ไม่มี (ข้ามไปข้อ 34)

☐ มี ( ) 1. เมื่อเป็นหวัด เป็นมานาน.....ปี

( ) 2. บางครั้งนอกเหนือจากเป็นหวัด เป็นมานาน.....ปี

( ) 3. เกือบตลอดทั้งวันหรือทั้งคืน เป็นมานาน.....ปี

28. ท่านเคยมีอาการหายใจเสียงดังหวีด จนหายใจไม่ทันหรือหายใจขัด หรือไม่

☐ ไม่มี

☐ มีอาการ เมื่ออายุ.....ปี ความถี่.....ครั้ง/ปี

เป็นมานาน.....ปี

ถ้าตอบ “ **มี** ” ในข้อ 27 หรือ ข้อ 28

29. ท่านมีอาการเช่นนี้ ขณะทำงานเก็บขนขยะมูลฝอย/กวาด หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

30. ท่านมีอาการเช่นนี้ ขณะทำงานสัมผัสฝุ่น/ควัน/กลิ่นแรงๆ หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

31. ท่านมีอาการเช่นนี้ ขณะทำงานหนักหรือเครียด หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

32. ท่านมีอาการเช่นนี้ ขณะออกกำลังกาย หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

33. ท่านมีอาการเช่นนี้ ขณะพักหรืออยู่เฉยๆ หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

อาการแน่นหน้าอก หายใจลำบาก

34. ท่านมีอาการแน่นหน้าอก หรือหายใจลำบาก หรือไม่

☐ ไม่มี ☐ มี

35. ก. ท่านมีอาการเหนื่อยง่าย หรือหายใจหอบ เมื่อเดินอย่างเร่งรีบบนพื้นราบ หรือเมื่อเดินขึ้นที่สูงชันเพียงเล็กน้อย หรือไม่

☐ ไม่มี ☐ มี

ถ้า **“ใช่”**

ข. ขณะที่ท่านกำลังเดินอย่างธรรมดาบนพื้นราบ ท่านมีอาการเหนื่อยง่ายหรือเดินได้ช้ากว่าคนอื่นที่อยู่ในวัยเดียวกัน หรือต้องหยุดเพื่อหายใจเมื่อเดินตามปกติบนพื้นราบ หรือไม่

☐ ไม่มี ☐ มี

ค. ขณะที่ท่านกำลังเดินบนพื้นราบ หลังจากเดินได้ประมาณ 100 เมตร หรือหลังจากเดินได้สักพักประมาณ 2-3 นาทีผ่านไป ท่านต้องหยุดพักเพื่อหายใจ หรือไม่

☐ ไม่หยุดพัก ☐ หยุดพัก

ง. ท่านมีอาการหายใจหอบมากเกินกว่าที่จะออกจากบ้าน หรือหอบมากขณะแต่งตัว/เปลี่ยนเสื้อผ้า หรือไม่

☐ ไม่มี ☐ มี

36. ท่านมีอาการแน่นหน้าอกหรือหายใจลำบาก ขณะทำงานเก็บขนขยะมูลฝอย/กวาด หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

37. ท่านมีอาการแน่นหน้าอกหรือหายใจลำบาก ขณะทำงานสัมผัสฝุ่น/ควัน/กลิ่นแรงๆ หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

38. ท่านมีอาการแน่นหน้าอกหรือหายใจลำบาก ขณะทำงานหนักหรือเครียด หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

39. ท่านมีอาการแน่นหน้าอกหรือหายใจลำบาก ขณะออกกำลังกาย หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

40. ท่านมีอาการแน่นหน้าอกหรือหายใจลำบาก ขณะพักหรืออยู่เฉยๆ หรือไม่

☐ ไม่มี ☐ มี ความถี่ในการเกิดอาการ.....

แบบบันทึกการตรวจสมรรถภาพปอด

1. เพศ ❍ ชาย ❍ หญิง
2. เชื้อชาติ.....
3. อายุ.....ปี (วันที่เกิด.....เดือน.....พ.ศ.....)
4. น้ำหนัก.....กิโลกรัม
5. ส่วนสูง.....เซนติเมตร
6. ประวัติการดื่มสุรา
   - ❍ ไม่ดื่ม
   - ❍ เคยดื่ม เลิกไปนาน.....ปี
   - ❍ ปัจจุบันยังดื่ม ความถี่.....ดื่มมานาน.....ปี
7. ความดันโลหิต .....มิลลิเมตรปรอท (mm.Hg)
   - ❍ ความดันโลหิตอยู่ในเกณฑ์ ปกติ
   - ❍ ความดันโลหิต สูง
   - ❍ ความดันโลหิต ต่ำ
8. ข้อห้ามในการตรวจสมรรถภาพปอด (การทำสไปโรเมตรีย์)
   ท่านมีภาวะหรืออาการดังต่อไปนี้ หรือไม่

(1) ไอเป็นเลือด	☐ มี	☐ ไม่มี
(2) ภาวะลมรั่วในช่องเยื่อหุ้มปอดที่ยังไม่ได้รับการรักษา	☐ มี	☐ ไม่มี
(3) ระบบหลอดเลือด หรือ หัวใจทำงานไม่คงที่ ได้แก่	☐ มี	☐ ไม่มี
- ความดันโลหิตสูงที่ยังไม่ได้รับการรักษาหรือควบคุมได้ไม่ดี ความดันโลหิตต่ำ		
- เคยมีภาวะกล้ามเนื้อหัวใจขาดเลือดในช่วง 1 เดือนที่ผ่านมา		
(4) เส้นเลือดแดงโป่ง (aneurysm) ในทรวงอก ท้อง หรือสมอง	☐ มี	☐ ไม่มี
(5) เพิ่งได้รับการผ่าตัดตา เช่น ผ่าตัดลอกต้อกระจก	☐ มี	☐ ไม่มี
(6) เพิ่งได้รับการผ่าตัด ช่องอก หรือช่องท้อง	☐ มี	☐ ไม่มี
(7) ติดเชื้อในระบบทางเดินหายใจ เช่น วัณโรคปอดระยะติดต่อ	☐ มี	☐ ไม่มี
(8) สตรีมีครรภ์	☐ มี	☐ ไม่มี
(9) อาการเจ็บป่วยที่อาจมีผลต่อการทดสอบสไปโรเมตรีย์ เช่น คลื่นไส้หรือ อาเจียนมาก	☐ มี	☐ ไม่มี

ผลการตรวจสมรรถภาพปอด

☐ ปกติ

☐ ผิดปกติ ลักษณะ ❍ Obstructive

❍ Restrictive

❍ Mixed

FVC ..... ลิตร

FEV1 ..... ลิตร

FEV1 / FVC1 ..... %

% predicted FVC ..... %

% predicted FEV1 ..... %

กราฟแสดงผลการตรวจสมรรถภาพปอด

(การคัดเลือก Spirogram เพื่อการแปลผล เลือกจากกราฟที่มีค่า FVC มากที่สุด และ ค่า FEV1 มากที่สุด)

Acceptability criteria

- **เริ่มต้นถูกต้อง** โดยหายใจเข้าจนสุดแล้วเป่าออกให้เร็วและแรง ดูจากกราฟปริมาตร-เวลา
- **หายใจออกได้เต็มที่** โดยดูจากกราฟปริมาตร-เวลา ซึ่งเวลาในการหายใจออกต้องนานเพียงพอ อย่างน้อยที่สุด 6 วินาที มี plateau อย่างน้อย 1 วินาที และจะต้องไม่มีอาการไอ การรั่วออกของลมขณะเป่า หรือมีสิ่งไปอุด mouthpiece เช่น ลิ้น ฟันปลอม

Reproducibility criteria

- ค่า FVC และ FEV1 ที่มากที่สุด ต่างจากค่าที่รองลงมา ไม่เกิน 200 มิลลิลิตร

APPENDIX B

Certificate of Approval
Ethical Review Committee for Human Research
Faculty of Public Health, Mahidol University

COA. No. MUPH 2014-210

Protocol Title :	PREVALENCE AND FACTORS ASSOCIATED WITH RESPIRATORY SYMPTOMS AND PULMONARY FUNCTION AMONG SOLID WASTE COLLECTORS OF BANGKOK METROPOLITAN ADMINISTRATION
Protocol No. :	166/2557
Principal Investigator :	Miss Laddawan Dokkaew
Affiliation :	Master of Science Program in Industrial Hygiene and Safety Faculty of Public Health, Mahidol University
Approval Includes :	1. Project proposal 2. Information sheet 3. Informed consent form 4. Data collection form/Program or Activity plan
Date of Approval :	24 November 2014
Date of Expiration :	23 November 2015

The aforementioned project have been reviewed and approved according to the Declaration of Helsinki by Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University.

S. Nanthamongkolchai

(Assoc. Prof. Dr. Sutham Nanthamongkolchai)
Chairman of Ethical Review Committee for Human Research

(Assoc. Prof. Dr. Prayoon Fongsatitkul)
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BIOGRAPHY

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