A STUDY OF FACTORS AFFECTING THE PULMONARY FUNCTION IMPAIRMENT OF RICE MILL WORKERS

KALLAYA HARNPICHARNCHAI

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE
(INDUSTRIAL HYGIENE AND SAFETY)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2006

ISBN 974-04-6832-2

COPYRIGHT OF MAHIDOL UNIVERSITY

Copyright by Mahidol University

Thesis
Entitled

A STUDY OF FACTORS AFFECTING TO THE PULMONARY FUNCTION IMPAIRMENT OF RICE MILL WORKERS

Kallaya Harnpicharnchai
Miss Kallaya Harnpicharnchai
Candidate

Chantanakul, Suttinun
Lect.Suttinun Chantanakul
M.D.
Major-Advisor

Pornpimol Kongtip
Assoc. Prof. Pornpimol Kongtip
Ph.D.
Co-Advisor

Pipat Sribenjalux
Assoc. Prof. Pipat Sribenjalux
M.Sc.
Co-Advisor

Vajira Singhakajen
Assoc. Prof. Vajira Singhakajen
M.A.
Co-Advisor

Assoc. Prof.M.R. Jisnuson Svasti
Ph.D.
Dean
Faculty of Graduate Studieds

Assoc. Prof. Chompusakdi Pulket
Ph.D.
Chair
Master of Science Pragramme in
Industrial Hygiene and Safety
Faculty of Public Health

Copyright by Mahidol University

Thesis
Entitled

A STUDY OF FACTORS AFFECTING TO THE PULMONARY FUNCTION IMPAIRMENT OF RICE MILL WORKERS

Was submitted to the Faculty of Graduate Studies, Mahidol University
For the degree of Master of Science (Industrial Hygiene and Safety)
On
January 11,2006

Kallaya Harnpichamchai
.....
Miss Kallaya Harnpicharnchai
Candidate

Chantanakul, Suttinun
.....
Lect.Suttinun Chantanakul
M.D.
Chair

Pipat Sribenjalux
.....
Assoc. Prof. Pipat Sribenjalux
M.Sc.
Member

Pornpimol Kongtip
.....
Assoc. Prof. Pornpimol Kongtip
Ph.D.
Member

Sawang Saenghirunvattana
.....
Prof. Sawang Saenghirunvattana
M.D.
Member

Vajira Singhakajen
.....
Assoc. Prof. Vajira Singhakajen
M.A.
Member

.....
Assoc. Prof.M.R. Jisnuson Svasti
Ph.D.
Dean
Faculty of Graduate Studieds
Mahidol University

.....
Assoc. Prof. Chalermchai Chaikittiporn
Dr.P.H.
Dean
Faculty of Public Health
Mahidol University

Copyright by Mahidol University

ACKNOWLEDGEMENT

The achievement of this research was completed under guidance, reinforcement and kindness of many persons that have to be, mentioned and recieived appreciation from the researcher.

I would like to express my sincere and deep appreciation to my major advisor, Mr.suttinun Chantanalul, for his valuable guidance, understanding and encouragement and prompt assistance with great warm help and support throughout the research process.

My deepest gratitude is also extended to my co-advisor, Assoc. Prof. Dr. Pornpimol Kongtip, Assoc. Prof. Vajira Singhakajen and Assoc. Prof. Pipat Sribenjalux for their constructive comments, supervision and insightful guide throughout this study. I am greatly thankful to the committee member : Professor Sawang Saenghirunvattana for kindly guidance, as well as associate and valuable comments that enabled this research most benevolently and effectively.

I sincerely thank to Mr. Chaisiri leesilikul and Mr. Sarawut Rattanachawanon for his co-operation and providing data.

I sincerely thank to staffs of Industrial Hygiene and Safety Department, Faculty of Public Health, Burapha University for using of their personal pump and I would like to thank the staffs of Occupational Health and Safety Department, Faculty of Public Health, Mahidol University for their encouragement co-operation and great assistance.

Finally, I greatly appreciate and deepest gratitude to my lovely family, father, mother, brother and friends for encouragement, understanding, chance and confidence to me. The usefulness of this thesis, I delicate to my father, my mother and all the teachers who have taught me since my childhood.

Kallaya Harnpicharnchai

Copyright by Mahidol University

A STUDY OF FACTORS AFFECTING THE PULMONARY FUNCTION IMPAIRMENT OF RICE MILL WORKERS

KALLAYA HARNPICHARNCHAI 4637072 PHIH/M

M.Sc. (INDUSTRIAL HYGIENE AND SAFETY)

THESIS ADVISORS : SUTTINUN CHANTANAKUL, M.D., PORNPIMOL KONGTIP, Ph.D., VAJIRA SINGHAKAJEN, M.A., PIPAT SRIBENJALUX, M.Sc.

ABSTRACT

Factors affecting pulmonary function impairment were examined on workers in a rice mill factory. The study was devided into four parts. The first part was collecting the data of rice mill workers using interview forms. The forms consisted of four parts. The first part included general information, working history, smoking habit, exercise habit, and habit of wearing personal protective equipment and past respiratory symptoms. The second part was a pulmonary function test using a spirometer. The third part was collecting atmospheric inhalable dust and respirable dust by using the personal sampling technique, and collecting atmospheric silica dust by the area sampling technique. The fourth part was collecting atmospheric bioaerosal by the area sampling technique. The samples were the 78 rice mill workers working the day shift.

Results of the air sampling analysis showed that the highest average concentrations of inhalable, respirable rice mill dust and silica dust in milling areas were 11.98 mg/m^3, 5.61 $mg/m^3$and $29.97x10^{-3}$ mg/m^3 respectively. The highest average concentrations of bioaerosal, and fungi and bacteria , were 1182 CFU/m^3 and 7601 CFU/m^3 respectively. Results of abnormal pulmonary function revealed that 37 persons (47.44%) had restrictive, 7 persons (8.97%) obstructive and 8 persons (10.26%) combined patterns.

Results showed that factors associated with pulmonary function impairment were accumulated inhalable dust (p-value =0.048), sex (p-value=0.032), smoking habit (p-value<0.001) and past respiratory illness (p-value=0.039), (p-value<0.05).

KEY WORDS: RICE MILL / PULMONARY FUNCTION TEST / BIOAEROSAL / DUST EXPOSURE

110 P. ISBN 974-04-6832-2

Copyright by Mahidol University

ปัจจัยที่มีกระทบต่อการเสื่อมสมรรถภาพปอดของคนงานในโรงสีข้าว

(A STUDY OF FACTORS AFFECTING THE PULMONARY FUNCTION IMPAIRMENT OF RICE MILL WORKERS)

กัลยา หาญพิชาญชัย 4637072 PHIH/M

วท.ม. (สุขศาสตร์อุตสาหกรรมและความปลอดภัย)
คณะกรรมการควบคุมวิทยานิพนธ์ : สุทธินันท์ ฉันท์ธนกุล M.D., พรพิมล กองทิพย์ Ph.D., วชิระ สิงหเชนทร์ M.A., พิพัฒน์ ศรีเบญจลักษณ์, M.Sc.

บทคัดย่อ

การศึกษาครั้งนี้ มีวัตถุประสงค์เพื่อหาปัจจัยที่มีความสัมพันธ์ต่อการเสื่อมสมรรถภาพปอดของคนงานในโรงสีข้าว วิธีการศึกษาแบ่งออกเป็น 4 ส่วน คือ ส่วนแรกเป็นการศึกษาลักษณะของกลุ่มตัวอย่าง โดยใช้แบบสัมภาษณ์ ซึ่งประกอบด้วย 4 ส่วน ส่วนที่หนึ่ง คือ ลักษณะทั่วไป ประวัติการทำงาน พฤติกรรมการสูบบุหรี่ การออกกำลังกาย การใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคล และ อาการแสดงของโรคระบบทางเดินหายใจ ส่วนที่สองเป็นการตรวจสมรรถภาพปอดของกลุ่มตัวอย่างโดยใช้เครื่องมือ Spirometer ส่วนที่สามเป็นการเก็บตัวอย่างอนุภาคในอากาศบริเวณที่ทำงาน เพื่อประเมินปริมาณความเข้มข้นของฝุ่นที่สามารถเข้าสู่ทางเดินหายใจได้ โดยใช้วิธีการเก็บตัวอย่างแบบติดตัวบุคคล ปริมาณความเข้มข้นของฝุ่นทุกขนาดและปริมาณความเข้มข้นของซิลิกา โดยใช้วิธีการเก็บตัวอย่างแบบพื้นที่ ส่วนที่สี่ เป็นการเก็บตัวอย่างแบบพื้นที่เพื่อประเมินปริมาณจำนวนโคโลนีของจุลินทรีย์ในบรรยากาศ กลุ่มตัวอย่างที่ทำการศึกษาคือ คนงานที่ปฏิบัติงานในโรงสีข้าว จำนวน 78 คน ซึ่งทำงานในกะปกติ

ปริมาณความเข้มข้นเฉลี่ยของฝุ่นที่สามารถเข้าสู่ทางเดินหายใจ ฝุ่นทุกขนาด และฝุ่นซิลิกาในพื้นที่การสีข้าว เป็น 11.98 mg/ m^3, 5.61 mg/ m^3 และ 29.97x10^{-3} mg/ m^3 ปริมาณจำนวนโคโลนีของเชื้อราและเชื้อแบคทีเรียในบรรยากาศเป็น 1,182 CFU/ m^3 และ 7601 CFU/ m^3 ตามลำดับ การประเมินการเสื่อมสมรรถภาพปอดของคนงานพบว่า คนงานมีความผิดปกติชนิด restrictive 37 คน (47.44%) , 7 คนเป็นมีความผิดปกติชนิดobstructive (8.97%) และ 8 คน (10.26%)มีความผิดปกติcombined

ผลการศึกษา พบว่า ปัจจัยที่มีความสัมพันธ์ต่อการเสื่อมสมรรถภาพปอดของคนงานในโรงสีข้าว คือ ปริมาณความเข้มข้นของฝุ่นทุกขนาด(p-value =0.048) เพศ (p-value=0.032) การสูบบุหรี่ (p-value<0.001) และอาการแสดงของโรคระบบทางเดินหายใจ(p-value=0.039) (p-value<0.05)

110 P. ISBN 974-04-6832-2

Copyright by Mahidol University

CONTENTS

	Page
ACKNOWLEDGEMENT	iii
ABSTRACT	iv
LIST OF TABLES	viii
LIST OF FIGURES	ix
CHAPTER I INTRODUCTION	
Background and Rational	1
General Objectives	2
Specific Objectives	2
Research Hypothesis	3
Research variables	3
Scope of the study	4
Preliminary agreement	4
Conceptual framework	5
Definition of keywords	5
CHAPTER II LITERATURE REVIEW	
Rice Mill Industry	10
Hazard of rice mill dust	17
Bioaerosal	25
Respiratory system	28
Pulmonary function tests	31
Pulmonary function impairment	35
Literature cite	42

Copyright by Mahidol University

CONTENTS (continued)

	Page
CHAPTER III MATERIAL AND METHODS	
Study design	51
Sample size and groups	51
Instruments	52
Study and sampling method	53
Data analysis	59
CHAPTER IV RESULTS	
General characteristics	60
The results of rice mill dust and bioaerosal concentration	69
Relation between studied factors with abnormal pulmonary function test	71
CHAPTER V DISCUSSION	
Discussion of Methodology	81
Discussion on study results	83
Test for the relation between factors and pulmonary function impairment	85
CHAPTER VI CONCLUSION AND RECOMMENDATION	
Conclusion	87
Recommendations	90
REFERENCE	92
APENDIX	98
BIOGRAPHY	110

Copyright by Mahidol University

LIST OF TABLES

Tables		Page
1	Thailand's total rice production in 1999	11
2	Trends in Thailand rice exports (1999-2003)	11
3	Siriraj equations	41
4	Number and percentage of the general characteristic of rice mill workers	60
5	Number and percentage of the working characteristics of rice mill workers	63
6	Number and percentage of the samples classified by previous occupation before working at this factory	65
7	Number and percentage of the samples classified by smoking behaviors	66
8	Number and percentage of the samples classified by illness histories	67
9	Number and percentage of the samples classified by Inhalable dust, Respirable dust and silica dust concentration (mg/m3)	69
10	Number and percentage of the samples classified bioaerosal concentration (CFU/m3)	70
11	Number of pulmonary function impairment of the samples classified by section of rice mill places	71
12	Comparison of means dust exposure among normal pulmonary function group and abnormal pulmonary function group	72
13	Comparison of means bioaerosal exposure among normal pulmonary function group and abnormal pulmonary function group	73
14	Association between variables and pulmonary function impairment	74
A-1	Association between gender and other factor	99
A-2	Association between zone of work and other factor	101
A-3	Association between smoking and other factor	103

Copyright by Mahidol University

LIST OF FIGURES

Figures		Page
1	Conceptual frame work	5
2	World rice export share 1999	10
3	Brown Rice (Caryosis)	12
4	Rice mill processing	16
5	Classification causes of occupational lung disease	20
6	The anatomy of the respiratory tract	30
7	Normal spirogram and lung volumes	35
8	Spirogram and lung volumes in obstructive disease	36
9	Spirogram and lung volumes in restrictive disease	37
10	Flow-volume loops. (A) Normal. Inspiratory. (B) Restrictive disease	38
11	Flow-volume loops. (C) COPD, asthma. (D) Fixed obstruction of upper airway. (E) Variable extrathoracic obstruction (F) Variable intrathoracic obstruction	39

Copyright by Mahidol University

CHAPTER I
INTRODUCTION

1.1 Background and Rational (1, 2,3,4)

The world's top three rice exporters are Thailand, India, and Vietnam, respectively. Thailand was held on to the world's highest rice export market share from the year 1995-2001. Thailand has tremendously increased the productivity, from 2.36 metric ton per hectare in 1997 to 6.265 metric ton per hectare in 1999. The total land devoted to rice production also increases to 10.18 million hectares, along with the dramatic increase in the rice production, in 1999. There is a slight change in the year 2000. While the land devoted to rice production shows a slight decrease, the production and yield continue to increase. Thai farmers produce approximately 19-20 million tons of rice annually. Two-thirds is consumed by farmers themselves, used as seed, or sold for domestic consumption. The remaining one-third is sold abroad, gaining for Thailand a world-wide reputation. While the country is not the world's leading rice producer, it has been the number one exporter for the past 20 years.

Rice mill industry had been rapidly and increasingly developed in term of technology, equipment, device, communication tool and manufacturing machine. Therefore, the increase in rice production will result in the increase of the labor. The result from operating the machine in rice mill process might lead to the contaminants such as dust, particle, bioaerosal, smoke and poison gas. Those contaminants apparently affect to the health of the employees. Rice mill workers may be exposed to potential hazards which has harmful to health, such as milling dust, noise, ergonomics and accidents. Although, many processes are used by machines but it has to be done by hand in many step, therefore the worker can get dust by inhaling.

Copyright by Mahidol University

Effects to respiratory system from exposure to rice mill dust include decreased lung capacity, occupation asthma and allergic reaction in the lung as hypersensitivity pneumonitis. In addition, the Encyclopedia of Occupational Health and Safety of ILO has classified rice mill dust as grain dust. Many studies have shown that exposure to rice mill dust can cause many health problems, such as irritation of the nose and throat. Rice mill dust contaminating with the skin can also cause contact dermatitis.

Allergic reactions to fungi and bacteria are common and can occur year round. People sensitive to fungi and bacteria can experience symptoms such as skin irritation, nasal congestion, eye irritation and wheezing. Severe allergic reactions to fungi and bacteria may include fever, shortness of breath and may cause asthma or other respiratory ailments. People who are allergic to other airborne allergens (e.g., pollen, dander, dust & dust mites) may be more susceptible to fungi and bacteria allergies.

Rice mill dust and bioaerosal result in health problems to rice mill workers, especially, the skin irritation, nasal congestion and respiratory system. This study has surveyed work related pulmonary function and factors associated with these symptoms of rice mill worker. The studied results can be also used for disease surveillance of rice mill workers.

1.2 General Objectives

To determine the factors affecting impairment of pulmonary function of rice mill workers.

1.3 Specific Objectives

1.3.1 To compare between the concentration of ricc mill dust (inhalation dust, respirable dust and silica dust) and pulmonary function impairment of rice mill worker.

1.3.2 To compare between the concentration of bioaerosal (fungi and bacteria) and pulmonary function impairment of rice mill worker.

1.3.3 To analyze the relationship between zone of work and pulmonary function impairment of rice mill worker.

Copyright by Mahidol University

1.3.4 To analyze the relationship between other factors and pulmonary function impairment of rice mill worker.

1.4 Research Hypothesis

1.4.1 Concentration of rice mill dust, silica, fungi and bacteria that exposed to rice mill workers might have difference effect to the pulmonary function impairment.

1.4.2 There is relationship between other factors such as the age, working duration, personal protective equipment usage, past respiratory illness, exercise smoking and the pulmonary function impairment of rice mill workers.

1.5 Research variables

1.5.1 Independent variables

1. Concentration of rice mill dust to consist of
   - 1.1 Inhalation dust
   - 1.2 Respirable dust
   - 1.3 Silica dust
2. Concentration of bioaerosal to consist of
   - 2.1 Fungi
   - 2.2 Bacteria
3. Zone of work to devided 3 section
   - 3.1 Milling area (machinist, diver, storekeeper and cleaner)
   - 3.2 Packaging area (packer)
   - 3.3 Office area (quality control and office)
4. Another factors
   - 4.1 Age
   - 4.2 Sex
   - 4.3 Smoking
   - 4.4 Exercise
   - 4.5 Wearing personal protective equipment

Copyright by Mahidol University

4.6 Past respiratory illness

4.7 Working duration

1.5.2 **Dependence variable** as the pulmonary function impairment

1.6 Scope of the study

This study emphasized on the analysis and comparison between the concentration of different kinds of dust, for example, inhalable dust, respirable dust, silica dust and bioaerosal in different zone of work. Another factors like age, sex, smoking, exercise, wearing personal protective equipment, past respiratory illness, working duration, work experienced and zone of work, relating to the pulmonary function impairment of rice mill worker in rice mill factory situated in Khonkaen province.

1.7 Preliminary agreement

1.7.1 Population were workers in rice mill factory who worked in production line and in office in Khonkaen province.

1.7.2 The interpretation of the result will be using the standard of pulmonary function impairment from Siriraj Hospital standard (32)

Copyright by Mahidol University

1.8 Conceptual framework

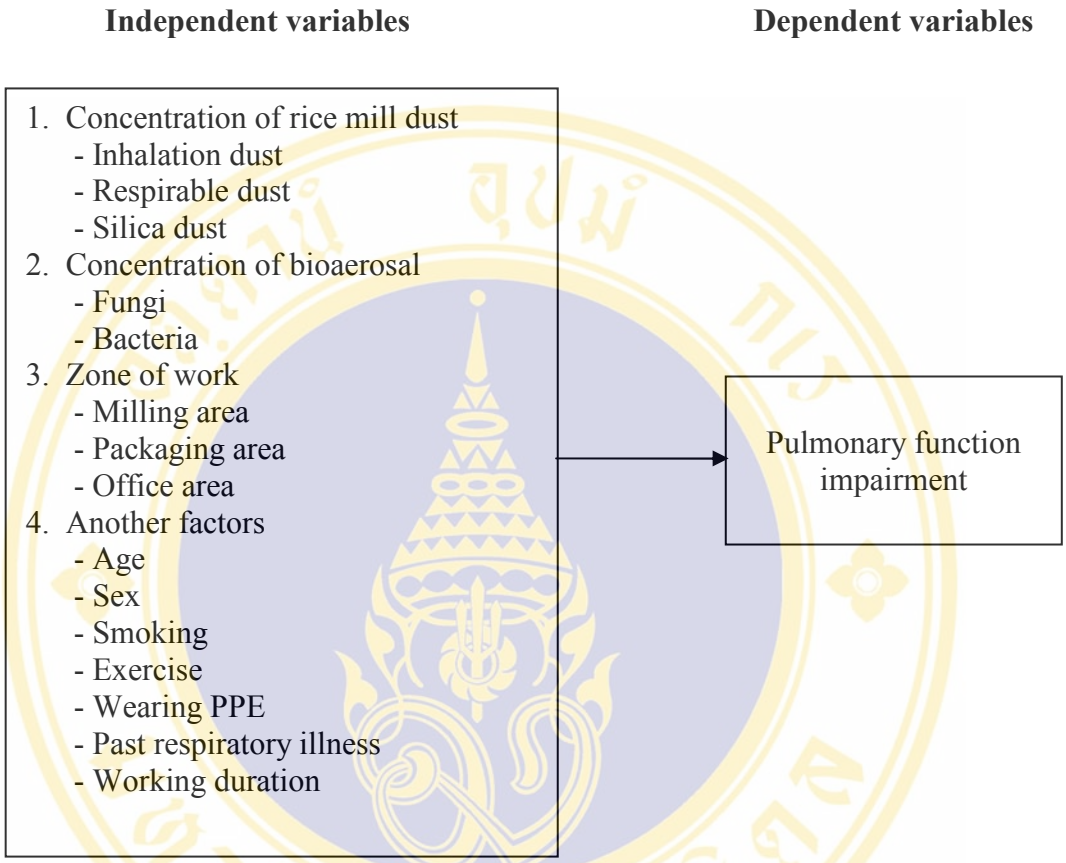


Figure 1 conceptual frame work

1.9 Definition of keywords

1.9.1 Prevalence rate is computed as the number of cases divided by the number off workers in the study.

1.9.2 Dust are solid aerosols caused by mechanical fragment of rocks, minerals and other materials from blasting, crushing, grinding, milling, polishing and sawing. In this study divided 3 categories i.e. :

1. Inhalable dust are particulates through the upper respiratory tract and diameter less than 100 micron.

Copyright by Mahidol University

2. Respirable dust are particulates through the alveolar sac and diameter less than 10 micron. These particulates will be chlonic effects when collected in respiratory tract.

3. Silica or silicon dioxide (SiO_2) is an abundant mineral found in rock, sand, and soil.

1.9.3 Fungi are kingdom of heterotrophic single-celled, multinucleated, or multicellular organisms, including yeasts, molds, and mushrooms. The organisms live as parasites , symbionts, or saprobes. Previously classified in the plant kingdom, fungi are nonmotile, like plants, but lack the vascular tissues (phloem and xylem) that form the true roots, stems, and leaves of plants. Most coenocytic or multicelluar fungi are composed of multiple filaments, called hyphae, grouped together into a discrete organism called a mycelium. The cell walls of fungi are of chitin or other noncellulose compounds. In many ways fungi are more closely related to animals than to plants, and they have been thought to share a common protist ancestor with animals. A recent classification system suggested by nucleic acid (genetic material) comparisons places the fungi with the animals and the plants in an overarching taxonomic group called the eukarya. Most fungi are capable of asexual and sexual reproduction . Asexual reproduction is by fragmentation or spore formation. Those that reproduce sexually produce gametes in specialized areas of the hyphae called gametangia. The gametes may be released to fuse into spores elsewhere, or the gametangia themselves may fuse. In some cases dikaryons, which are found only among fungi, result when unspecialized hyphae fuse but their nuclei remain distinct for part of the life cycle.

1.9.4 Bacteria are microscopic unicellular prokaryotic organisms characterized by the lack of a membrane-bound nucleus and membrane-bound organelles. Once considered a part of the plant kingdom, bacteria were eventually placed in a separate kingdom, Monera . Bacteria fall into one of two groups, Archaebacteria (ancient forms thought to have evolved separately from other bacteria) and Eubacteria. A recently proposed system classifies the Archaebacteria, or archaea, and the Eubacteria as major groupings above the kingdom level.

Copyright by Mahidol University

1.9.5 Pulmonary function tests are a broad range of tests that are usually done in a health care provider's office or a specialized facility. Pulmonary function tests are a group of procedures that measure the function of the lungs, revealing problems in the way a worker breathes. The tests can determine the cause of shortness of breath and may help confirm lung diseases, such as asthma, bronchitis or emphysema. The tests also are performed before any major lung surgery to make sure the person won't be disabled by having a reduced lung capacity. The value obtained from this test call "lung capability value" which consists of the following value.

1. Forced Vital Capacity (FVC). The total amount of air you exhaled as forcefully and rapidly as possible after a maximal inspiration.

2. Forced Expiratory Volume (FEV). The amount of air you can exhale forcefully in a sustained breath. The amount of air you exhale may be measured at 1 second (FEV_1), 2 seconds (FEV_2), or 3 seconds (FEV_3).

3. Forced Expiratory Volume in 1 second/ Forced Vital Capacity Ratio (FEV_1/FVC) . The compare volume of FEV_1 and FVC in percentage that can be calculated from (FEV_1/FVC)* 100. The FEV_1/FVC ratio is used as a broad indicator of airway obstruction.

4. Force Expiratory Flow ($FEF_{25-75\%}$). The average flow rate over the middle half of expiration maneuver is commonly used to assess the status of medium sized airways in obstructive lung disease.

1.9.6 Type of abnormal pulmonary function : Spirometry can be interpreted from vitalogram that have 3 type of abnormal pulmonary function as

1. Obstructive pattern : Pattern system from narrowing of any portion of the airways from upper airway to bronchioles less than 2 mm. In diameter that reduces airflow. Included this group of disorder are chlonic obstructive diseases of the airways such as exposure to the cigarette smoke and other common air pollutants can trigger a reflexive constriction of bronchial airways and the hallmark of this pattern is a reduction in Forced Expiratory Volume in 1 second value and Forced Vital Capacity value FEV_1/FVC less than 80 % of predicted value.

Copyright by Mahidol University

2. Restrictive pattern : Involve restriction (reduced stretch) of the alveoli , inhabit inspiration, reduce pulmonary volumes and capacities such as inflammation or fibrosis of lung tissue caused by exposure to asbestos, coal or silica dust can restrict alveoli, the hallmark of this pattern is a reduction in Forced Vital Capacity (FVC < 80 %) of predicted value.

3. Combined pattern : Both Forced Expiratory Ratio valve (FEV_1/FVC) is less than 80 % and $FEF_{25-75\%}$ value is less than 57 % of predicted value. This pattern results from pathologic processes that reduce lung volumes, vital capacity and airflow, and that also include an element of airway narrowing. The combined pattern is characterized by a low FEV_1 (indicating obstructive airway disease) and small lung volume.

1.9.7 Zone of work defined as the different section of office area and process or production area of workplace which rice mill workers were worked, this study were classified into 3 group:

1. Milling area : This process consist of cleaned, husked and paddy separated of rice. The rice move to milling machines. Workers in section of milling area such as : machinist and cleaner
2. Packaging area : The finished of rice will be packed workers in section of packaging area such as : storekeeper, packer and diver.
3. Office area : Workers in section of office area such as : Quality control and Officer.

1.9.8 The factors related to the pulmonary function impairment defined as

1. Age as the age of rice mill workers calculated from the birth date until the studied date (the until is year)
2. Working duration as total duration calculated from the start working date in rice mill until the studied date (the until is year)
3. Personal protective equipment usage means the usage of dust prevention mask that will be studied as

3.1 The duration in using personal protective equipment means the length of time calculated from the starting date of using personal protective equipment until the studied date (the until is year).

3.2 The frequency in using personal protective equipment means the frequency during working time divided into 2 level a as use and not use

Copyright by Mahidol University

4. Smoking is inhalation and exhalation of the fumes of burning tobacco in cigarettes. Smoking is considered a health hazard because tobacco smoke contains nicotine , a poisonous alkaloid, and other harmful substances such as carbon monoxide, acrolein, ammonia, prussic acid, and a number of aldehydes and tars. In this study mean the length of time in smoking, ever smoke, smoking behavior, and type of cigarettes of the rice mill workers.

4.1 The frequency in smoking means the frequency of smoker in present categorized into smoke some day and smoke everyday.

4.2 The length of time in smoking means the duration calculated from the starting date of smoking until the studied date (the until is year).

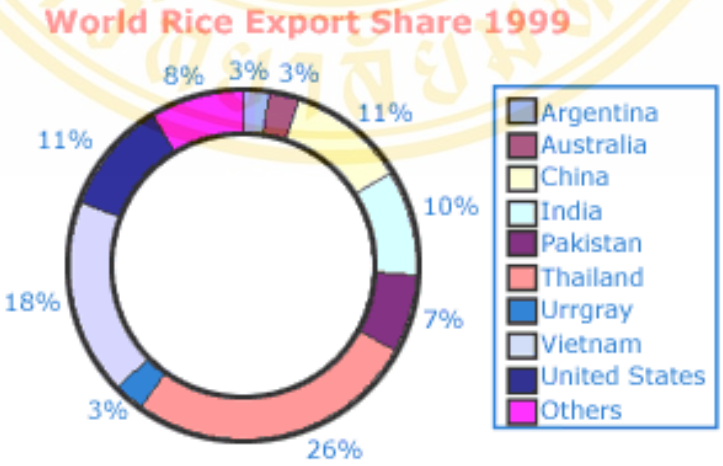
4.3 Type of cigarettes means the cigarette types which can be classified into filtered cigarette, normal cigarette, and both of them.

Copyright by Mahidol University

CHAPTER II
LITERATURE REVIEW

2.1 Rice Mill Industry (4,5,6,7,8,9,10)

The world's top three rice exporters are Thailand, India, and Vietnam, respectively. Thailand held on to the world's highest rice export market share from the year 1995-1998. Although at the end of the year 1998, Thailand's export market share has declined 4.2% from its original level in 1995, Thailand is projected to hold on to the largest market share, at approximately 26-28% of the world's rice production. India and Vietnam traded places in the year 1998, as India's export market share dropped to the third place, while Vietnam's increased to the second place. India's export production declined from 3.6 million metric tons in the year 1996 to 2.0 million metric tons in the year 1997. The global rice trade is projected to increase in the year 2000. Figure 2 showed world rice export share 1999.



Source: United States Department of Agriculture (USDA), 2000.

Figure 2 world rice export share 1999

Copyright by Mahidol University

In 1999, Thailand devoted approximately 60 million rais (6.25 rais = 1 hectare) of land to rice cultivation. Table 1 showed Thailand's total rice production in 1999 could be categorized as follows :

Table 1 Thailand's total rice production in 1999

Paddy	22.5 million MT
Milled	15 million MT
Local consumption	9 million MT
The rest for export	6 million MT

Source: Department of Foreign Trade, Ministry of Commerce

With the global market share of 23%, Thailand produced approximately 23 million metric tons of rice in 1999, 6 million of which were exported. As the world's number 5 rice producer, following closely behind Indonesia and Bangladesh, Thailand exports about 27% of rice produced domestically. This trend in rice production is projected to increase to 24 million metric tons in the year 2001. Table 2 showed trends in Thailand rice exports (1999-2003)

Table 2 Trends in Thailand rice exports (1999-2003)

Region / Year	2001	2002	2003	2004	2005 (June 30,2005)
Asia	2,036,074	2,364,617	2,681,249	2,584,491	928,471.00
Middle East	1,080,349	1,220,294	1,165,997	1,610,267	563,135.73
Europe	410,718	345,072	344,069	441,633	181,155.96
Africa	3,558,058	2,863,159	2,615,450	4,757,263	1,798,427.52
America	383,238	373,024	699,397	613,534	182,943.79
Oceania	76,932	79,473	91,253	133,036	66,013.99
Total	7,545,368	7,245,638	7,597,415	10,140,224	3,720,147.99

Units : metric tons

Copyright by Mahidol University

Source : Department of Foreign Trade (Grain Division) Board of Trade of Thailand

Rice Varieties

Rice Grain

A kernel of rice consists of several layers. On the brown rice (Caryosis). In general, each rice kernel is composed of the following layers (Figure 2) :

- Rice is an example of a rice grain called true fruit or hell or Husk: encloses the brown rice, consists mainly of embryo and endosperm.

- Bran layer: a very thin layer of differentiated tissues. This layer contains fiber, vitamin B, protein and fat. The most nutritious part of rice resides in this layer.

- Embryo: the innermost part of rice consisting mainly of starch called amylose and amylopactin. The mixture of these two starches determines the cooking texture of rice.

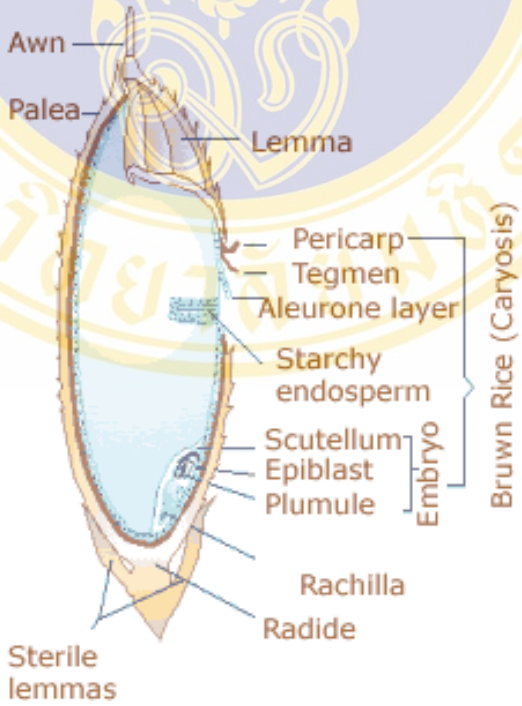


Figure 3 Brown Rice (Caryosis)

Copyright by Mahidol University

Rice Varieties

Rice is a short-lived plant related to the grass family, with a life cycle of 3-7 months. The span of one cycle varies, depending on its type and the growing environment. Rice growing requires an extensive irrigation system and properly leveled fields. A uniformly leveled field enables each rice kernel to absorb the same amount of moisture from the field. This uniform moisture level will maintain a consistency in the rice quality. If the moisture level runs too high, the rice may spoil faster.

In general, the rice family could be broken down into three main categories:

1. Indica (long grain) - grown in the warm climate region, such as Thailand, India, Pakistan, Brazil, and Southern USA.

2. Japonica (round grain) - grown in the cold weather area, such as Japan, Korea, Northern China and California.

3. Javanica (medium grain) - only grown in Indonesia

Land Area/ Growing Season

Rice is produced all around the globe, from North America to Australia. Asia has the most suitable climate for rice cultivation. Most of the time, the world's top three rice producers remain all with in the Asian region, although the total production may vary from year to year

The most recent statistics show that India and China devote the most land area to producing rice. These two countries also attained the highest production of rice in the year 1997. In terms of land productivity, however, the United States and China were the most productive, with the highest yield per hectare of land. Thailand, geographically much smaller than the United States, India, and China, demonstrated a much less productivity. Although it bears no relation with the geographic size, Thailand's less productivity relative to the other rice producing countries may due to the lack of advanced agricultural technology and its focus on lower yield, high quality, varieties such as Jasmin rice.

Copyright by Mahidol University

In 1999, Thailand has tremendously increased the productivity. From 2.36 metric ton per hectare in 1997 to 6.265 metric ton per hectare in 1999. The total land devoted to rice production also increases to 10.18 million hectares, along with the dramatic increase in the rice production, in 1999. There is a slight change in the year 2000. While the land devoted to rice production shows a slight decrease, the production and yield continue to increase

Rice Growing Area in Thailand

In 1999, Thailand's total rice production area amounted to approximately 60 million rais (6.25 rais = 1 hectare). Rice production is scattered throughout the country's six major regions:

- Upper northern: This region concentrates on glutinous rice cultivation, although the land is also dedicated to growing other varieties of rice.

- Lower northern: The second largest production plain, this region is suitable for growing many varieties of rice, including White rice and Jasmine rice. Because of its furtile land, the lower northern region produces high quality rice in a large quantity.

- Central plain: Thailand's largest rice production area resides in the central plain. Here, rice production continues all year round, circulating through all 3 possible production cycles in a year. The central plain benefits from massive irrigation systems and a resevoir of enriched land pieces. As a result, rice grown in this region is mainly intended for exports.

- Upper northeastern and Lower northeastern: This region is well-known for cultivating both glutinous and fragrant rice. However, due to unpredictable climate--draughts and floods--the upper and lower northeastern region is not suitable for a year-round rice production.

- Southern: The smallest rice growing area of the country. In this region, rice is mostly grown in a small scale, only for regional consumption. Growing Land Area/ Growing Season Rice Environment Rice Farming Rice Harvesting/ Storage

Copyright by Mahidol University

Growing Seasons

For North, Northeast and Central regions, growing season begins in May and ends in July; and the harvesting season begins November and ends in December. In the south and other regions, growing season is between November and December; the harvesting season starts from March and ends in May

Rice mill processing

- Cleaning. Dried paddy passes through ventilating sieve cleaner to remove large foreign matter like hay, straw, large stone, tree stump, snail shell and energetic drink.

- Husking. Cleaned paddy passes through husker. Husker can be of 2 stone disks or 2 rubber rollers running against each other at different speed. When paddy passed through, husk will be rubbed out from paddy, leaving brown rice and husk. Husk will then be separated using ventilation.

- Paddy separator. In order to lessen brokerage in husking process, husker will not hard pressed to rub away all husk, so there will be some paddy mixed in brown rice. Brown rice will pass through paddy separator. Traditional name of this separator is "German Sieve". Paddy separator will separate paddy from brown rice, using difference in gravity and surface friction. Separated paddy will return to husker, leaving pure brown rice. Paddy separator will determine the total through put speed of whole rice mill.

- Milling. This process is where the word rice mill come from. Brown rice passes through different miller, typicaly is 2-3 passes, depending on milling degree required. Miller is made of cylinder stone rotate against rubber bars. Bran will be rubbed out from rice and sucked by air ventilation.

- Grading. Milled rice will be mixture of different sizes grains, whole grain, head rice, broken, coursed by breakage during husking and milling. Sizes are separated by sieve grader. Thai rice mill usually use flat bed sieve and rotary sieve. Difference sizes of rice are stored separately in 100kgs jute bags, ready for warehousing or delivery.

Copyright by Mahidol University

- Packaging. Packing Machineries are grouped into different packing lines according to the packing sizes. Packing sizes vary from 1 to 1,000 kg .

Figure 4 shown rice mill processing

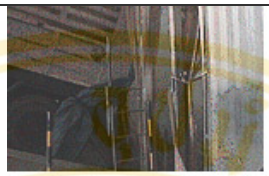
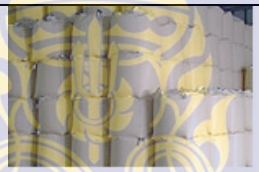
 1 SAMPLING Raw materials are sampled for quality check to ensure that they meet our standards.	 2 RECEIVING Paddy could be received quickly through enclosed system which prevents dust dispersion.	 3 QUALITY STORAGE Temperature control of the storage keeps paddy to remain fresh and clean.
 4 STORAGE Large silos can keep high volume of paddy, sufficient for demands of all year round.	 5 WAREHOUSE Both raw materials and finished goods are kept in clean and contamination-free environment and easy to transport.	 6 QUALITY CONTROL Rice grains will be inspected before milling.
 7 HUSKING Paddy is husked into brown rice.	 8 WHITENING Bran is removed from brown rice to become white rice.	 9 POLISHING Rice is polished to gain glossiness, cleaner rice and longer storage life.

Figure 4 Rice mill processing

Copyright by Mahidol University

10 MULTI-SORTER	11 FINAL INSPECTION	12 PACKING
Rice is finally sorted to remove all impurities before packing.	Rice and packing materials as well as packing machines will be inspected before final packing.	Packing Machineries are grouped into different packing lines according to the packing sizes. Packing sizes vary from 1 to 1,000 kg .

Figure 4 (Cont) Rice mill processing

2.2 Hazard of rice mill dust

Dust Type (26)

Industrial dust could divided dust in 2 types that are organic dusts and inorganic dusts.

Organic dusts are dusts from plant, animal or synthetic. Dusts which get into alveoli had particle size smaller than 10 micron and exposure dose not over 5 mg./m^3. For the total dust , the exposure does not exceed 15 mg./m^3.

Inorganic dust are divided into metallic particulates and Non-metallic particulates.

2.2.1 Grain dust(11)

Grain dust causes "grain fever," wheezing, chest tightness, productive cough, eye and nasal irritation, and symptoms of chronic respiratory disease. Grain dust may also induce asthmatic reactions via an allergic mechanism, particularly in individuals who are predisposed to develop allergies (i.e., atopic individuals).

Copyright by Mahidol University

OSHA (13) is establishing an 8-hour TWA limit of 10 mg/m^3 for grain dust, measured as total dust. Grain dusts other than oat, wheat, and barley are regulated under OSHA's generic "particulates not otherwise regulated" PEL of 15 mg/m^3 (total particulate) and 5 mg/m^3 (respirable fraction). The Agency concludes that this limit will substantially reduce the significant risk of acute and chronic respiratory symptoms and disease associated with exposure to grain dust at the levels formerly permitted by OSHA standard. The Agency has determined that the respiratory effects caused by exposure to grain dust represent material impairments of health.

2.2.2 Silica dusts. (12,24)

Silica or silicon dioxide (SiO_2) is an abundant mineral found in rock, sand, and soil. Silica primarily exists in its crystalline state as quartz, which is structurally and chemically different from amorphous silica (e.g., diatomaceous earth); silicates (e.g., talc or asbestos); and silicone [a polymer containing silicon ($[SiO(CH_3)_2]_n$)]. Ubiquitous in the environment, silica is part of the small particulate fraction of air pollution and may comprise a significant fraction of environmental dust levels in some geographic regions . In this review, the term silica dust exposure refers to occupational exposure to the respirable fraction of crystalline silica dust.

Crystalline silica can be harmful when inhaled as a respirable dust (< 5-µm particles). Silicosis, a form of pulmonary fibrosis, is a well-known occupational disease that results from acute or chronic high-level exposure to silica or silica-containing dusts. Silicosis increases susceptibility to tuberculosis and other respiratory diseases. Silica has recently been categorized by the International Agency for Research on Cancer as a known human carcinogen .

Source of exposure (25)

The sources of occupational exposure to silica dust are diverse and include many manufacturing and construction processes that use silica as either a tool or a raw material, as well as the mining and processing of silica-containing rock. Many of these industries are traditionally known as the dusty trades. Some jobs may involve regular contact with silica but are not commonly recognized as dusty trades (e.g., dental technician, chemist, or sculptor). Silica sand and gravel are used in road construction

Copyright by Mahidol University

and concrete and in the manufacture of glass and ceramics, foundry castings, and abrasives such as sandpaper and sandblasting materials. Silica sand or flour is also used as a filler in detergents, paints, plastics, and cements; as a filtering agent for water, sewage, and food production; and as the primary component of some abrasive cleansers (e.g., scouring powder).

The permissible exposure limit (PEL) (13) for respirable silica dust used by the Occupational Health and Safety Administration (OSHA) is approximately 0.10 mg/m^3 (8-hr time-weighted average for quartz) , which is twice the recommended exposure limit ([REL]; 0.05 mg/m^3) suggested by the National Institute of Occupational Safety and Health to minimize risk of silicosis. Approximately 1-3 million people in the United States work in jobs with potential exposure to silica, and at least 10% of these workers may have dangerously high exposures (at least 2-10 times the REL) . The National Occupational Exposure Survey (1981-1983) estimated that women comprise approximately 20% of workers in the United States with potential silica exposure. This number may increase as more women move into occupations traditionally held by men. Recently, the burden of silica-related disease has shifted from industrialized to developing countries.

The potential for silica dust exposure in agriculture was recently recognized by OSHA based on measurements in some food-processing operations. The levels of silica exposure in farming depend on the tasks and crops involved and may also vary by soil characteristics and quartz content. Exposures as high as 0.10-0.65 mg/m^3 (1-6.5 times greater than PEL for silica exposure in other industries) have been reported in mechanized and manual harvesting of some crops. Approximately 10 million people in the United States work on a farm. The impact of silica dust exposure in agriculture could be substantial, but relatively few studies have characterized exposure levels and associated risks in this population.

Copyright by Mahidol University

2.2.3 Lung diseases were happened from dust (29,30)

Occupational lung disease

The particulates when we breathe while working were consisted of dust, smoke, mist, fume and a portion of that dust is retained in the lungs. Inhaling too must dust can cause occupational lung disease. Those particulates were produce irritation or toxic in respiratory system. Some cases maybe cause pneumoconiosis or fibrosis. Some body had allergic that cause asthma. The above symptoms called “Occupational lung desease” figure 5 shown Classification causes of occupational lung disease.

Classification causes of occupational lung disease

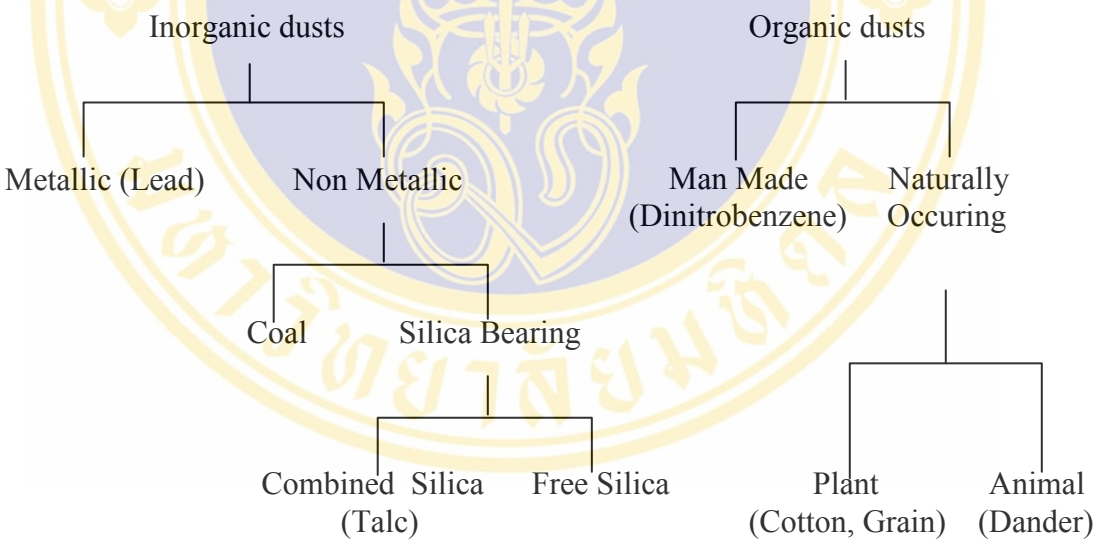


Figure 5 Classification causes of occupational lung disease

Copyright by Mahidol University

Inorganic Dusts or inorganic metallic particulates can be classified as metallic or non metallic. Non metallic consist of coal and silica bearing. There are 2 types of silica bearing ; crystalline and amorphous. which can produce local dermatitis and sensitization (such as nickel itch) and systemic toxicity. Particularly to kidneys, blood, and central nervous system (CNS). Inorganic silica bearing particulates containing crystalline or “free” silica can cause pneumoconiosis (silicosis) as a result of chronic exposure.

Organic Dusts are originate term plant and animal material or from synthetic material. In general, naturally occurring organic particulates tend to produce allergic responses after acute and chronic exposures. Synthetic organic particulates can produce irritation and allergic responses as well as whole range of local effects (such as dermatitis) or systemic toxic effects, depending on the chemical involved.

- Occupational asthma
- Occupational lung that breathe gases or toxic smoke
- Lung cancer and mesothelioma

2.2.3.1. Some of the pulmonary diseases that show obstructive patterns (31)

Occupational Asthma

Occupational asthma is caused by repeated exposure to certain airborne contaminants, which results in sensitization, leading to a chronic allergic response. On subsequent exposures, the smooth muscles of the bronchial tubes go into a spasm and some of the smaller airways close down. Excessive mucous is also produced, which further aggravates the problem by clogging small airways. Coughing, difficulty breathing, and wheezing are common symptoms. A wide variety of sensitizing agents can induce attacks. These may occur in people who are essentially normal and who become sensitized, or in individuals with a prior history of allergies or childhood asthma. (Certain agents, such as the diisocyanates, are such potent sensitizers and irritants that they cause respiratory reactions in most individuals.) Workers can sometimes relate their asthmatic symptoms to a specific exposure, or at least to a specific part of the workplace. In many cases, however, the symptoms begin after the work shift and subside by the following morning.

Copyright by Mahidol University

Reactive Airways Dysfunction Syndrome (RADS)

Reactive Airways Dysfunction Syndrome mimics asthma, but is due to an irritant rather than an allergic stimulus. Individuals with RADS will experience airflow obstruction at exposure levels much lower than would produce a response in non-affected individuals. One special case of RADS involves a heightened response to cold air. It is known that asthmatics can have their attacks initiated by cold air. Other individuals with no known history of asthma may develop bronchoconstriction and tightness and shortness of breath when exposed to cold air, either on the job or during exercise. Removal from the exposure usually causes symptoms to subside within 1-2 hours.

Emphysema

Chronic exposure to irritant substances, most notably cigarette smoking, can cause emphysema. These exposures lead to the destruction of the elasticity of the smaller bronchi. When pressure in the chest begins to increase upon exhalation, these bronchi may collapse, trapping air inside. As a result, the air sacs remain partially expanded. Shortness of breath is a permanent problem and trying to breathe faster or more deeply only causes more air to become trapped inside. The lungs frequently become distended, causing a barrel-chested appearance. The disease is progressive and damage to the heart is a frequent side effect.

Chronic Bronchitis

Chronic bronchitis is caused by repeated infections and/or exposure to irritants such as fumes and dusts (including wood dusts and mineral fibers), oil aerosols, gases such as ozone and nitrogen dioxide, and smoke from cigarettes or exposure to fire (such as fire-fighting). Inflammation, swelling, and increased mucous production occur, fostering chronic bacterial infections in the mucous-plugged small airways. Symptoms include shortness of breath and a persistent and productive cough.

2.2.3.2 Some of the pulmonary diseases that show restrictive patterns

Pneumoconioses

The three major types of pneumoconioses in the United States are asbestosis, silicosis, and coal worker's pneumoconiosis (Black Lung Disease). The pneumoconioses are some of the best-known of the occupational lung diseases, yet for

Copyright by Mahidol University

a long time the courts doubted their existence and refused to consider them as compensable illnesses. Most causes of pneumoconioses are inorganic dusts or fibers, with particles less than 5 microns in size. Particles of this size are called "respirable particulates." Since these particulates are invisible, it is possible to be exposed without knowing it. However, many of the heaviest exposures were accompanied by larger particulates so that the industries were recognizably "dusty". The pathology in the lung is fibrosis, a profusion of fibrous tissue between the alveoli which interferes with the normal expansion of the lungs. The fibrosis can take two forms: nodular and localized around the bronchi (peribronchial), (typical of silicosis), or interstitial (between the alveoli) and diffuse (typical of asbestosis). With continued exposure, the fibrosis increases, leading to shortness of breath and a persistent cough, and, in late stages, heart failure. Pneumoconioses are almost exclusively occupational diseases and therefore are compensable.

Hypersensitivity Pneumonitis

Hypersensitivity Pneumonitis is also referred to as Extrinsic Allergic Alveolitis. The disease occurs mainly in the alveoli and terminal bronchi in response to organic dusts associated with specific occupations. In some cases the offending agents are fungi, such as in Farmer's lung and Bagassosis. In other cases they are animal proteins (such as bird breeder's lung, and furrier's lung) or vegetable proteins (such as coffee worker's lung). The workers develop an acute illness with cough and shortness of breath, usually without wheezing, but often accompanied by chills and fever. The first occurrence may be mistaken for a "flu syndrome". Once workers are sensitized, they may respond to very small doses of the allergen. Fluid accumulates in the alveoli interfering with the oxygen diffusing capacity. Termination of exposure allows the acute phase to resolve over a period of 1-2 weeks. However, recurrent exposures may produce a chronic disease with interstitial fibrosis and severe shortness of breath.

Granulomatous Disease

Granulomas are inflammatory responses that occur as a reaction to infections (e.g., tuberculosis) or toxins. Large inflammatory cells move in and begin to collect around the point of exposure. Later fibrous tissue migrates in and surrounds the

Copyright by Mahidol University

site, producing a globular mass that can be seen under the microscope. Berylliosis is the best known occupational example of this class of lung diseases.

Other Health Conditions

Several preexisting conditions can cause restrictive patterns. These include pregnancy, obesity, anatomical abnormalities, and thoracic or abdominal surgery. Although these conditions are not occupationally induced, they are mentioned here because their impact must be considered when reviewing spirometric results.

2.2.3.3 Some of the pulmonary diseases that show either obstructive or restrictive patterns

Pneumonias

Pneumonias may have a restrictive effect due to accumulation of fluid and inflammatory cells in the alveoli (much like alveolitis) or an obstructive effect due to accumulation of cells around the bronchi (bronchial pneumonia). Pneumonias can arise as part of a toxic process, or more commonly through infections. Occupational lung disease of infectious origin occurs primarily in health care workers, child care workers, and animal care workers. The offending agents may be fungi, bacteria, viruses, or other microorganisms. In many cases these diseases are accompanied by chills and fever.

Pneumoconioses

Although pneumoconioses are primarily restrictive diseases, in advanced cases the fibrous tissue may impinge on the bronchial tree causing obstructive symptoms as well.

Occupational Lung Cancer

Lung cancer is characterized by an enlarging mass of cells that grow uncontrollably. Smoking is the single most important cause and has a synergistic effect with some occupational carcinogens. Epidemiological studies have shown higher than normal rates of lung cancer for individuals exposed repeatedly to bis-chloromethyl ether, coal tar, pitch volatiles, mustard gas, arsenic, asbestos, radium, petroleum, chromates, and uranium. Lung cancer is especially insidious because symptoms frequently do not appear until it is too late to intervene medically.

Copyright by Mahidol University

Depending on where the tumor(s) grows, in late stages it may cause obstructive or restrictive pattern

2.3 Bioaerosal (27,28)

2.3.1 Fungi

Fungi is kingdom of heterotrophic single-celled, multinucleated, or multicellular organisms, including yeasts, molds, and mushrooms. The organisms live as parasites , symbionts, or saprobes. Previously classified in the plant kingdom, fungi are nonmotile, like plants, but lack the vascular tissues (phloem and xylem) that form the true roots, stems, and leaves of plants. Most coenocytic (multinucleated) or multicellular fungi are composed of multiple filaments, called hyphae, grouped together into a discrete organism called a mycelium. The cell walls of fungi are of chitin or other noncellulose compounds. In many ways fungi are more closely related to animals than to plants, and they have been thought to share a common protist ancestor with animals. A recent classification system suggested by nucleic acid (genetic material) comparisons places the fungi with the animals and the plants in an overarching taxonomic group called the eukarya. Most fungi are capable of asexual and sexual reproduction . A sexual reproduction is by fragmentation or spore formation. Those that reproduce sexually produce gametes in specialized areas of the hyphae called gametangia. The gametes may be released to fuse into spores elsewhere, or the gametangia themselves may fuse. In some cases dikaryons, which are found only among fungi, result when unspecialized hyphae fuse but their nuclei remain distinct for part of the life cycle.

Unlike algae or plants, fungi lack the chlorophyll necessary for photosynthesis and must therefore live as parasites or saprobes. Typically they release digestive enzymes onto a food source, partially dissolving it to make the necessary organic or inorganic nutrients available. Some parasitic types obtain their food directly from the cells of a living food source. Some types of fungi are involved in symbiotic relationships, for example, lichens (a combination of a fungus and a green alga or a cyanobacterium) and the mycorrhizae (symbiosis between a fungus and the roots of a vascular plant).

Copyright by Mahidol University

Some fungi are pathogenic to humans and other animals. Such diseases are called mycoses or fungal infections . Some molds, in particular, release toxic chemicals called mycotoxins that can result in poisoning or death. Various fungi can also cause serious damage to fruit harvests and other crops

***Aspergillus* spp.**

Aspergillus is a filamentous, cosmopolitan and ubiquitous fungus found in nature. It is commonly isolated from soil, plant debris, and indoor air environment. While a teleomorphic state has been described only for some of the *Aspergillus* spp., others are accepted to be mitosporic, without any known sexual spore production.

Aspergillus spp. are well-known to play a role in three different clinical settings in man: (i) opportunistic infections; (ii) allergic states; and (iii) toxicoses. Immunosuppression is the major factor predisposing to development of opportunistic infections. These infections may present in a wide spectrum, varying from local involvement to dissemination and as a whole called aspergillosis. Among all filamentous fungi, *Aspergillus* is in general the most commonly isolated one in invasive infections. It is the second most commonly recovered fungus in opportunistic mycoses following *Candida*.

Almost any organ or system in the human body may be involved. Onychomycosis, sinusitis, cerebral aspergillosis, meningitis, endocarditis, myocarditis, pulmonary aspergillosis, osteomyelitis, otomycosis, endophthalmitis, cutaneous aspergillosis, hepatosplenic aspergillosis, as well as *Aspergillus* fungemia, and disseminated aspergillosis may develop. Nosocomial occurrence of aspergillosis due to catheters and other devices is also likely. Construction in hospital environments constitutes a major risk for development of aspergillosis particularly in neutropenic patients.

Aspergillus spp. may also be local colonizers in previously developed lung cavities due to tuberculosis, sarcoidosis, bronchiectasis, pneumoconiosis, ankylosing spondylitis or neoplasms, presenting as a distinct clinical entity, called aspergilloma. Aspergilloma may also occur in kidneys.

Some *Aspergillus* antigens are fungal allergens and may initiate allergic bronchopulmonary aspergillosis particularly in atopic host. Some *Aspergillus* spp. produce various mycotoxins. These mycotoxins, by chronic ingestion, have proven to

Copyright by Mahidol University

possess carcinogenic potential particularly in animals. Among these mycotoxins, aflatoxin is well-known and may induce hepatocellular carcinoma. It is mostly produced by *Aspergillus flavus* and contaminates foodstuff, such as peanuts .

***Penicillium* spp.**

Penicillium spp. are widespread and are found in soil, decaying vegetation, and the air. Showing again how it is distinct from other species in this genus, *Penicillium marneffei* is endemic specifically in Southeast Asia where it infects bamboo rats which serve as epidemiological markers and reservoirs for human infections.

Penicillium spp. other than *Penicillium marneffei* are commonly considered as contaminants but may cause infections, particularly in immunocompromised hosts. *Penicillium marneffei* is pathogenic particularly in patients with AIDS and its isolation from blood is considered as an HIV marker in endemic areas. In addition to their infectious potential, *Penicillium* spp. are known to produce mycotoxins. Some *Penicillium* spp. have telemorphs included in genera *Eupenicillium*, *Talaromyces*, *Hamigera*, and *Trichocoma*.

Penicillium spp. are occasional causes of infection in humans and the resulting disease is known generically as penicilliosis. *Penicillium* has been isolated from patients with keratitis, endophtalmitis, otomycosis, necrotizing esophagitis, pneumonia, endocarditis, peritonitis, and urinary tract infections. Most *Penicillium* infections are encountered in immunosuppressed hosts. Corneal infections are usually post-traumatic. In addition to its infectious potential, *Penicillium verrucosum* produces a mycotoxin, ochratoxin A, which is nephrotoxic and carcinogenic. The production of the toxin usually occurs in cereal grains at cold climates.

2.3.2 Bacteria

Bacteria is microscopic unicellular prokaryotic organisms characterized by the lack of a membrane-bound nucleus and membrane-bound organelles. Once considered a part of the plant kingdom, bacteria were eventually placed in a separate kingdom, Monera . Bacteria fall into one of two groups, Archaebacteria (ancient forms thought to have evolved separately from other bacteria) and Eubacteria. A recently proposed system classifies the Archaebacteria, or archaea, and the Eubacteria as major

Copyright by Mahidol University

groupings (sometimes called domains) above the kingdom level. Bacteria were the only form of life on earth for 2 billion years.

Bacteria are remarkably adaptable to diverse environmental conditions: they are found in the bodies of all living organisms and on all parts of the earth—in land terrains and ocean depths, in arctic ice and glaciers, in hot springs, and even in the stratosphere. Our understanding of bacteria and their metabolic processes has been expanded by the discovery of species that can live only deep below the earth's surface and by species that thrive without sunlight in the high temperature and pressure near hydrothermal vents on the ocean floor. There are more bacteria, as separate individuals, than any other type of organism; there can be as many as 2.5 billion bacteria in one gram of fertile soil.

2.4 Respiratory system (14,15,16,17)

The respiratory system is responsible for the exchange of gases (oxygen, nitrogen and carbon dioxide). Oxygen is an odorless gas that comprises about 20 percent of the air. It is essential to life because the body uses it for the chemical reactions that occur in the cells of the body. Carbon dioxide and nitrogen are also an odorless gases that are waste products. Oxygen is brought in and carbon and dioxide are expelled from the body.

The respiratory system is divided into the upper respiratory tract (figure 6) (including the nose, nasal cavities, pharynx, larynx and upper trachea), and the lower respiratory tract (lower trachea and the lungs).

Air is brought in primarily through the nose, over the nasal cavities, which are lined with mucous membranes and cilia. The nasal cavities warm, moisten and filter the air of possible contaminants. Air is also brought in through the mouth, but this is considered to be a secondary method of breathing.

From either the nose or mouth, air then takes the following pathway:

Pharynx (throat). The passageway at the back of the neck. Both air and food travel down the pharynx. When food is swallowed, a flap of tissue called the *epiglottis*, located at the top of the *larynx* (voice box) presses down to prevent food from going down the *trachea* (air passage).

Copyright by Mahidol University

Larynx (voice box). Air passes from the pharynx through the larynx, located at the upper end of the trachea (windpipe). This organ contains the vocal chords and leads to the trachea.

Trachea (windpipe). A long tube featuring a series of “C” shaped rings of cartilage that begins at the larynx and then splits into the bronchial tubes that lead to the lungs. It is the largest breathing tube in the body, connecting the upper respiratory system (mouth, nose and throat) to the bronchi leading to the lungs.

The actual exchange of gases takes place in the major organs of the respiratory system the lungs. These cone shaped organs have a spongy, porous, highly elastic texture.

Each lung is made up of lobes, three in the right lung and two in the left lung (which is smaller, to make room for the heart). Each lobe contains lung tissue, air sacs, ducts and bronchioles that are used for respiration. The lobes operate relatively independently of each other.

The lungs are located in the thoracic cavity (chest). The floor of this cavity is called the diaphragm. The lungs are separated from the chest wall by the pluera, a continuous membrane that covers the lobes and the inner chest wall.

The lungs are separated from each other by the mediastinum, a space that contains the heart, the esophagus (a tube connecting the throat with the stomach) and part of the trachea. When air leaves the trachea, it takes the following path to the lungs:

Bronchi (bronchial tubes). A pair of tubes that branch off from the trachea, each leading to a lung. Like an upside–down tree, air passageways begin with the trunk (trachea) and divide into large branches (bronchi).

Bronchioles. Branches of increasingly smaller passageways connecting to the alveoli. In the respiratory–stem tree, they are the smaller branches (bronchioles).

Alveoli. Tiny sacs in the lungs where gases in air are exchanged for gases in the blood (in tiny blood vessels called capillaries). Alveoli are the endpoint of the respiratory system.

Copyright by Mahidol University

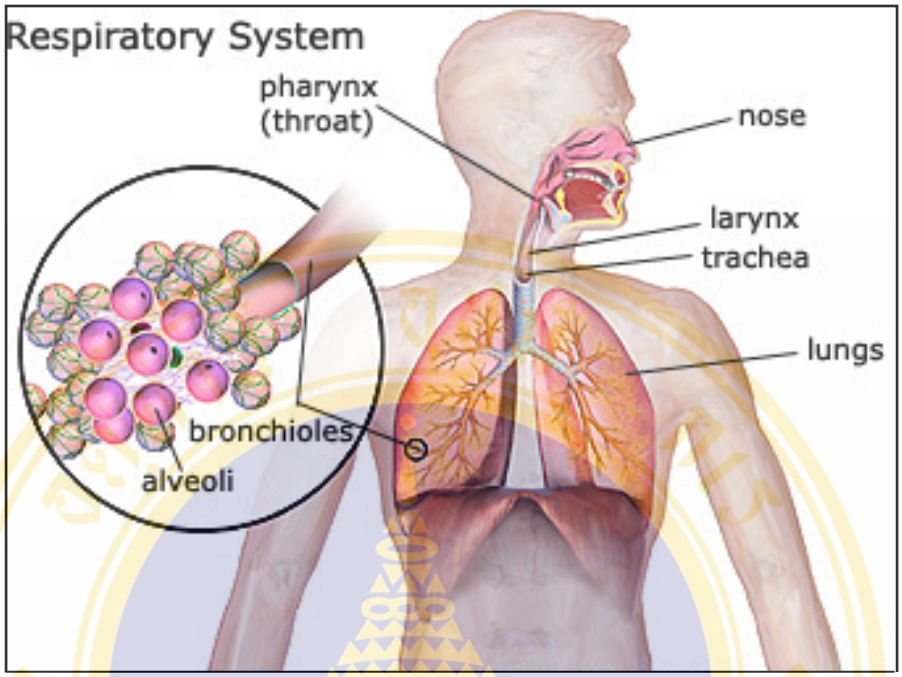


Figure 6 The anatomy of the respiratory tract

Respiration is the body process of inhaling air, exchanging gases between air and blood, and exhaling those gases out of the body. This is accomplished during three phases:

External respiration. The exchange of oxygen and carbon dioxide between the atmosphere and the blood. It takes place in the (large) capillaries in the lungs.

Internal respiration. The exchange of oxygen and carbon dioxide between the blood and the cells of the body.

Cellular respiration. The process by which body cells use the oxygen taken from the bloodstream as fuel for their work. As the cells work, the metabolic activity produces carbon dioxide. If this carbon dioxide were allowed to build up to high levels, it could damage cells, organs and body tissue. Therefore, the blood picks up the carbon dioxide and brings it to the lungs to be exhaled into the atmosphere.

The normal breathing cycle begins when air enters the body through the nose. During vigorous exercise, a person may open his or her mouth to bring air into the body, a process known as mouth breathing. However, the usual starting point of respiration is the nose and nasal passages. By the time air has reached the lungs, the

Copyright by Mahidol University

mucous lining and cilia have warmed the air to a relative humidity of about 75 degrees. This is important process because cold air can damage delicate lung tissues. The mucus and cilia also help filter out contaminants.

When the air reaches the alveoli, gases are exchanged on the cellular level. The lungs contain about 300 million of these air sacs, which are surrounded by capillaries, the smallest blood vessels in the body.Here, the hemoglobin within red blood cells exchanges carbon dioxide for fresh oxygen to be delivered back to the heart, which pumps the oxygen–rich blood throughout the body to nourish the tissues.

2.5 Pulmonary function tests (PFTs) (18,19,20,21)

Pulmonary function tests (PFTs) is the measurement of lung function and offer inclues to the nature and severity of problems affecting an individual's ability to breathe. The tests record both an individual's capacity to breathe in (inspiration) and to breathe out (expiration). PFTs measure several different aspects of lung function to diagnose lung conditions.

There is no single test that can determine if a lung condition is obstructive or restrictive in nature. It is therefore common for more than one type of pulmonary function test to be performed. The three primary types of pulmonary function testing are:

Spirometry. The most widely used for pulmonary function test. It records the amount of air breathed in and out and the rate at which this process takes place. The device used in this testing is a spirometer, a long piece of tubing with a mouthpiece at one end, and a recording device at the other. Spirometry reveals any degree of narrowing or obstruction of the airways. An abnormally low reading indicates an obstructive disorder, such as asthma, bronchitis or emphysema.

Lung volume measurement. Records the maximum amount of air the body can hold and helps determine the elasticity of the lungs and rib cage. The most accurate way to obtain this measure is using a body plethysmograph, a sealed, transparent box that looks like a phone booth and helps reveal the volume of gas in the lungs. An abnormally low reading reveals a stiffness that is common in restrictive disorders, such as scarring of the lung tissue (interstitial lung disease) and kyphoscoliosis (curvature of the spine).

Copyright by Mahidol University

Diffusing capacity measurement. Determines how efficiently the body is able to transfer oxygen from the lungs into the bloodstream. An abnormal reading indicates that oxygen is not being properly diffused between the lungs and the bloodstream. Poor results in this test might indicate a disorder that affects the blood vessels of the lungs, such as pulmonary fibrosis or emphysema.

There is other tests to help rule out other conditions. These tests include:

Chest x-ray. The presence of scarring and enlarged airway walls may indicate chronic bronchitis, often referred to as a "dirty chest." Chest x-rays can also reveal several other conditions, including a low–lying diaphragm, overly inflated lungs, large spaces in the lungs (bullae) and an abnormally small heart.

Arterial blood gas study. These tests measure how effectively the lungs get oxygen into the blood and carbon dioxide out of it. There are two types of tests:

Pulse oximetry. A small probe is placed on the ear or finger to measure the amount of oxygen in the blood. This painless procedure allows physicians to determine blood oxygen levels without drawing blood.

Arterial blood sample. Blood is drawn from the patient and analyzed. Using this procedure, a physician can also detect carbon dioxide concentrations in the blood and blood acidity

Exercise stress test. Helps determine the effect of exertion on the lungs. During this test, the patient walks on a treadmill while being monitored by a physician. The results can be analyzed to determine whether a patient might be suffering from coronary artery disease. Results also indicate how well the heart responds to inadequate blood supply (ischemia).

Sputum analysis. A sample of a patient's sputum – a substance expelled from the throat – can be analyzed to check for a respiratory infection.

Copyright by Mahidol University

Preparation for pulmonary function test.

Preparation is minimal for a pulmonary function test. workers who are anxious about testing should be reassured that the procedures are painless, and that patients are allowed to rest between each phase of the testing if necessary. A researcher may suggest the following preparatory steps:

Do not eat a heavy meal before the test. A full stomach can keep the lungs from fully expanding.

Do notsmoke for four to six hours before testing.

Workers may be advised not to use bronchodilators and inhalers prior to testing. Such use can skew test results and mask potential problems.

Tell any medications being taken prior to testing. Some medications, such as painkillers, can affect the results of the test.

Use the bathroom just prior to testing.

Wear loose clothing or loosen any tight–fitting clothing.

Those with dentures should wear them during testing. This will help form a seal around the mouthpiece used in the tests.

Step for the pulmonary function test

Workers cooperation is the most important factor to obtain the most accurate results from pulmonary function test. The tests require patients to inhale and exhale with a specific degree of effort and at various rates and repetitions. The information gleaned from these tests is only as accurate as worker participation allows.

There are many different types of pulmonary function tests, and each measures a different aspect of lung function. In many of these tests, a clip is attached to the worker's nose to ensure that air doesn't escape through the nostrils. Testing usually takes between five and 30 minutes, depending on which tests are being administered.

The most common side effects of pulmonary function testing are shortness of breath or dizziness from breathing in and out forcefully. Much of this discomfort is quickly alleviated by taking short rest periods between each phase of testing. Those who feel any discomfort during testing should immediately tell the test administrator.

Copyright by Mahidol University

The three primary pulmonary function tests are as follows:

Spirometry. workers are asked to sit up straight or stand, place their mouths on the spirometer's mouthpiece and form a tight seal around it while breathing normally. The spirometer records lung functions during this normal breathing pattern.

Workers then are asked to inhale deeply, then exhale vigorously and quickly. Typically, this is repeated twice more, and the best reading will be recorded and compared to normal based on age, gender and height. Sometimes, the ethnicity and weight of the patient also are considered. A reading that falls below 80 percent of the predicted norm is considered abnormal.

Lung volume measurement. Workers sit in the body plethysmograph and seal their mouths around a mouthpiece. As they breathe in and out, changes in pressure inside the box reveal the volume of gas in the lungs.

After the pulmonary function test. Patients can resume normal activities immediately after finishing the tests. A healthcare provider will contact the patient once testing results have been analyzed and interpreted. Some of the common aspects of lung function that are analyzed include:

Tidal volume (VT) – Amount of air inhaled in a normal breath

Vital capacity (VC) – Maximum amount of air exhaled after inhaling as deeply as possible

Forced expiratory flow (FEF) – Average rate of flow during middle half of FVC

Force expiratory volume (FEV) – Amount of air exhaled forcefully in a sustained breath at 1 second (FEV1) 2 seconds (FEV2) or 3 seconds (FEV3)

Functional residual capacity (FRC) – Amount of air remaining in lungs after normal respiration.

Forced vital capacity (FVC) – Total amount of air exhaled during forced expiratory volume test

Inspiratory capacity (IC) – Amount of air that can be inhaled after normal expiration.

Peak expiratory flow rate (PEFR) – Measure of how quickly a person can exhale

Copyright by Mahidol University

Maximum ventilation volume (MVV) – Greatest amount of air a person can breathe in and out in one minute

Residual volume (RV) – Amount of air left in the lungs after complete exhalation

Total lung capacity (TLC) – Maximum amount of air in the lungs after complete inhalation

2.6 Pulmonary function impairment (21)

Measurements of pulmonary function may be useful in a diagnostic sense but there are also useful in following the natural history of disease over a period of time, assessing preoperative risk and in quantifying the effects of treatment. The presence of pulmonary abnormality can be inferred if any of FEV_1, FVC or FEV_1/FVC% are outside the normal range. Normal Value of pulmonary function (figure 7) are the following :

- FVC $\geq$ 80 % of predicted value
- FEV_1/FVC $\geq$ 70 % of predicted value
- $FEF_{25-75\ \%}$ $\geq$ 65 % of predicted value

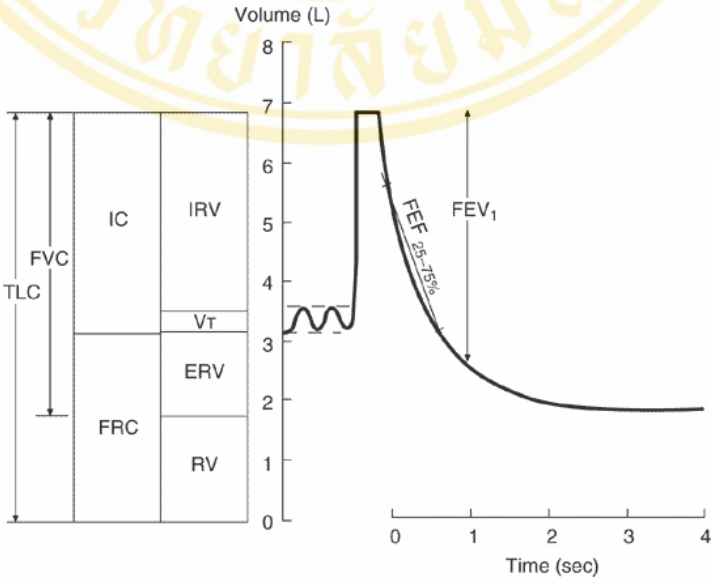


Figure 7 Normal spirogram and lung volumes

Copyright by Mahidol University

Pulmonary function impairment can be classified into 3 patterns : Airway obstruction, restrictive pattern and combined pattern

(1.) Obstructive Pattern (22)

This pattern system from narrowing of any portion of the airways from upper airway to bronchioles less than 2 mm. Included this group of disorder are chlonic obstructive diseases of the airways such as exposure to the cigarette smoke and other common air pollutants can trigger a reflexive constriction of bronchial airways and the hallmark of this pattern is a reduction in Forced Expiratory Volume in 1 second value (figure 8) and Forced Vital Capacity value FEV_1/FVC less than 80 % of predicted value that can be classified into the severity i.e.;

- Mild % predicted $FEV_1/FVC = 50 – 69$ %
- Moderate % predicted $FEV_1/FVC = 35 – 49$ %
- Severe % predicted $FEV_1/FVC < 35$ %

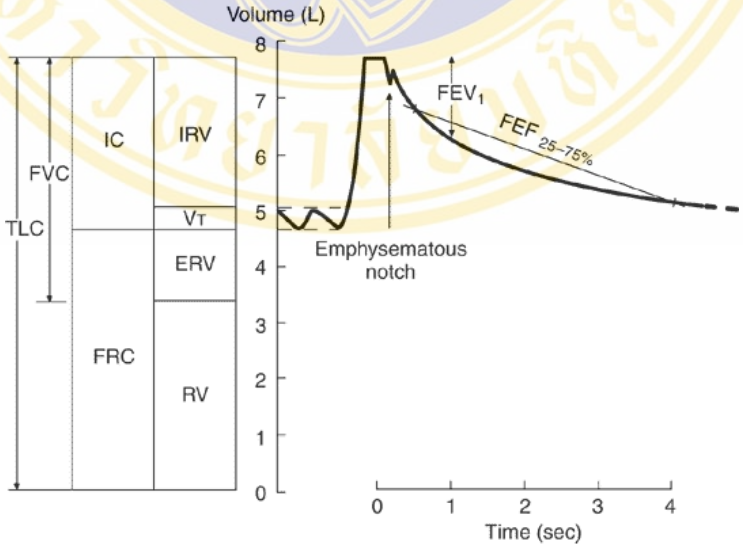


Figure 8 Spirogram and lung volumes in obstructive disease

Copyright by Mahidol University

(2.) Restrictive Pattern

Restrictive pulmonary disorders involve restriction (reduced stretch) of the alveoli , inhabit inspiration, reduce pulmonary volumes and capacities such as inflammation or fibrosis of lung tissue caused by exposure to asbestos, coal or silica dust can restrict alveoli, the hallmark of this pattern is a reduction in Forced Vital Capacity (FVC < 80 %) (figure 9) of predicted value that can be classified into the severity i.e.;

- Mild % predicted FVC = 66 – 80 %
- Moderate % predicted FVC = 50 – 65 %
- Severe % predicted FVC <50 %

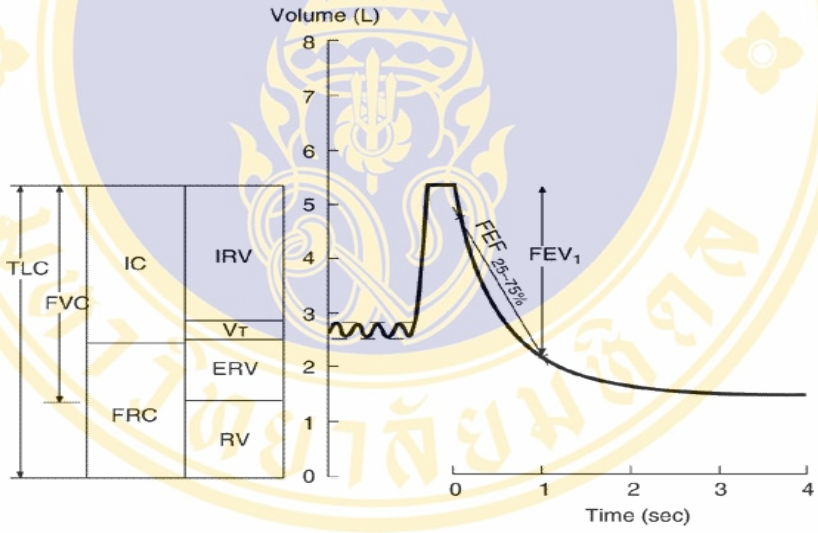


Figure 9 Spirogram and lung volumes in restrictive disease

(3.) Combined pattern

The pattern that both Forced Expiratory Ratio valve (FEV_1/FVC) is less than 80 % and $FEF_{25-75\%}$ value is less than 57 % of predicted value. This pattern results from pathologic processes that reduce lung volumes, vital capacity and airflow, and that also include an element of airway narrowing. The combined pattern is

Copyright by Mahidol University

characterized by a low FEV_1 (indicating obstructive airway disease) and small lung volume. (indicating coexisting restrictive disease)

Flow-volume loop (23)

The flow-volume loop is generated by continuously recording flow and volume with an electronic spirometer during a forced inspiratory and expiratory VC maneuver. The shape of the loop reflects the status of the lung volumes and airways throughout the respiratory cycle. Characteristic changes occur in restrictive and in obstructive disorders. The loop is especially helpful in detecting laryngeal and tracheal lesions. It can distinguish between fixed obstruction (eg, tracheal stenosis) and variable obstruction (eg, tracheomalacia, vocal cord paralysis) of the upper airway. Figure 9-10 shown illustrates some characteristic flow-volume loop abnormalities.

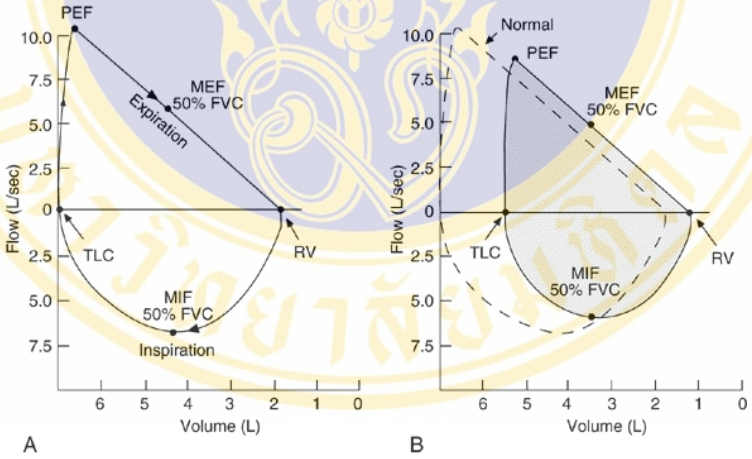


Figure 9 Flow-volume loops.

(A) Normal. Inspiratory.

(B) Restrictive disease

Copyright by Mahidol University

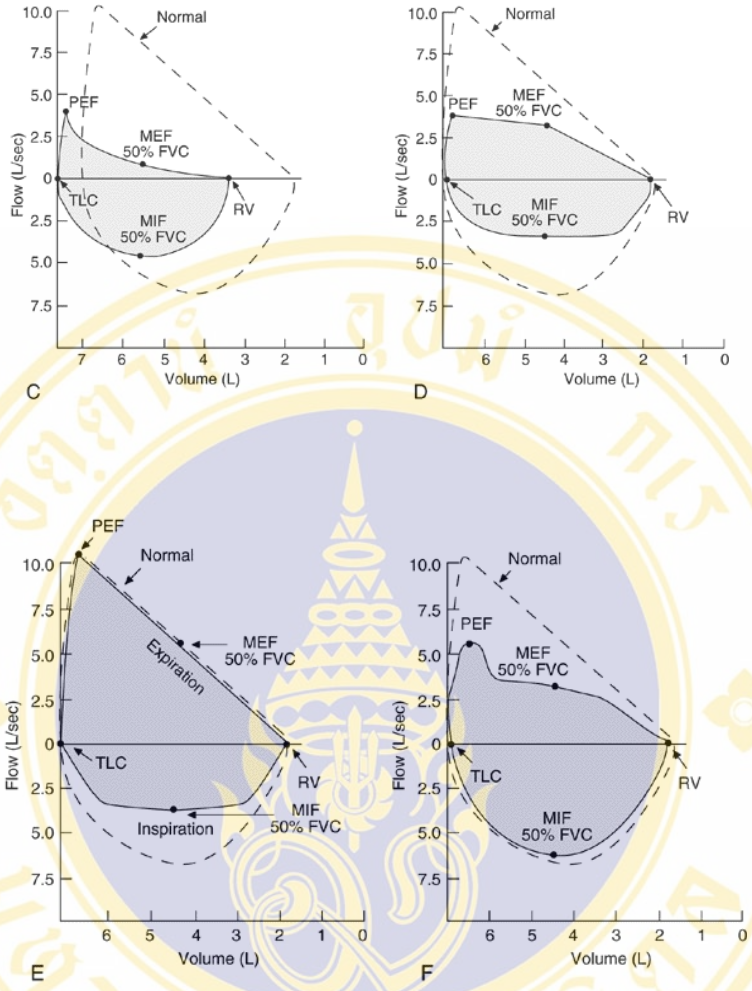


Figure 10 Flow-volume loops.

(C) COPD, asthma.

(D) Fixed obstruction of upper airway.

(E) Variable extrathoracic obstruction

(F) Variable intrathoracic obstruction

Predicted normal values (20)

To interpret pulmonary function tests in any individual, the method is compairing the result with reference values obtained from well-defined population of normal subjects matched for gender, age, height and ethic origin . By using similar test protocols and carefully calibrated validate instruments. Normal predicted values for pulmonary function generally vary as following.

Copyright by Mahidol University

1. Gender : Usually the lung volumes and capacities of males are larger than the lung volumes and capacities of females. Even when males and females are matched for height and weight, males have larger lungs than females. Because of this gender-dependent lung size difference, different normal tables must be used for males and females. For a given height and age, males have a larger FEV_1, FVC,$FEF_{25-75\%}$ and PEF, but a slightly lower FEV_1/FVC.

2. Age : As a person ages, the natural elasticity of the lungs decreases. This translates into smaller and smaller lung volumes and capacities as we age. When determining whether or not your patient has normal PFT findings, it would be important to compare the patient with the PFT results of a normal person of the same age and gender. FEV1, FVC,FEF25-75% and PEF increase, while FEV1/FVC% decrease, for the age about 20 years old in females and 25 years in male.

3. Height : Body size has a tremendous effect on PFT values. A small man will have a smaller PFT result than a man of the same age who is much larger. Normal tables account for this variable by giving predicted PFT data for males or females of a certain age and height. Sometimes as people age they begin to increase their body mass by increasing their body fat to lean body mass ratio. If they become too obese, the abdominal mass prevents the diaphragm from descending as far as it could and the PFT results will demonstrate a smaller measured PFT outcome then expected - i.e. the observed (measured) values are actually smaller than the predicted values (predicted values from the normal tables). All indices except FEV1/FVC% increase with standing height.

4. Ethic Origin : Caucasians have the largest FEV1and FVC, of the various ethic groups, Polynesians are among the lowest. The values for black African are 10-15% lower than for Caucasians of similar age, sex, and height because their thorax is shorter compairing with the given standing height. Chinese have been found to have an FVC about 20% lower than Caucasians. There is little difference in PEF between ethic groups.

There is a vast literature of normal population studies. For examples, there is the research of the “Reference Spirometric Values for Healthy Lifetime Nonsmokers in Thailand” by Siliraj Hospital. The resulting of the research indicate the standard values of pulmonary function in nonsmoker. The standard values are 3654 ; 1655

Copyright by Mahidol University

males and 2299 females, ages are ten years upward, nonsmoker or smoking less than 0.5 packs/year and stop smoking more than 6 months. Subjects do not have heart and respiratory disorders and non pregnant during studied. The questionnaire of the American Thoracic Society (ATS-DLD-78), physical examination and chest x-ray are used for the study method. Instrument for pulmonary function test is electronic turbine pneumotachometer getting standardize from ATS. Siriraj Equation (table 3) for predicted normal values of Thailand population are following :

Table 3 Siriraj equations

Parameters	Sex	Equations
FVC(L)	Male	$-2.601+0.122A-0.00046A^2+0.00023H^2-0.00061AH$
	Female	$-5.894+0.089A-0.0003A^2+0.056H-0.0005AH$
FEV_1(L)	Male	$-7.697+0.123A+0.067H-0.00034A^2-0.0007AH$
	Female	$-10.603+0.085A-0.00019A^2+0.12H-0.00022H^2-0.00056AH$
PEFR (L/S)	Male	$-16.859+0.307A-0.00018A^2+0.141H-0.001AH$
	Female	$-31.362+0.162A-0.00084A^2+0.391H-0.00099H^2-0.00072AH$
FEV_1/ FVC (%)	Male	$19.362+0.49A+0.829H-0.0023H^2-0.0041AH$
	Female	$82.25+0.25A+0.002A^2+0.09H-0.0037AH$
$FEF_{25-75\%}$ (L/S)	Male	$-19.049+0.201A-0.00042A^2+0.207H-0.00039H^2-0.0012AH$
	Female	$-21.518+0.11A-0.00017A^2+0.272H-0.0007H^2-0.00082AH$
A = age (years) , H = height (cm.)		

Values of FVC and FEV_1 in Siriraj equation are 84% of American values and 90% of Europe values but closely with Hongkong values. The researchers believed the standard values of this study should be convincible. Thus, in these thesis will be used Siriraj equation in calculating the predicted normal values, for interpret pulmonary function test of sample.

Copyright by Mahidol University

2.7 Literature cite

In 1991, Bhat MR, and Ramaswamy C. (32) studied ploblem of lung function study was carried out to determine the relative effect of rice husk and saw dust on mill workers. The study consisted of 195 subjects of which 56 rice mill workers, 71 saw mill workers and 68 controls of similar age, sex and socio-economic condition. FVC was significantly reduced in saw-mill workers compared to both the controls and rice mill workers. Both FEV1 and PEFR/min were significantly reduced in both mill workers compared to controls. The fall in PEFR/min in saw mill workers was also significant when compared to rice mill workers. FVC was reduced after 5 years of exposure only in saw mill workers. FEV1 was reduced within a year which was further reduced after 5 years in both mill workers. PEFR/min was highly reduced within a year remained so even after 5 years.

In 1994 , Pitt JI et. al. (33) comprehensive study of fungi occurring in commodities in Thailand, this results from 276 samples of mung beans, rice, sorghum and soybeans as well as other minor crops. Samples for major commodities were taken from farmers' stocks, middlemen and retail outlets, while those for minor crops were mostly from retail. Each sample was divided into two portions, one being examined in Bangkok and the second at North Ryde. The dominant fungus found in mung beans was *Fusarium semitectum*, which was present in 40% of samples and at a high level (18% of all seeds) overall. *Aspergillus flavus* was also found in 40% of samples, but only in 2% of seeds overall. *Lasiodiplodia theobromae* was the only other fungus exceeding 1% total infection. The major fungi found in soybeans were A. flavus (67% of samples; 6% overall) and Cladosporium cladosporioides (49% of samples; 9% overall). Storage fungi were more common in soybeans than the other commodities, indicating longer or adverse storage. Paddy rice contained high levels of a wide variety of field fungi, notably *Fusarium semitectum*, *Bipolaris oryzae*, and *Curvularia, Phoma* and *Colletotrichum* species. However, probably due to the heat generated by milling, milled rice contained very few fungi, which were mostly of storage origin. Only 3% of particles examined contained internal fungi. Infection in sorghum was typical of oilseeds, dominated by Aspergillus flavus, which was present in 86% of samples, with an overall infection rate of 12%. Beans other than soybeans were infected by a wide

Copyright by Mahidol University

range of field fungi, but at low levels, with less than half of seeds examined being infected internally. With the exception of sorghum, the levels of mycotoxigenic fungi encountered were much lower than observed previously in nuts and oilseeds.

In 2002, Burge (34) studied changes in climate were altering pollen distribution. Predictive modeling can be used to forecast long- and short-term changes in pollen concentrations. Increasing evidence confirms the presence of pollen allergens on small, respirable particles in the air, explaining the occurrence of pollen-season increases in asthma. Like pollens, above ground indoor fungal aerosols primarily reflect outdoor concentrations. Basement spore concentrations might be higher and reflective of local sources. Fungal presence in the indoor or outdoor air can be monitored on an area basis or with personal monitors. The samples can be analyzed by means of microscopy, culture, DNA probes, HPLC, or immunodetection. Total fungal biomass can be estimated on the basis of measurements of ergosterol or glucan in environmental samples. Unfortunately, there are no generally accepted standards for interpretation of fungal levels in indoor or outdoor air. At present, the best approach to indoor fungal control is moisture control in the indoor environment. This will essentially prevent fungal growth, except from extraordinary events.

In 2003, Manisha Rajib Desai et. al. (35) studied undertaken on environmental mycoflora of rice mills situated in Bawla town, Ahmedabad district. The airborne fungal communities were isolated and identified quantitatively by using Andersen-6-stage viable sampler, midget impingerand high volume samplers (Cone and Hexhlet for total and respirable dusts respectively). Of all the isolates, genus *Aspergillus* was predominant and among the *Aspergillus* species, *A. flavus* was the common isolate, irrespective of the method applied for sample collection. Number of isolates recovered from the working place was significantly greater ($p < 0.01$) compared to control. Total percentage of aflatoxin positive strains of *A. flavus* was 8%. These aflatoxin producing strains were identified on various media, such as Czapek agar (Cz) with 0.05% anisaldehyde, APA and CAM. Surface morphology of aflatoxin positive strains was studied by SEM. Highly significant total and respirable dust concentrations were found in the work place ($p < 0.01$) whereas in the store, only the total dust concentration was significantly higher ($p < 0.05$) than the control site. The study

Copyright by Mahidol University

indicates that the rice mill workers are occupationally exposed to airborne aflatoxin producing strains of *A. flavus*. Thus, they require protective mask for their safety.

In 2005, Je Won ParkT et.al. (36) were analyzed for fungal mycoflora and mycotoxins: fumonisins, ochratoxin A, trichothecenes, and zearalenone. The potential of the fungi to produce each mycotoxin was also examined, so that the fungal isolates associated with mycotoxins occurring in rice could be verified. *Penicillium citrinum* and *Aspergillus candidus* were the most prevalent species infecting the samples, while *Fusarium proliferatum* was found as the dominant Fusarium species. Ochratoxin A was the most commonly detected mycotoxin analyzed in the present study; moreover, its level in some samples was above the EU tolerable limit (3 ng/g). According to rice culture experiments, it was revealed that in Korea, fumonisins detected in rice were due to F. proliferatum infection, whereas the occurrence of ochratoxin A was caused by *Penicillium verrucosum*, though there were no symptoms of disease in rice found in any sample. Furthermore, there appears to be an uneven geographical distribution of P. verrucosum as well as ochratoxin A in that most of them are found in the rice samples produced in the northern region of Korea.

In 2001, Krysińska-Traczyk et.al. (37) were sampled of stored wheat grain and 10 samples of settled grain dust released during machine threshing of wheat grain were collected on 10 farms located in Lublin province (eastern Poland). The concentration of total Fusarium species in grain dust samples was significantly correlated with the concentration of nivalenol ($p<0.05$). In conclusion, the majority of samples of wheat grain and grain threshing dust collected on farms in eastern Poland contained notable quantities of fusaria and/or fusariotoxins. This fact poses a potential risk of mycotoxicoses to agricultural workers exposed to grain dust when handling wheat during threshing, unloading, shuffling, and other farm occupations.

In 2001, George (38) showed endotoxin is one of the principal components of grain dust that causes acute reversible airflow obstruction and airway inflammation. To determine whether endotoxin responsiveness influences the development of chronic grain dust-induced airway disease, physiological and airway inflammation remodeling parameters were evaluated after an 8-wk exposure to corn dust extract (CDE) and again after a 4-wk recovery period in a strain of mice sensitive to (C3H/HeBFeJ) and one resistant to (C3H/HeJ) endotoxin. After the CDE exposure,

Copyright by Mahidol University

both strains of mice had equal airway hyperreactivity to a methacholine challenge; however, airway hyperreactivity persisted only in the C3H/HeBFeJ mice after the recovery period. Only the C3H/HeBFeJ mice showed significant inflammation of the lower airway after the 8-wk exposure to CDE. After the recovery period, this inflammatory response completely resolved. Lung stereological measurements indicate that an 8-wk exposure to CDE resulted in persistent expansion of the airway submucosal cross-sectional area only in the C3H/HeBFeJ mice. Collagen type III and an influx of cells into the subepithelial area participated in the expansion of the submucosa. Our findings demonstrate that subchronic inhalation of grain dust extract results in the development of chronic airway disease only in mice sensitive to endotoxin but not in mice that are genetically hyporesponsive to endotoxin, suggesting that endotoxin is important in the development of chronic airway disease.

In 2003, Pahwa (39) Evaluated the relationship between the long term effects of grain dust and decline in lung function among grain elevator workers in Saskatchewan, studied over a 15-year period. Previous lung function, as one of the covariates in the transitional model, played an important role. Significant predictors of FEV1 were previous FEV1, base height, weight, years in the grain industry, current smoking status, cycle II, cycle III and cycle V. Significant predictors of FVC were previous FVC, base height, weight, years in the grain industry, cycle II, cycle III and cycle IV. The estimated annual decline in FEV1 and FVC increased according to length of time in the grain industry among nonsmoking, ex-smoking and smoking grain elevator workers. Lung function values improved after dust control, and yearly declines in FEV1 and FVC after dust control were smaller compared with yearly losses before dust control.

In 2000, Musa (40) studied a cross sectional was carried out to evaluate the effect of rice husk dust in rice millers in Malaysia. Altogether 69 workers participated in this study. They were interviewed using standardized questionnaires and lung function tests were performed. Chest tightness was among the common symptoms (34.9%) complained by workers. Age, duration of employment and smoking status were among the factors associated with respiratory symptoms ($p < 0.01$). Lung function tests revealed some degree of impairment compared to the healthy population.

Copyright by Mahidol University

In 1999, Christine G. Parks (41) Examined a possible risk factor with respect to several systemic autoimmune diseases, including scleroderma, rheumatoid arthritis, systemic lupus erythematosus, and some of the small vessel vasculitidies with renal involvement (e.g., Wegener granulomatosis). Crystalline silica, or quartz, is an abundant mineral found in sand, rock, and soil. High-level exposure to respirable silica dust can cause chronic inflammation and fibrosis in the lung and other organs. Studies of specific occupational groups with high-level silica exposure (e.g., miners) have shown increased rates of autoimmune diseases compared to the expected rates in the general population. However, some clinic- and population-based studies have not demonstrated an association between silica exposure and risk of autoimmune diseases. This lack of effect may be due to the limited statistical power of these studies to examine this association or because the lower- or moderate-level exposures that may be more common in the general population were not considered. Experimental studies demonstrate that silica can act as an adjuvant to nonspecifically enhance the immune response. This is one mechanism by which silica might be involved in the development of autoimmune diseases. Given that several different autoimmune diseases may be associated with silica dust exposure, silica dust may act to promote or accelerate disease development, requiring some other factor to break immune tolerance or initiate autoimmunity. The specific manifestation of this effect may depend on underlying differences in genetic susceptibility or other environmental exposures.

In 1999, Mark J Nieuwenhuijsen (42) Were randomly Ten farms selected in Yolo and Solano counties and workers wereinvited to wear personal sampling equipment to measure inhalable and respirable dust levels duringvarious operations. The measurements showed considerable difference in exposure levels between various operations in particular for the inhalable fraction of the dust and the endotoxin. Machine harvesting of tree crops (Geometric mean (GM) = 34 mg/m^2) and vegetables (GM = 6.8 mg/m^2) and cleaning of poultry houses (GM=5.6 mg/m^2) showed the highest inhalable dust levels. Cleaning of poultry houses also showed the highest inhalable endotoxin levels (GM = 1861 EU/m^2. Respirable dust levels were generally low except for machine harvesting of tree crops (GM = 2.8 mg/m^2 and vegetables (GM = 0.9 mg/m^2. Respirable endotoxin levels were also low. For the inhalable dust

Copyright by Mahidol University

fraction levels were reduced considerably when an enclosed cabin was present. The percentage of crystalline silica was overall higher in the respirable dust samples than the inhalable dust samples. Considerable differences exist in personal exposure levels to dust endotoxin and crystalline silica during various agricultural operations in California agriculture with some operations showing very high levels.

In 2000, Kline, J N (43) associated with the presence of airway inflammation in asthma and is seen in individuals occupationally exposed to grain dust. To better understand the relationship between BHR and pulmonary inflammation after grain dust exposure, we carried out an inhalation challenge to corn dust extract (CDE) on seven subjects with BHR [a 20% or greater decrease in forced expiratory volume in 1 s (FEV1) compared with diluent FEV1 with a cumulative dose of histamine </=47.3 breath units] and compared their physiological and inflammatory responses with those of seven matched control subjects. BHR subjects were exposed to nebulized CDE (target dose of 0.16 microg/kg endotoxin) as tolerated; matched controls received equal amounts of CDE. Subjects with BHR complained of chest tightness and dyspnea within the 2 hours after inhalation of CDE significantly more frequently than controls. Similarly, subjects with BHR developed significantly greater percent declines in FEV1 at time points up to 4 hours after exposure to CDE. Significant increases in total cells, neutrophils, tumor necrosis factor-alpha, interleukin-6, and interleukin-8 were detected in bronchoalveolar lavage fluid 4 hours after inhalation of CDE in all subjects, but no differences were detected between the control and BHR groups. These results suggest that, although subjects with BHR develop a more precipitous decline in FEV(1) after exposure to CDE, the inflammatory response to CDE is similar in subjects with and without BHR.

In 2003, Baur (44) Reviewed two case reports described in detail show that grain dust induces asthmatic reactions and ODTS which are obviously not of allergic origin. For diagnosis occupational-type exposure tests are decisive whereas allergological testing usually is not. Endotoxins which are present in the grain dust samples in high concentrations have to be regarded as the major causative components. To avoid irreversible lung function impairment a comprehensive early diagnosis is necessary. Generally, a remarkable reduction of exposure to dust with

Copyright by Mahidol University

high levels of airborne endotoxin in agriculture has to be achieved since in many workplaces corresponding exposures are still rather high.

In 1997, Ghosh (45) Studied airborne aflatoxin generated in rice and maize processing plants was assayed by an indirect competitive enzyme-linked immunosorbent assay. In the rice mill, levels of airborne aflatoxin were always higher in the respirable dust samples (< 7 microns) compared with the total dust samples (< 7 microns). The concentrations of total airborne aflatoxin in the respirable dusts were 26 picogram/m3 and 19 pg/m3, respectively, for the workplace and the storage area of the rice mill, while the concentrations of total dust were 12 pg/m3 for the workplace and 11 pg/m3 for the storage area. Airborne aflatoxin was not detected in control sites of either of the grain processing plants or from the total dust samples obtained from the maize plant. Three sites in the maize processing plant-the elevator (18 pg/m3), the loading/unloading area (800 pg/m3), and the oil mill (816 pg/m3)-showed the presence of airborne aflatoxin only in the respirable dust samples.

In 2002. Pusat Pengembangan (46) Tried to identify the relationships between respiratory, skin and eye impairments measured by radiologic chest examination, spirometric lung function test, blood eosinophyl count and personal dust sampling among rice mill workers. A sample of 688 questionnaires of subjective symptoms (respiratory, skin and eye), 688 results of spirometry, 159 blood eosinophyl counts, 191 result of chest X-ray and 181 personal dust samplers, had been recruited among rice mill workers from rice mill companies in five provinces in Indonesia. Data was collected by questionnaires, spirometric lung function test, chest X-ray, blood eosinophyl count and personal dust sampler. Statistical analysis were bivariate, multivariate analysis logistic regression and test of association. Mean and standard deviation of Age are : 35,54 and 11,64 years ; Length of work : mean 6,14 and SD 5,13 years. The range of Dust concentration : 0,0003 - 5,0850 mg/m3 with mean 1.167, SD 1.118 and 3.3 % above TLV. Chest X-ray impairments 11.5 %, consist of Bronchitis, Bronchiectasis, TBC and heart enlargement. Blood eosinophyl count over 5 cells 14.5 %. Spirometric lung function test impairments 18.5 % consist of Restriction, Obstruction and combination of Restriction and Obstruction. Respiratory symptoms 72.1 %. Skin symptoms 28.6 % and Eye symptoms 13.7 %. There were significant relationships to these risk factors, which all described their cumulative dust

Copyright by Mahidol University

exposure, i.e. : length of work over 5 years to chest X-ray (p=0,0194); age over 30 years to chest X-ray (p=0,00002); dust concentration over 4 mg/m3 to chest X-ray (p=0,0232); length of work over 5 years to spirometry (p=0.0000) and dust concentration over 4 mg/m3 to spirometry (p=0,0291)

In 1998, Yu (47) Conducted a cross-sectional study of 474 rice-granary workers and 235 non-granary worker controls in a rural area near Shanghai, the People's Republic of China. Responses to a respiratory-symptom questionnaire and pre- and post-shift spirometry were obtained for all subjects. Area sampling was performed for total and vertically elutriated (</= 15 micrometer) dust levels. Total dust levels were high, ranging from 6.6 mg/m(3) to 59.8 mg/m(3), with vertical elutriated dust concentrations ranging from 2.0 to 10. 4 mg/m(3). The granary workers reported significantly more respiratory symptoms, including chronic cough, sputum production, chronic bronchitis, grain fever (ODTS), and nasal and skin irritation. Grain dust and tobacco smoking were more than additive for the prevalence of chronic cough and chronic bronchitis. After adjusting for confounders, the granary workers had lower mean FEV&inf1;/FVC values both pre- and post-shift, indicating an association between chronic grain-dust exposure and chronic airway obstruction. The results suggest that exposure to rice dust can induce pulmonary responses similar to those observed with exposures to other types of grains.

In 2001, Laraqui et. al. (48) have carried out a retrospective survey which concerned exposed workers and control in twenty small handicraft workshops in joiners' souk of Marrakesh, it evaluated the prevalence of the clinical symptoms and disorders of respiratory function in 242 exposed subjects to wood dust and 121 controls. The resultant from questionnaire, clinical examination and spirometry discovered rhinitis, asthma, chronic bronchitis and dermatitis were significantly in exposed workers than non-exposed. Smoking exhibited a potential effect on airborne contaminants because among exposed workers disorder were 1.8 times more more frequent in smokers than non-smokers.

In 2002, Ananthaphol, L., (49) studied the factors related to respiratory impairment among workers in Sulfuric acid plant, He found that, the concentration of sulfuric acid and sulfur dioxide were statistically significantly different between the high and low exposed groups, the duration of employment was statistically

Copyright by Mahidol University

significantly different between normal and abnormal lung function (p-value<0.05) and also he found that, lung function value of people in low exposure group were higher than people in high expose group, but there were not statistically significantly different (p-value>0.05)

In 1999, Pornpan Watcharavitoon, (50) studied the factors to abnormal lung function of animal-feed workers. The results showed that, factors associated with reduced lung function were accumulated respirable dust, total dust concentration, exercise and past history of respiratory illness (p-value<0.05) and she found that, age, PPE usage and cigarette smoking among normal and abnormal pulmonary function group were not statistically significantly different (p-value>0.05)

In 1975, Bosse' and et al: (64) had studied combine effect between age and smoking behavior which affect to lung function. The sample sizes were 1,516 persons: age could to devided 3 groups that were less than 44 years, 45- 54 years and more than 55 years, smoking behavior could divided also 3 groups which were never smoked, mild smoked and severe smoked. When them did lung function test especially VC and FEV_1 found group 45- 54 years and more than 55 years which severe smoked, VC and FEV_1 has been difference from never and mild smoked groups. In smoked group the result of smoked that had effect to FEV_1 more than VC.

In 1985, Yach D. et al., (65) studied prevalence of respiratory symptoms, a topic status and lung function changes, as a measure by pulmonary function test in 582 grain mill workers and 152 control not exposed to grain dust were studied in Cape town. There were no significant differences in age, height, weight, year of exposure, or smoking habit between grain workers and control subjects. Grain workers had significantly higher prevalence than did control subject of regular cough. These symptoms were not related to the duration of employment.

Copyright by Mahidol University

CHAPTER III
MATERIAL AND METHODS

3.1 Study design

This study was a cross sectional study. The factors associated with abnormal pulmonary function test among rice mill workers were obtained from study.

3.2 sample size and groups

Population was workers in rice mill factory who worked in production line and in office. Worker size was calculated by the following.

3.2.1 Sample size

The number of workers in rice mill factory will be calculated from formula :

$$n_0 = \frac{Z^2_{\alpha/2}\, pq}{d^2}$$

Where n_0 = the desired worker size

$Z^2_{\alpha/2}$ = the standard normal deviate, set at 1.96 with 95% confindence level

p = the proportion of work related symptoms as 0.79

q = $1.0 - p$

d^2 = degree of accuracy desired, set at 0.05

$n_0 = (1.96^2)(0.79)(0.21)/(0.05^2)$

$= 254.98 \approx 255$

Copyright by Mahidol University

Due to the value of n_0 more than the number of workers in rice mill factory. Thus, value of n_0 must be calculated for adjust the number of sample size when known the number of population from formula :

$$n = \frac{n_o}{1+ n_o/N}$$

Where n = the number of workers after adjusted

N = the number of population in rice mill factory as 100

n = 255/(1+(255/100))

= 71.83 $_y$ 72

In rice mill factory 72 workers were needed. Workers size in each section were calculated and random sampling was used for collection of the data.

3.2.2 Characteristics of rice mill factory

The rice mill factory buildings are located in Khonkaen province as :

- Dryer grain building
- Rice Mill Building
- Optimum Treatment Rice Buildings
- Packing building
- Warehouse Building

The plant will operate continuously 24 hours per day (eight-hour-shift per day). Output capacity of the plant will be 400 metric ton per day .

3.3 Instruments

The following instruments were used :

3.3.1 Questionnaire : these questionnaire should be applied from British Medical Research council(51), divided into 4 parts i.e.

Part I General informations

Part II Work history

Part III Health behavior included smoking exercise and wearing PPE

Part IV Past illness history

Copyright by Mahidol University

3.3.2 Pulmonary Function Test : Minato spirometer model PAL will be used for standardized tests of FVC, FEV_1, FEV_1/FVC% and $FEF_{25-75\ \%}$

3.3.3 Dust sampler : Inhalation dust, respirable dust and silica will be collected by personal pumps and analyzed following NIOSH Method 0500, 0600, and 7500, respectively.

3.3.4 Bioaerosal sampler : Fungi and bacteria will be collected by Anderson 1-state impactor pumps and analyzed following NIOSH Method 0800.

3.4 Study and sampling method

3.4.1 Collected data by questionnaire : The rice mill workers (78 workers) were random sampling and interviewed.

3.4.2 Pulmonary Function Test : PFT was tested after the workers worked at least 2 hours. The workers should refrain from eating a heavy meal and should not smoke. Wearing loose fitting clothes to the test is a good idea, as it allows the workers to breathe without restriction. Worker who wear dentures should keep them in for the test, as the dentures will make it easier for themto create a tight seal on the mouthpiece of the spirometer. The parameters collected are FVC, FEV_1, FEV_1/FVC% and $FEF_{25-75\ \%}$. The results will be interpreted the predicted normal values from the reference spirometric values for healthy lifetime nonsmorkers in Thailand from Siriraj Hospital. The test procedure is as follows:

1. Workers place the mouthpiece of the spirometer in their mouth. If they are unable to create a tight seal around the mouthpiece, Workers should notify the person conducting the test of the problem.
2. Nose clips are applied to the worker, preventing them from breathing through their nose.
3. The physician or technician may have workers go through several breathing exercises or tests, which will be explained to patients during the procedure.
4. Workers are instructed to inhale as much air into the lungs as possible, then fast exhalation and for as long as possible.
5. Workers remove the mouthpiece and breathe normally.

Copyright by Mahidol University

3.4.3 Dust sampler : In this study, inhalable dusts respirable dusts and silica used consecutive sample for full period measurement method. Inhalable dust will be collected by filter holder attach with worker (personal sampling method). Respirable dust will be collected by aluminum cyclone attach with worker. Silica dust will be collected by aluminum cyclone in workplace or area sampling.

1. Inhalable dust would be collected by filter holder attach with worker. Equipments and methods (52) in dust collected are the following.

- Equilibrate 37-mm PVC, 5-µm pore size membrane the filters in an environmentally controlled weighing area or chamber for at least 24 hours.
- Number the backup pads with a ballpoint pen and place them, numbered side down, in filter.
- Weigh the filters in an environmentally controlled area or chamber. Record the filter tare weight, W1 (mg).
- Assemble the filter in the filter cassettes and close firmly so that leakage around the filter will not occur. Place a plug in each opening of the filter cassette. Place a cellulose shrink band around the filter cassette, allow to dry and mark with the same number as the backup pad.
- Calibrate each personal sampling pump at 1.5 L/min with a representative sampler in line.
- Bring the series attach with workers who had more risks exposed to inhalable dust throught type of work . Set up the series in breathing zone of worker. Turn on the personal sampling pump and record time to start.
- After collected dust finish, wipe dust from the external surface of the filter cassette. Remove the top and bottom plugs from the filter cassette. Equilibrate for at least 24 hours in the chamber.
- Remove the cassette band, try open the cassette, and remove the filter gently to avoid loss of dust.

Copyright by Mahidol University

- Weigh each filter, including field blanks. Record the post-sampling weight, W 2 (mg).
- Calculate the concentration of total particulate.

$$C = \frac{(W_2 - W_1) - (B_2 - B_1) \times 10^3}{V}, \text{ mg/m}^3$$

where: C = concentration of total particulate (mg/m 3)
W_1 = tare weight of filter before sampling (mg)
W_2 = post-sampling weight of sample-containing filter (mg)
B_1 = mean tare weight of blank filters (mg)
B_2 = mean post-sampling weight of blank filters (mg)
V = air volume sampled (L)

2. Respirable dust used the same equipments as inhalable dust collected but add aluminum cyclone attach with cassette for collected size lass than 10 micron. Method to collected respirable dust (54) were the following.

- Equilibrate 37-mm PVC, 5-µm pore size membrane filters in an environmentally controlled weighing area or chamber for at least 24 hours.
- Number the backup pads with a ballpoint pen and place them, numbered side down, in filter.
- Weigh the filters in an environmentally controlled area or chamber. Record the filter tare weight, W 1 (mg).
- Assemble the filter in the filter cassettes and close firmly so that leakage around the filter will not occur. Place a plug in each opening of the filter cassette. Place a cellulose shrink band around the filter cassette, allow to dry and mark with the same number as the backup pad.
- Connected aluminum cyclone with personal sampling pump that part to calibrated at 1.9 L/min(56)

Copyright by Mahidol University

- Bring the series attach with workers who had more risks exposed to inhalable dust throught type of work . Set up the series in breathing zone of worker. Turn on the personal sampling pump and record time to start.
- After collected dust finish, wipe dust from the external surface of the filter cassette. Remove the top and bottom plugs from the filter cassette. Equilibrate for at least 24 hours in the chamber.
- Remove the cassette band, pry open the cassette, and remove the filter gently to avoid loss of dust.
- Weigh each filter, including field blanks. Record the post-sampling weight, W 2 (mg).
- Calculate the concentration of respirable particulate.

$$C = \frac{(W_2 - W_1) - (B_2 - B_1) \times 10^3}{V} \text{ , mg/m}^3$$

where:
C = concentration of total particulate (mg/m 3)
W_1 = tare weight of filter before sampling (mg)
W_2 = post-sampling weight of sample-containing filter (mg)
B_1 = mean tare weight of blank filters (mg)
B_2 = mean post-sampling weight of blank filters (mg)
V = air volume sampled (L)

3. Silica dust used the same equipments as respirable dust collected. Method to collected silica dust(55) were the following.

- Equilibrate 37-mm PVC, 5-µm pore size membrane filters in an environmentally controlled weighing area or chamber for at least 24 hours.
- Number the backup pads with a ballpoint pen and place them, numbered side down, in filter.
- Weigh the filters in an environmentally controlled area or chamber. Record the filter tare weight, W 1 (mg).

Copyright by Mahidol University

- Assemble the filter in the filter cassettes and close firmly so that leakage around the filter will not occur. Place a plug in each opening of the filter cassette. Place a cellulose shrink band around the filter cassette, allow to dry and mark with the same number as the backup pad.
- Connected aluminum cyclone with personal sampling pump that part to calibrated at 1.9 L/min
- Bring the series attach with workers who had more risks exposed to inhalable dust throught type of work . Set up the series in breathing zone of worker. Turn on the personal sampling pump and record time to start.
- After collected dust finish, wipe dust from the external surface of the filter cassette. Remove the top and bottom plugs from the filter cassette. Equilibrate for at least 24 hours in the chamber.
- Remove the cassette band, pry open the cassette, and remove the filter gently to avoid loss of dust.
- Weigh each filter, including field blanks. Record the post-sampling weight, W 2 (mg).
- Bring to the laboratory to analyze silica volume in the filter paper with UV-VIS Recordind Spectrophotometer
- Calculated tofind the silica quantiy by using below equation.

Si with molecule mass is equal to 28.1compared to SiO_2 with molecule mass is equal to 60.1

Si with analysis A mg/l compared to SiO_2 equal to $\frac{60.1xA}{28.1}$ mg/L

= D mg/L

When adjust the volume in the final process equal to 100 ml.

SiO_2 1000 milliliter equal to D milligram

SiO_2 100 milliliter equal to $\frac{D \times 100}{1000}$

= E milligram / 100 milliliter

Copyright by Mahidol University

The weight of dust is equal to $W_1 - W_2$ miligram with SiO_2 E/1000 miligram. If the weight of dust 100 milligram with SiO_2 $= \frac{(E/1000) \times 100}{W_2 - W_1}$

$=$ F milligram

Thus. % SiO_2 is equal to F milligram

Take the value % SiO_2 to calculate PEL (Permissible Exposure Limit) of OSHA by using the following equation.

PEL for Respirable crystalline silica (quartz) $= \frac{10\ mg/m^3}{\%Sio_2 + 2}$

3.4.4 Bioaerosal sampler (57) Malt extract agar (MEA) have been recommened as broad spectrum media for the collection and enumeration of fungi. Blood agar have been recommened as broad spectrum media for the collection and enumeration of bacteria. Sampling time depended on concentration contaminated areas, such that 30 – 100 colonies (up to 300 in some situations) develop per plate. Method to collected bioaerosalare the following.

- Calibrated each sampling pump and Anderson 1-stage by the dry gas meter at a flow rate of 28.3 liter per minute with a representative sampler in line.
- Before each run, carefully and thoroughly wipe each sampler stage with 70% isoopanol alcohol. Allow to dry. Make sure air passages are not blocked.
- Load sampling media into sampler, remove covers from media, and attach sampler to pump with flexible tubing.Take special care to prevent contamination of media during loading and unloading. Do not touch agar surface.
- Sample at known preset flow for an accurately known time
- Replaced covers on sampling media, unload, and pack securely for shipment (plates should be media side up).
- Incubated at 37 ^{0}C for 24 to 48 hours. Afterward the total concentration of bacteria and fungi were counted and calculated.

Copyright by Mahidol University

3.5 Data analysis (58,59,60)

3.5.1 Descriptive analysis

Prevalance rate of symptoms and abnormal pulmonary function test, demographic and other characteristics of study subject, particulate matter size distribution and concentration of dust were showed by percentage, mean and standard deviation.

3.5.2 Analytical analysis

1. t-test used to test the comparison of means dust exposure among normal pulmonary function group and abnormal pulmonary function group.
2. Chi-square used to test association between qualitative variables and abnormal pulmonary function test.
3. Simple linear regression used to test association between dependent variables and independent variable. This method used to study association of quantitative variables such as concentration of dust, concentration of bioaerosal, age, and duration of work.
4. Program for analyze was SPSS for Window Version 12.0

Copyright by Mahidol University

CHAPTER IV
RESULTS

The collected data, from 78 rice mill workers, summarized into 3 parts as the following :

1. General characteristics
2. The results of rice mill dust and bioaerosal concentration
3. Relation between studied factors with abnormal pulmonary function test

4.1 General characteristics

The general characteristics of workers were collected among 78 workers show in Table 4 - 8

Table 4 Number and percentage of the general characteristic of rice mill workers.

Variables	Number (n=78)	Percentage
Gender		
Male	40	51.3
Female	38	48.7
Marietal status		
Single	20	25.6
Married	56	71.8
Divorce/Widow	2	2.6

Copyright by Mahidol University

Table 4 Number and percentage of the general characteristic of rice mill workers. (Cont.)

Variables	Number (n=78)	Percentage
Age (years)		
Less than 20	3	3.8
20 – 29	28	35.9
30 – 39	34	43.6
40 – 49	6	7.7
More than 50	7	9.0
($\overline{X}$ = 33.3, S.D. = 9.4, Min-Max = 18-56)		
Education level		
Primary school	25	32.1
Grade 9	15	19.2
Grade 12	18	23.1
Diploma	5	6.4
Bachelor degree	15	19.2
Residence house		
Private	77	98.7
Rented	1	1.3
Residence location		
City	10	12.8
Outskirts	65	83.4
Rural area	3	3.8
Number in family (person)		
1-3	29	37.2
4-5	38	48.7
6-8	11	14.1

Copyright by Mahidol University

Table 4 Number and percentage of the general characteristic of rice mill workers. (Cont.)

Variables	Number (n=78)	Percentage
Salary (Bath)		
Less than 5000	46	59.0
5001 - 7500	23	29.5
More than 7501	9	11.5
($\overline{X}$ = 5,541, S.D. = 1,713.3, Min-Max = 4,000-11,000)		
Exercise habit		
Exercise	47	60.3
Not exercise	31	39.7

Sex

The majority of the workers were males (51.3%) while the females consisted of 48.7%.

Status

The status of workers were classified into 3 groups such as single, married and divorce or widow. The majority of the workers were married (71.8%), minority were single (25.6%). The least number of workers were divorce or widow (2.6%).

Age

The majority of the workers were in the age group of 30-39 years (43.6%). Minority of the workers were in the age group of 20 – 29 years (35.9%), more than 50 years (9.0%) and 40-49 years (7.7%). The least number (3.8%) were less than 20 years old. The average ages of the workers were 33.3 years old (33.3 ± 9.4), the minimum of age were 18 years old and the maximum were 56 years old.

Education level

The majority of the workers were primary school (32.1%). Minority of the workers were grade 12 (23.1%), and grade 9 and Bachelor degree (19.2%). The least number of workers were Diploma (6.4%).

Copyright by Mahidol University

Residence house

The Residence house of the workers were private (98.7%) while the rented consisted of 1.3%.

Residence location

The Residence location of workers were classified into 3 groups such as city, outskirts and rural area. The majority of the workers were outskirts (83.3%), minority were city (13.8%). The least number of workers were rural area (3.8%).

Number in family

The majority of the workers were 4-5 persons in the family (48.7%). Minority of the workers were 1-3 persons (37.2%). The least number (14.1%) were more than 6 persons.

Salary

The salary of the workers were less than 5,000 Bath (59.0%), 5,000-7500 bath (29.5%) while more than 7,500 Bath consisted of 11.5%. The average salary of the workers was 5,541 Bath (5,541 ± 1,713.3), the minimum of salary was 4,000 Bath and the maximum was 11,000 Bath.

Exercise habit

60.3% of the workers exercise while only 39.7% did not exercise.

Table 5 Number and percentage of the working characteristics of rice mill workers

Variables	Number (n=78)	Percentage
Type of work		
Machinist	9	11.5
Storekeeper	13	16.7
Diver	5	6.4
Cleaner	4	5.1
Packer	28	35.9
Office	15	19.2
Quality control	4	5.1

Copyright by Mahidol University

Table 5 Number and percentage of the working characteristics of rice mill workers (Cont.)

Variables	Number (n=78)	Percentage
Duration of work (years)		
≤ 1	42	53.8
2	12	15.4
3	11	14.1
≥4	13	16.7
($\overline{X}$ = 1.9, S.D. = 1.3, Min-Max = 1-6)		
Working duration (hour/week)		
Less than 48	28	35.9
More than 49	50	64.1
($\overline{X}$ = 56.4, S.D. = 7.6, Min-Max = 42-72)		
PPE usage		
Usage	59	75.6
Never	19	24.4

For the working characteristics of worker would be concluded as the following ;

Type of work

Type of work was divided into 7 group as the following : packer (35.9%), office (19.2%), storekeeper (16.7%), machinist (11.5%), diver (6.4%), cleaner (5.1%) and quality control (5.1%)

Duration of work

The majority of the workers were ≤ 1 years (53.8%), more than 4 years (16.7%), 2 years (15.4%) and 3 years (14.1%). The average duration of work was 1.9 years (1.9 ± 1.3), the minimum of duration of work was 1 year and the maximum was 6 years.

Copyright by Mahidol University

Working duration

The majority of the workers were more than 49 hour/week (64.1%) while the working duration less than 48 hour/week were 35.9%. The average working duration was 56.4 hour/week (56.4 ± 7.6), the minimum of duration of work was 42 hour/week and the maximum was 72 hour/week.

PPE usage

The majority of the workers used PPE (75.6%) while the workers did not used PPE consisted of 24.4%.

Table 6 Number and percentage of the samples classified by previous occupation before working at this factory

Previous occupational	Number	Percentage
Type of previous occupation (n=78)		
Never	9	11.5
Used to work	69	88.5
Concentration of dust around working area (n=69)		
Little	57	82.6
High	12	17.4

The percentage of the samples who used to work before work in rice mill factory were 88.5% and never work were 11.5%. The percentage of previous working area that contains few dust was 82.6% and a lot of dust was 17.4%.

Copyright by Mahidol University

Table 7 Number and percentage of the samples classified by smoking behaviors

Smoking behaviors	Number (n=78)	Percentage
Non-smoke	53	68.0
Currently still smoke	22	28.2
Smoking (has been smoke)		
Duration of smoking (years)		
≤ 5	1	4.5
6-10	11	50.0
11-15	7	31.8
> 15	3	13.7
($\overline{X}$ = 12.4, S.D. = 6.7, Min-Max = 5-30)		
Type of cigarette		
Filter cigarette	18	81.8
Non filter cigarette	4	28.2
Smoking characteristic		
To emit smoke in the nose and mouth but no lungs inhalation	19	86.4
To emit smoke in the nose and mouth and inhalation in the lungs	3	13.6
Used to smoke but currently quit	3	3.8
Duration of smoking (years)		
≤ 5	1	33.3
6-10	2	66.7
($\overline{X}$ = 7.3, S.D. = 4.6, Min-Max = 2-10)		
Duration of stopped smoking (years)		
≤ 5	1	33.3
6-10	2	66.7
($\overline{X}$ = 7.7, S.D. = 4.0, Min-Max = 3-10)		

Copyright by Mahidol University

Smoking habit

68.0% of the workers were non-smoking, 28.2% smoking while only 3.8% used to smoke but currently quite.

The most of the samples were the workers who still currently smoke for 6-10 years (50%), 11-15 years (31.8%), more than 15 years (13.7%) and ≤ 5 years(4.5%). Mostly, the percentage of the samples who smoked filter cigarette were 81.8% and emit smoke in the nose and mount but no lungs inhalation (86.4%)

The percentage of the samples who used to smoke but currently quit with the 6-10 years duration for smoking was 66.7% and ≤ 5 years (33.3%). There were 66.7% of the samples who quit smoking for 6-10 years.

Table 8 Number and percentage of the samples classified by illness histories

Illness histories	Number (n=78)	Percentage
Health status		
Healthy	67	85.9
Underlying disease	11	14.1
Peptic ulcer	3	27.2
Goiter	1	9.1
Sinusitis	1	9.1
Asthma	2	18.2
Heart disease	2	18.2
other	2	18.2

Copyright by Mahidol University

Table 8 Number and percentage of the samples classified by illness histories (Cont.)

Illness histories	Number (n=78)	Percentage
Respiratory symptom		
No symptoms	16	20.5
Had symptoms	62	79.5
Allergic	9	11.5
Chronic Cough	12	15.4
Chest tightness	18	23.1
Dyspnea (walking)	4	5.1
Dyspnea (steping)	8	10.3
Wheeze	5	6.4
Skin Irritation	47	60.3
Past respiratory illness		
Obstructive respiratory symptom		
No symptom	65	83.3
Had symptom	13	16.7
Restrictive respiratory symptom		
No symptom	69	88.5
Had symptom	9	11.5
Combine respiratory symptom		
No symptom	52	66.7
Had symptom	26	33.3

The samples had personal illness (14.1%). The sample had respiratory symptom in which skin irritation were the most case (60.3%), chest tightness (23.1 %), chronic cough (15.4 %), allergic (11.5%), dyspnea (steping) (10.3%), wheeze (6.4%) and dyspnea (walking) (5.1%). Workers had past respiratory illness in which combine respiratory symptom (33.3%), obstructive respiratory symptom (16.7%) and restrictive respiratory symptom (11.5%).

Copyright by Mahidol University

4.2 The results of rice mill dust and bioaerosal concentration

The sampling of rice mill dust and bioaerosal were done both of personal sampling and area sampling. The total of inhalable dust sampling were 23 samples, respirable dust sampling were 59 samples and bioaerosal sampling were 36 samples. The results showed in Table 9-10.

Table 9 Number and percentage of the samples classified by Inhalable dust, Respirable dust and silica dust concentration (mg/m^3)

Zone	n	Mean	S.D.	Min	Max
Inhalable dust	23	7.11	4.83	0.15	13.56
Milling area	9	11.98	1.02	10.45	13.56
Packaging area	8	6.57	2.01	3.18	9.29
Office area	6	0.52	0.26	0.15	1.09
Respirable dust	59	2.43	2.14	0.02	7.37
Milling area	19	5.21	0.83	3.73	7.37
Packaging area	23	1.75	0.76	0.55	3.54
Office area	17	0.23	0.15	0.01	0.53
Silica dust	15	14.60×10^{-3}	10.68	4.34	55.45
Milling area	9	26.10×10^{-3}	14.25	14.83	55.45
Packaging area	3	11.66×10^{-3}	3.74	7.38	14.34
Office area	3	6.16×10^{-3}	1.58	4.34	7.21

Inhalable dust : workers who work in milling area (Machinist, storekeeper, driver) have a lot of rice mill dust spread over working area and more than the other processes. The average concentration of inhalable dust in milling area were 11.98 mg/m^3 (11.98±1.02). The least concentration of rice mill dust in working area were office area that had only 0.52 mg/m^3 (0.52±0.26).

Copyright by Mahidol University

Respirable dust : workers who work in milling area (Machinist, storekeeper, driver) have a lot of rice mill dust spread over working area and more than the other processes. The average concentration of respirable dust in milling area were 5.21 mg/m^3 (5.21±0.83). The least concentration of rice mill dust in working area were office area that had only 0.23 mg/m^3 (0.23±0.15).

Silica dust : workers who work in milling area (Machinist, storekeeper, driver) have a lot of rice mill dust spread over working area and more than the other processes. The average concentration of silica dust in mechanist area were 43.25 μg/m^3 (43.25±10.65). The least concentration of rice mill dust in working area were office area that had only 6.16 μg/m^3 (6.16±1.58).

Table 10 Number and percentage of the samples classified bioaerosal concentration (CFU/m^3)

Zone	n	Mean	S.D.	Min	Max
Fungi	18	682.00	615.00	11	1837
Milling area	9	1437.65	400.21	636	1837
Packaging area	6	251.35	321.97	46	848
Office area	3	42.40	40.75	11	88
Bacteria	18	4237.00	3087.00	452	9611
Milling area	9	7601.00	1023.60	6219	9611
Packaging area	6	640.75	158.57	452	641
Office area	3	1338.04	311.38	1131	1696

Fungi : workers who work in milling area (Machinist, storekeeper, driver) have a lot of fungi spread working area and in more than other processes. The average concentration of fungi in milling area were 1437.65 CFU/m^3 (1437.65±400.21). The least concentration of fungi in working area were office area that have only 42.40 CFU/m^3 (42.40±40.75). Aspergillus spp. and Penicillium spp. were the most organism found in sample**s.**

Copyright by Mahidol University

Bacteria : workers who work in milling area (Machinist, storekeeper, driver) have a lot of bacteria spread working area and in more than other processes. The average concentration of bacteria in mechanist area were 8669.02 CFU/m^3 (8669.02±863.62). The least concentration of bacteria in working area were Packaging area that have only 640.75 CFU/m^3 (640.75±158.57). Cocci spp. (gram +) and Bacilli spp. (gram -) were the most organism found in samples.

4.3 Relation between studied factors with abnormal pulmonary function test

Relation between studied factors with abnormal pulmonary function test shown in Table 11-14

Table 11 Number of pulmonary function impairment of the samples classified by section of rice mill places

Characteristics of abnormal pulmonary function	Zone						
	Milling area				Packaging area	Office area	
	Machinist (9)	Storekeeper (13)	Driver (5)	Cleaner (4)	Packer (28)	Quality control (4)	Office (15)
Normal	4	7	2	1	10	1	1
Obstructive	2	1	1	1	2	-	-
Restrictive	2	4	-	2	13	3	13
Combine	1	1	2	-	3	-	1
Total	9	13	5	4	28	4	15

There were abnormal pulmonary function test of the samples in milling area (17 persons), packaging area (18 persons) and office area (17 persons). The total numbers of abnormal pulmonary function were 52 persons (66.67 % of the samples).

Copyright by Mahidol University

Table 12 Comparison of means dust exposure among normal pulmonary function group and abnormal pulmonary function group

Dust exposure / Pulmonary Function test	Mean (mg/m^3)	S.D.	t-value	d.f.	p-value
Inhalable dust					
- normal	9.93	3.92	2.284	39.294	0.028*
- abnormal	7.09	5.21			
Respirable dust					
- normal	1.96	2.27	-1.087	57	0.282
- abnormal	2.62	2.08			
Silica dust					
- normal	$24.15x10^{-3}$	18.29	1.431	57	0.158
- abnormal	$17.60x10^{-3}$	14.92			

Tested and compared the difference means of dust exposure (inhalable dust, respirable dust and silica dust) among normal pulmonary function groups and abnormal pulmonary function group, the result showed that, respirable dust and silica dust were not statistically significant difference (p-value>0.05). Inhalable dust was statistically significantly with at p-value < 0.05

Copyright by Mahidol University

Table 13 Comparison of means bioaerosal exposure among normal pulmonary function group and abnormal pulmonary function group

Dust exposure / Pulmonary Function test	Mean (CFU/m^3)	S.D.	t-value	d.f.	p-value
Fungi					
- normal	994.41	587.48	1.670	57	0.100
- abnormal	714.10	582.73			
Bacteria					
- normal	3833.47	3608.64	1.077	25.196	0.292
- abnormal	2770.36	2963.69			

Tested and compared the difference means of bioaerosal exposure (fungi and bacteria) among normal pulmonary function groups and abnormal pulmonary function groups, the result showed that all types of bioaerosal exposure were not statistically significant difference (p-value>0.05)

Copyright by Mahidol University

Table 14 Association between variables and pulmonary function impairment.

Variables	Number of workers (%)	Pulmonary function test		χ^2	d.f.	r (r^2)	p-value
		Normal (%)	Abnormal (%)				
Zone							
Milling area							
Machinist	9 (11.5)	4 (44.4)	5 (55.6)				
Storekeeper	13 (16.7)	7 (53.8)	6 (46.2)				
Driver	5 (6.4)	2 (40.0)	3 (60.0)				
Cleaner	4 (5.1)	1 (25.0)	3 (75.0)	4.075	2	-	0.130
Packaging area							
Packer	28 (35.9)	10 (35.7)	18 (64.3)				
Office area							
Quality control	4 (5.1)	1 (25.0)	3 (75.0)				
Office	15 (19.2)	1 (6.7)	14 (93.9)				
Sex							
Male	40 (51.3)	18 (45.0)	22 (55.0)	5.029	1	-	0.032*
Female	38 (48.7)	8 (21.1)	30 (78.9)				

Copyright by Mahidol University

Table 14 Association between variables and pulmonary function impairment. (cont.)

Variables	Number of workers (%)	Pulmonary function test		χ^2	d.f.	r (r^2)	p-value
		Normal (%)	Abnormal (%)				
Age							
Less than 20	3 (3.8)	0 (0)	3 (100)	-	-	0.104 (0.011)	0.365
20 – 29	28 (35.9)	8 (28.6)	20 (71.4)				
30 – 39	34 (43.6)	12 (35.3)	22 (64.7)				
40 – 49	6 (7.7)	4 (66.7)	2 (33.3)				
More than 50	7 (9.0)	2 (28.6)	5 (71.4)				
Duration of work							
≤ 2 years	54 (69.2)	16 (29.6)	38 (70.4)	-	-	0.083 (0.007)	0.473
> 2 years	24 (30.8)	10 (41.7)	14 (58.3)				
Exercise habit							
Exercise	31 (39.7)	8 (25.8)	23 (74.2)	1.312	1	-	0.328
Not exercise	47 (60.3)	18 (38.3)	29 (61.7)				

Copyright by Mahidol University

Table 14 Association between variables and pulmonary function impairment. (cont.)

Variables	Number of workers (%)	Pulmonary function test		χ^2	d.f.	r (r^2)	p-value
		Normal (%)	Abnormal (%)				
Smoking habit							
Smoking	25 (32.1)	16 (64.0)	10 (36.0)	15.571	1	-	<0.001*
No smoking	53 (67.9)	10 (18.9)	42 (81.1)				
PPE Usage							
Usage	59 (75.6)	22 (37.3)	37 (62.7)	1.705	1	-	0.266
Never	19 (24.2)	4 (21.1)	15 (78.9)				
Respiratory symptom							
Had symptoms	62 (79.5)	17 (27.4)	45 (72.6)	4.757	1	-	0.039*
No symptoms	16 (20.5)	9 (56.3)	7 (43.8)				

Copyright by Mahidol University

Table 14 Association between variables and pulmonary function impairment. (cont.)

Variables	Number of workers	Pulmonary function test		χ^2	d.f.	r (r^2)	p-value
		Normal	Abnormal				
Past respiratory illness							
- Obstructive respiratory symptom		2 (15.4)	11 (84.6)	4.171	1	-	0.244
- Restrictive respiratory symptom		2 (22.7)	7 (77.3)	1.868	1	-	0.321
- Combine respiratory symptom		10 (38.5)	16 (61.5)	8.615	1	-	0.138
Dust concentration							
Inhalable dust	59 (100)	17 (28.8)	42 (71.2)	-	-	0.259 (0.067)	0.048*
Respirable dust	59 (100)	17 (28.8)	42 (71.2)			0.142 (0.020)	0.282
Silica dust	59 (100)	17 (28.8)	42 (71.2)			0.186 (0.035)	0.158
Bioaerosal concentration							
Fungi	59 (100)	17 (28.8)	42 (71.2)	-	-	0.216 (0.047)	0.100
Bacteria	59 (100)	17 (28.8)	42 (71.2)			0.153 (0.023)	0.246

Copyright by Mahidol University

To find association between factors and pulmonary function impairment. The results of association are the following :

Zone

The results showed association between zone of working area and pulmonary function impairment with χ^2 of 4.075 and p-value of 0.130. There were not associated significantly at p-value > 0.05

Sex

The results showed association between sex and pulmonary function impairment with χ^2 of 5.029 and p-value of 0.032. There were statistically significantly related at p-value < 0.05

Age

The results showed association between concentration of bacteria dust and pulmonary function impairment with r of 0.104, r^2 of 0.011 and p-value of 0.365. There were not associated significantly at p-value > 0.05.

Duration of work

The results showed association between concentration of bacteria dust and pulmonary function impairment with r of 0.083, r^2 of 0.007 and p-value of 0.473. There were not associated significantly at p-value > 0.05.

Exercise habit

The results showed association between age and pulmonary function impairment with χ^2 of 1.312 and p-value of 0.328. There were not associated significantly at p-value > 0.05

Smoking habit

The results showed association between smoking habit and pulmonary function impairment with χ^2 of 15.571 and p-value of <0.001. There were statistically significantly related at p-value < 0.001.

Copyright by Mahidol University

PPE Uasge

The results showed association between PPE usage and pulmonary function impairment with χ^2 of 1.705 and p-value of 0.266. There were not associated significantly at p-value > 0.05

Respiratory symptom

The results showed association between past respiratory illness and pulmonary function impairment with χ^2 of 4.757 and p-value of 0.039. There were statistically significantly related at p-value < 0.05

Past respiratory illness

The results showed association between obstructive respiratory symptom and pulmonary function impairment with χ^2 of 4.171 and p-value of 0.244, association between restrictive respiratory symptom and pulmonary function impairment with χ^2 of 1.868 and p-value of 0.321 and association between combine respiratory symptom and pulmonary function impairment with χ^2 of 8.615 and p-value of 0.138. There were not associated significantly at p-value > 0.05

Concentration of inhalable dust

The results showed association between concentration of inhalable dust and pulmonary function impairment with r of 0.259, r^2 of 0.067 and p-value = 0.048. There were associated significantly statistically at p-value = 0.048. ($p<0.05$)

Concentration of respirable dust

The results showed association between concentration of respirable dust and pulmonary function impairment with r of 0.142, r^2 of 0.020 and p-value of 0.282. There were not associated significantly at p-value > 0.05.

Concentration of silica dust

The results showed association between concentration of silica dust and pulmonary function impairment with r of 0.186, r^2 of 0.035 and p-value of 0.158. There were not associated significantly at p-value > 0.05.

Concentration of fungi

The results showed association between concentration of fungi dust and pulmonary function impairment with r of 0.216, r^2 of 0.047 and p-value of 0.100. There were not associated significantly at p-value > 0.05.

Copyright by Mahidol University

Concentration of bacteria

The results showed association between concentration of bacteria dust and pulmonary function impairment with r of 0.153, r^2 of 0.023 and p-value of 0.246. There were not associated significantly at p-value > 0.05.

Copyright by Mahidol University

CHAPTER V
DISCUSSION

5.1 Discussion of Methodology

This study was a cross sectional study in rice mill workers. The main objective was to study factors associated with work relating pulmonary function impairment. Sample were 78 workers in rice mill factory who worked in production line and office. Samples size were randomized assignment. The error of data collection and analyzing might be occurred due to random and systemic error.

5.1.1 Systemic errors

Personal error : There were many data collection procedures in this study, such as interview procedure, air sampling collection procedure and pulmonary function test. Many problems of data collection may be some errors from personal variations. The personal error was not only come from the researcher team but also from the sample of study. However, we could minimize the personal error if only one person performed the procedure.

Method error : The method error might happen at the method of air sampling, At the storage procedure, air sampling could not be analyzed immediately, after collected the cassette filters keep in dry and close the top and bottom of cassette with tightly plugs. About the analytical method, air samples will be open from the cassette and filter is removed gently to avoid losing of dust, then clean forcept and used it to handle filter for weighting.

Copyright by Mahidol University

Bioaerosol collection methods are “grab sample” techniques and, thus, represent only approximations of transient microbial concentrations in problematic atmospheres. Timely ascertainment of bioaerosol involvement is not possible, because of the time dependent nature of the cultivation of samples and the subsequent enumeration of colonies. This error occurred from sampling method and can be controlled by a shorter sampling time in heavily contaminated areas.

The other method error might happen at pulmonary function test by using spirometer. This method is quite difficult for the workers to do the standard posture pulmonaty function test. However, we could minimize the error by each worker repeat the process until getting the precise value at least 3 value and chose the best one.

Research instrument error : Research instrument in this study were questionnaire, personal pump, high volume pump, spectrophotometer analysis and spirometer test. These instrument errors might occur during the data collection and procedure of using instruments. We minimized the error by calibrating the personal pumps with soap bubble meter, calibrating the high volume pump with dry gas meter and calibrating the spirometer with standard calibrating test. The questionnaire, almost of topics were applied from British Medical Research council which used this questionnaire in the former studied.

5.1.2 Random errors

These errors may be occurred from selection of subject and sample size. In this study the subjects were selected 78 workers by randomization method. Asthmatic and tuberculosis workers were recruit from this study. The worker who were selected for personal sampling, worked in highly hazardous who exposed with pollutant in each processes and follow the NIOSH recommendation.

Copyright by Mahidol University

5.2 Discussion on study results

The results of the study, the relationship between the dust concentration exposure and some personal factors with impairment of pulmonary function of sugar mill workers are discussed as following :

5.2.1 The samples characteristics results

The samples consisted of 78 persons. The majority of general characteristic of the samples were male (51.3%). Most of age were 30-39 year old (43.6%). Most of status and residence were married (71.8%) and living in private house (98.7%). For education, most of them were educated in primary school (32.1%). About the type of work, most of them worked in packaging section (35.9%). Regard to smoking habit, non-smoke (68.0%). Exercise habit (60.3%). With regard to duration of work, the length of employment is 1.9 years by the average. For personal protective equipment, most of them used masks in working time (75.6%). With regard to respiratory symptom, most of them had skin irritant (60.3%). For past respiratory illness, most of them had combine respiratory symptom (33.3%).

5.2.2 Air sampling analysis results

Two components for sampling and analysis include :

1. Dust (Inhalable dust, respirable dust and silica dust)
2. Bioaerosal (Fungi and bacteria)

Air sampling for analysis were done in term of area and personal sampling. The total amount of the study was 59 samples. The results showed that the average concentration of inhalable, respirable rice mill dust and silica dust were 11.98 mg/m^3(11.98±1.02), 5.61 mg/m^3(5.61±0.64) and $29.97x10^{-3}$ mg/m^3(29.97±13.17) respectively in the milling area. Inhalable dust was not over the TLV-TWA (threshold limit values, time weight average in Thailand)(62), 15 mg/m^3. Respirable dust was over the TLV-TWA (threshold limit values, time weight average in Thailand), 5

Copyright by Mahidol University

mg/m^3. And silica (quartz) dust was not over the TLV-TWA (threshold limit values, time weight average in Thailand), 0.1 mg/m^3.

The average concentration of bioaerosal in milling area ; fungi and bacteria were 1182 CFU/m^3(1182±400) and 7601 CFU/m^3(7601±1024) respectively. MOREY recommend bioaerosal in air was not more than 1000 CFU/m^3(27).

5.2.3 Pulmonary function test results

Three patterns are used for analysis of abnormal pulmonary function (restrictive, obstructive and combined pattern). The abnormal pulmonary function patterns were found in 52 persons(66.67%), 37 persons (47.44%) in restrictive, 7 persons (8.97%) in obstructive and 8 persons (10.26%) in combined pattern. These abnormality were found in milling area, packaging area and office area of rice mill factory.

Restrictive dysfunction is marked by reduction in lungs volumes. Spirometry is not a conclusive test for restrictive pulmonary disease. But it is based on the results of spirometry it can be determined if there should have more specific test in order to identify the cause of the pulmonary difficulty. Primary identifier shows a low FVC value since technically the FEV_1 may show up normal in a spirograph of an individual with restrictive pulmonary disease. This makes sense because the effect of restrictive disease is lungs inability to expand and the FVC would decease, while the FEV_1 for that individual may be normal because the lung can collapse, or expire, in one second as normal. In addition, the most common patient-related problems when performing the FVC maneuver are the leak between the lips and mouthpiece, incomplete inspiration, hesitation at the start of expiration, cough, obstruction of the mouthpiece by the tongue, vocation during the force maneuver, poor posture and submaximal effort.

Copyright by Mahidol University

5.3 Test for the relation between factors and pulmonary function impairment

When testing for the relation between dust concentration (inhalable dust, respirable dust and silica dust) and pulmonary function impairment by simple linear regression, the results showed that respirable dust and silica dust did not associated with pulmonary function impairment ($p>0.05$). Inhalable dust associated with pulmonary function impairment ($p=0.048$) similar to Yu (47) who found inhalable dust had significantly effect of pulmonary function impairment.

Relation between bioaerosal concentration (fungi and bacteria) and pulmonary function impairment is analyzed by simple linear regression. The results showed that fungi and bacteria did not associated with pulmonary function impairment ($p>0.05$). This result is differented from the studied of George **(38)** who found that endotoxin is one of the principal components of grain dust that causes acute reversible airflow obstruction and airway inflammation. Je Won Park T (36) found that fungal isolates associated with mycotoxins occurring in rice could be verified. *Penicillium citrinum* and *Aspergillus candidus* were the most prevalent species infecting the samples.

Relation between other variables and pulmonary function impairment is analyzed by Chi-square test. Factors such as sex, smoking habit and past respiratory illness of the samples among normal and abnormal pulmonary were statistically significant ($p<0.05$). This explained that the sex, smoking habit and past respiratory illness of the rice mill workers were significant factors affecting to respiratory systems and pulmonary function values. The factor that associated with pulmonary function impairment was sex ($p=0.032$). The result of study was similar to Laraqui et. al.(48). Usually male had lung volume more than female although both of them as same as height. Female which has lung volume less than male 10 percentage (63).

Smoking habit associated with pulmonary function impairment ($p<0.001$). The result of study was similar with Musa(40) who found there is a statically significant different smoking from non smoking workers. Chronic cough, age, zone of work and sex associated with smoking habit, number of male workers who had smoking habit were more than in female workers. The result of study was similar with **Bosse'** (64).

Copyright by Mahidol University

Past respiratory illness associated with pulmonary function impairment ($p=0.039$). The result of study was similar to Pusat(46), for workers who had past respiratory illness, there is a statically significant differing from workers who had not past respiratory illness.

About extraneous factors such as age, duration of work, exercise habit, PPE usage and zone of work of the samples among normal and abnormal pulmonary function, there were not statistically significant difference ($p>0.05$). The results of study were similar to Pornpan (50). The PPE usage and pulmonary function impairment of the samples were not statistically significant difference ($p>0.05$). Therefore these results did not agree with hypotheses of study because the mask was not proper with work task; morever, the workers were not recognize the benefit of mask utilize.

For zone of work among normal and abnormal pulmonary function, there was not statistically significant difference ($p>0.05$). This result was different from the study of Anantaphol (49) who found that, pulmonary function value of persons in low exposed group were higher than persons in high exposed group. Sex and duration time of work associated with zone of work, the number of male workers who had worked in milling area were more than in female workers. Most of male workers worked in milling area more than 3 years than female workers.

Copyright by Mahidol University

CHAPTER VI
CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study was a cross sectional study. The purpose of study was to study the relationship between concentration of rice mill dust (inhalable dust, respirable dust and silica dust) and bioaerosal (fungi and bacteria) to the pulmonary function impairment of rice mill workers and also studied the relationship between zone of work, sex, age, duration of work, exercise habit, smoking habit, personal protective equipment usage and past respiratory illness with pulmonary function impairment of rice mill workers in Khonkaen province. The t-test, chi-square test and simple linear regression were performed to test the statistically significance and the significance level was set at α =0.05

From the study, the results can be concluded as the following :

1. The general characteristics, work characteristic, illness history, personal protective equipment usage, exercise habit and smoking habit of the samples.
   1.1 The samples consisted of 78 persons. The majority of general characteristic of the samples were male (51.3%). Most of the ages were 30-39 year old (43.6%). Most of the status and residence were married (71.8%) and living in private house (98.7%). With regard to education, most of them educated primary school (32.1%).
   1.2 With regard to type of work, most of them worked in milling area 39.7%, packaging area 35.9% and office area 24.4%. With regard to duration of work, most of them work duration (length of employment) by the average 1.9 years.

Copyright by Mahidol University

1.3 The majority of past illness history of the samples were healthy (85.9%) and personal illness was 14.1% in which skin irritant was 60.3% of the most case, chest tightness 23.1%, chronic cough and dyspnea 15.4%, allergic 11.5% and wheeze 6.4%

1.4 Most of the samples working in this rice mill used personal protective equipment (dust mask) in working time (75.6%).

1.5 The majority of exercise habit 60.3% while only 39.7% had not exercise.

1.6 The majority of sample were non-smoke (66.7%), currently still smoked 28.2% (for the workers who had smoke more than or equal 6 years). Mostly, the percentage of the samples who smoked filter cigarette was 81.8% and emit smoke in the nose and mouth but no lungs inhalation 86.4% of currently still smoked group

2. Comparison of the pulmonary function impairment and exposure of rice mill dust and bioaerosal

2.1 The data device collected from air sampling in order to evaluate the concentration of rice mill dust (inhalable dust, respirable dust and silica dust) and bioaerosal (fungi and bacteria). The sample would be collected from individual person to appraise anyone who was in the area. The results showed that :

(1.) The average of inhalable dust concentration in milling area were 11.98±1.02 mg/m^3, in packaging area were 6.57±2.01 mg/m^3 and in office area were 0.52±0.26 mg/m^3.

(2.) The average of respirable dust concentration in milling area were 5.21±0.83 mg/m^3, in packaging area were 1.75±0.76 mg/m^3 and in office area were 0.23±0.15 mg/m^3.

(3.) The average of silica dust concentration in milling area were 26.10±14.25 x10^{-3} mg/m^3, in packaging area were 11.66±3.74x10^{-3} mg/m^3 and in office area were 6.16±1.58 x 10^{-3} mg/m^3.

Copyright by Mahidol University

(4.) The average of fungi in milling area were 1437±400 CFU/m^3, in packaging area were 251±321 CFU/m^3 and in office area were 42±40 CFU/m^3.

(5.) The average of bacteria in milling area were 7601±1023 CFU/m^3, in packaging area were 640±158 CFU/m^3 and in office area were 1338±311 CFU/m^3.

2.2 The data are related to the pulmonary function impairment of rice mill workers by using lung function test with the SPIROMETER schiller brand, model spirovit SP -10 , serial number 530.01057, made in Swizerland the results showed that :

The pulmonary function impairment of the samples were found in normal (33.3%) and abnormal were 66.7% (obstructive 10.3%, restrictive 47.4% and combined 9.0%)

2.3 Percentage of pulmonary function impairment of the samples in level of rice mill dust concentration among normal pulmonary function group and abnormal pulmonary function group, respirable dust and silica dust of dust exposure were same percentage of each group of dust and dust exposure but inhalable dust was difference percentage of each group of dust and dust exposure. Fungi and bacteria exposure were same percentage of each group of dust and dust exposure.

3. There are relationship between pulmonary function impairment and rice mill dust, bioaerosal, zone of work, sex, age, duration of work, exercise habit, smoking habit, personal protective equipment usage and past respiratory illness.

3.1 No association between respirable dust concentration, silica dust concentration, fungi concentration, bacteria concentration, zone of work, age, duration of work, exercise habit and personal protective equipment usage.

Copyright by Mahidol University

3.2 Concentration of inhalable dust associated with pulmonary function impairment testat p -value = 0.048.

3.3 Sex associated with pulmonary function impairment test at p-value = 0.032.

3.4 Smoking habit associated with pulmonary function impairment test at p-value < 0.001.

3.5 Past respiratory illness associated with pulmonary function impairment test at p-value = 0.039.

3.6 The concentration of inhalable dust was over the TLV-TWA (threshold limit values, time weight average) in Thailand. The concentration of fungi and bacteria in air was over MOREY recommended. Concentration of respirable dust and silica dust concentration were not over the TLV-TWA (Threshold limit values, time weight average) in Thailand.

6.2 Recommendations

1. Recommendation for application.

1.1 The results from this study in some area of rice mill factory had more dust concentration than the standard values. Thus, control systems and improvement of work environment are necessary in workplace, including trained and promoted in personal protective equipment used. The workers should have safety at work and be prevented from occupational disease.

1.2 The program of engineering control should be used as the method to eliminate the potential for exposure of inhalable dust, respirable dust, silica dust, fungi and bacteria in the work place by controlling dust concentration with local exhaust ventilation, which removes dust from process area or production line.

Copyright by Mahidol University

1.3 Set up health surveillance system to monitor rice mill dust (inhalable dust, respirable dust and silica dust) and bioaerosal (fungi and bacteria) in working environment of rice mill workers. The occupational health program should be done by medical examination, especially chest x-ray with big film and pulmonary function test for evaluating pulmonary function of rice mill workers.

1.4 All programs should be continuing improvement.

2. Recommendations for further study.

2.1 Follow up pulmonary function test of rice mill workers especially the workers with abnormal pulmonary function for monitor the pulmonary function in the further and to find the correct causes of symptom.

2.2 To comparative study among the pulmonary function impairment of rice mill workers and another people nearby rice mill factory.

2.3 Further study should be researched about biological hazard. Especially bioaerosal that can cause health problems.

Copyright by Mahidol University

REFERENCES

1.Louise Fresco. Rice is life. Journal of Food Composition and Analysis. 2005; 18: 249–253.

2.International labour office. Enclyclopaedia of Occupational and Safety. 4th edition, 1998.

3.National Institute for Occupational Safety and Health. Health Effects of Occupational Exposure to Respirable Crystalline Silica. 2002.

4.United States Department of Agriculture. Market Trend in 2000-2001, 2000.

5.Department of Foreign Trade, Ministry of Commerce. Thailand's Rice, 2000.

6.Department of Foreign Trade (Grain Division) Board of Trade of Thailand. Thailand rice exports, 2005.

7.กรมการค้าภายใน. รายงานภาวะสินค้าข้าว ประจำเดือน มิถุนายน 2548. 2548

8.Way to mill rice. http://www.therice.org/ricemill.htm

9.กรมโรงงานอุตสาหกรรม. รายชื่อโรงงานที่ได้รับอนุญาตให้ประกอบกิจการ จังหวัดขอนแก่น ณ สิ้นปี 2547, 2548.

10.Rice mill processing. http://www.sagevfoods.com/MainPages/Rice101/Milling.htm

11.Occupational Safety and Health Administration. Chemical Sampling Information Grain Dust (Oats, Wheat & Barley). 1988

12.American Thoracic Society. Adverse effects of crystalline silica exposure. Am J Respir Crit Care Med 1997;155:761–5

13.Occupational Safety and Health Administration. OSHA Permissible Exposure Limit(PEL) for the General Industry, 2000

14.Norman Klein. Respiratory system. www.allergyhealthonline.com

15.ประพาศ ยงใจยุทธ และคณะ. โรคระบบทางเดินหายใจ1. กรุงเทพฯ: บริษัทแอคก้า อินเตอร์เนชั่นแนลจำกัด;2532.

Copyright by Mahidol University

16.คณาจารย์ภาควิชาสรีรวิทยา.สรีรวิทยา. พิมพ์ครั้งที่ 3.กรุงเทพฯ : คณะวิทยาศาสตร์ มหาวิทยาลัยมหิดล ; 2539

17.เลียงชัย ลิ้มล้อมวงศ์. ปอดและการหายใจ. พิมพ์ครั้งที่ 2.กรุงเทพฯ :โรงพิมพ์เรือนแก้วการพิมพ์ ; 2538.

18.American Thoracic Society. American Thoracic Society Statement Occupational Contribution to the Burden of Airway Disease : American Journal of Respiratory and Critical Care Medicine 2003; 167: 787-797.

19.Alberts WM, do Pico GA. Reactive airways dysfunction syndrome. Chest 1996;109:1618–1626.

20.คณะแพทย์ศาสตร์ โรงพยาบาลศิริราช. ผลงานวิจัยเรื่อง "ค่ามาตรฐานสมรรถภาพการทำงานของปอดในประชากรไทย". กองอาชีวอนามัย กระทรวงสาธารณสุข. 2539

21.สว่าง แสงหิรัญวัฒนาม พูนเกษม เจริญพันธุ์ และ กุลณี วงศ์วิวัฒน์. การคำนวณและแปลผลสมรรถภาพปอดในคนไทยโดยใช้เครื่องคอมพิวเตอร์. รามาธิบดีเวชสาร. 2533 ฉบับที่ 13 : หน้า 132-135.

22.The Merck Manual of Diagnosis and Therapy : Section 6. Pulmonary Disorders. http://www.merck.com/mrkshared/mmanual/section6/chapter64.html

23.สุปราณี ผลชีวิน. โรคปอดจากงานอาชีพ : หนทางป้องกันและการควบคุม : สำนักคณะกรรมการวิจัยแห่งชาติ, กรุงเทพฯ; 2536.

24.สมชัย บวรกิตติม จอนห์น พี. ลอฟกัส และ กฤษฎา ศรีสำราญ. ฝุ่นกับผลกระทบต่อสุขภาพ : เวชศาสตร์สิ่งแวดล้อม. กรุงเทพฯ : เรือนแก้วการพิมพ์ ; 2542

25.แพทย์หญิงพงษ์ลดา สุพรรณชาติ.พิษวิทยาและเวชศาสตร์อุตสาหกรรม.พิมพ์ครั้งที่ 2. นนทบุรี : มหาวิทยาลัยสุโขทัยธรรมาธิราช ; 2537.

Copyright by Mahidol University

26.ทนงศักดิ์ ยิ่งรัตนสุข. เอกสารประกอบการสอน เรื่องการเก็บตัวอย่างทางสุขศาสตร์อุตสาหกรรม. ภาควิชาสุขศาสตร์อุตสาหกรรมและความปลอดภัย คณะสาธารณสุขศาสตร์ มหาวิทยาลัยบูรพา; 2544

27.กนกรัตน์ ศิริพานิชกร. เอกสารประกอบการสอนเรื่องการตรวจวัดจุลินทรีย์ในอากาศ. ภาควิชาจุลชีววิทยา คณะสาธารณสุขศาสตร์ มหาวิทยาลัยมหิดล; 2546

28.Wainwright, M. An introduction to fungal biotechnology. John Wiley & Son Ltd. UK ; 1993

29.อนามัย ธีรวิโรจน์. เอกสารประกอบการสอนวิชาอาชีวอนามัยเบื้องต้น.ภาควิชาสุขศาสตร์อุตสาหกรรมและความปลอดภัย คณะสาธารณสุขศาสตร์ มหาวิทยาลัยบูรพา; 2543

30.นันทพร บุตรบำรุง. เอกสารการสอนวิชาพิษวิทยาอุตสาหกรรม. ภาควิชาสุขศาสตร์อุตสาหกรรมและความปลอดภัย คณะสาธารณสุขศาสตร์ มหาวิทยาลัยบูรพา; 2545

31. National Institute of Occupational Safety and Health. Appendices of spirometry training guide: appendices C Overview of occupational lung disease. 2004

32.Bhat MR, Ramaswamy C. A comparative study of lung functions in rice mill and saw mill workers. Indian J Physiol Pharmacol. 1991 Jan;35(1):27-30.

33.Pitt JI et. al..The normal mycoflora of commodities from Thailand. 2. Beans, rice, small grains and other commodities. International Journal of Food Microbiology, Volume 23, Issue 1; 1994

34.Burge. Journal of allergy and clinical immunology, Journal Of Allergy and Clinical Immunology; 2002, 110 (4): 544-552

35.Manisha Rajib Desai and Sandip Kumar Ghosh. Occupational exposure to airborne fungi among rice mill workers with special reference to aflatoxin product A. flavus strains. Ann Agric Environ Med 2003, 10, 159-162

36.Je Won ParkT. Fungal mycoflora and mycotoxins in Korean polished rice destined for humans. Korea University, Seoul 136-701, South Korea ; 2005

Copyright by Mahidol University

37.Krysińska-Traczyk. Levels of fungi and mycotoxins in samples of grain and grain dust collected on farms in Eastern Poland. Annals Of Agricultural And Environmental Medicine: AAEM Volume 8, Issue 2 , 2001, 269-274

38.George, C L. Endotoxin responsiveness and subchronic grain dust-induced airway disease. American Journal Of Physiology. Lung Cellular And Molecular Physiology Volume 280, Issue 2 , February 2001, L203-L213

39.Pahwa. Longitudinal decline in lung function measurements among Saskatchewan grain workers. Canadian Respiratory Journal: Journal Of The Canadian Thoracic Society, Volume 10, Issue 3 , April 2003, 135-141

40.Musa. Respiratory health of rice millers in Kelantan, Malaysia .The Southeast Asian Journal Of Tropical Medicine And Public Health , Volume 31, Issue 3 , September 2000, 575-578

41.Christine G. Parks. Occupational exposure to crystalline silica and autoimmune disease. Environmental health perspectives supplements, Volume 107, Number S5 ;1999

42.Mark J. Nieuwenhuijsen. Personal Exposure to Dust, Endotoxin and Crystalline Silica in California Agriculture. The Annals of Occupational Hygiene, Volume 43, Issue 1 , 2 January 1999, 35-42

43.Kline, J N. Bronchial hyperreactivity is associated with enhanced grain dust-induced airflow obstruction. Journal Of Applied Physiology (Bethesda, Md.: 1985) , Volume 89, Issue 3 , September 2000, 1172-1178

44.Baur. Asthma due to grain dust [Asthma durch Getreidestaub]. Pneumologie (Stuttgart, Germany), Volume 57, Issue 6 , June 2003, 335-339

45.Ghosh. Airborne aflatoxin in the grain processing industries in India. American Industrial Hygiene Association Journal, Volume 58, Issue 8 , August 1997, 583-586

46.Pusat Pengembangan. Study on health of ricemill's workers among five provinces of Indonesia has been done on July until November 2002. Jakarta Selatan. Indonesia ; 2002

Copyright by Mahidol University

47.Ye. Respiratory symptoms and pulmonary function among Chinese rice-granary workers. International Journal Of Occupational And Environmental Health: Official Journal Of The International Commission On Occupational Health , Volume 4, Issue 3 , July - September 1998, 155-159

48.Laraqui et. al. Respiratory risk in carpenters and cabinet markers. Rev mal Respir. 2001, Dec: 18 (6PT1) : 615-622

49.อนันตพล ล่าฟ้าเริงรณ. ปัจจัยที่มีความสัมพันธ์ต่อการเสื่อมสมรรถภาพของระบบทางเดินหายใจของพนักงานที่ทำงานในโรงงานผลิตกรดกำมะถัน [วิทยานิพนธ์วิทยาศาสตร์มหาบัณฑิต สาขาสุขศาสตร์อุตสาหกรรมและความปลอดภัย]. กรุงเทพฯ : บัณฑิตวิทยาลัย มหาวิทยาลัยมหิดล ; 2544.

50.พรพรรณ วัชรวิทูร. ปัจจัยที่มีความสัมพันธ์กับการเสื่อมสมรรถภาพปอดของคนงานในโรงงานผลิตอาหารสัตว์ [วิทยานิพนธ์วิทยาศาสตร์มหาบัณฑิต สาขาสุขศาสตร์อุตสาหกรรมและความปลอดภัย]. กรุงเทพฯ : บัณฑิตวิทยาลัย มหาวิทยาลัยมหิดล ; 2542.

51.American Thorasic Society (ATS) Respiratory Symptom Questionnaire

52.National Institute of Occupational Safety and Health. NIOSH particulates not otherwise regulated, total ; Method 0500. Fourth Edition, 1994.

53.ปวีณา มีประดิษฐ์. เอกสารประกอบการสอน เรื่องการเก็บตัวอย่างทางสุขศาสตร์อุตสาหกรรม. ภาควิชาสุขศาสตร์อุตสาหกรรมและความปลอดภัย คณะสาธารณสุขศาสตร์ มหาวิทยาลัยบูรพา2544

54.National Institute of Occupational Safety and Health. NIOSH particulates not otherwise regulated, respirable ; Method 0600. Fourth Edition, 1998.

55.National Institute of Occupational Safety and Health. NIOSH silica, crystalline, by XRD (filter redeposition); Method 7500. Fourth Edition, 2003.

56.Respirable Dust Aluminum Cyclone. SKC inc. 2005 http://www.skcinc.com/prod/225-01-01.asp

Copyright by Mahidol University

57.National Institute of Occupational Safety and Health. NIOSH bioaerosal sampling; Method 0800. Fourth Edition, 1998.

58.พิพัฒน์ ลักษมีจรัสกุล. กระบวนการวิจัยทางวิทยาศาสตร์สุขภาพ. พิมพ์ครั้งที่ 2. กรุงเทพฯ : คณะสาธารณสุขศาสตร์ มหาวิทยาลัยมหิดล ; 2546

59.สุมาลี สิงหนิยม. เอกสารประกอบการสอนวิชา BIOSTATIC (ส่วนที่ 1) ภาควิชาชีวสถิติ. คณะสาธารณสุขศาสตร์ มหาวิทยาลัยมหิดล ; 2547

60.เดชาวุธ นิตยสุทธิ. เอกสารประกอบการสอนวิชา BIOSTATIC (ส่วนที่ 2) ภาควิชาชีวสถิติ. คณะสาธารณสุขศาสตร์ มหาวิทยาลัยมหิดล ; 2547

61.TLVs and BEIs on the documentation of the Threshold Limit value for Chemical Substances and Physical Agents & Biological Exposure Indices. ACGIH Worldwild, 2003

62.กรมโรงงานอุตสาหกรรม กระทรวงอุตสาหกรรม. รวมกฎหมายอาชีวอนามัยและความปลอดภัย ; ประกาศกระทรวงมหาดไทย เรื่องความปลอดภัยในการทำงานเกี่ยวกับสภาวะแวดล้อม (สารเคมี) หมวดที่ 1 สารเคมี, กรุงเทพฯ: ธวิพัฒน์; 2542

63.Cotes JE. Lung function. 3 rd ed. Oxford: Blackwell Science Ltd.; 1975: 350-1.

64.Bosse'R. et al. Age, smoking inhalation and pulmonary function. Arch Environ Health, 1975; 30: 495-498.

65.Yach D., Myers J., Bradshaw D., and Benatar S R. A Respiratory Epidemiology survey of Grain Mill Workers in Cape Town, South Africa. Am. Rev. Respir. Dis. 1985; 131(4): 265-272.

Copyright by Mahidol University

APPENDIX

Copyright by Mahidol University

Table A-1 Association between gender and other factor.

Variables	Gender		χ^2	d.f.	p-value
	male	female			
ZONE OF WORK					
High	57.7	12.1	13.833	1	0.001*
low	42.3	87.9			
AGE					
< 30	62.5	57.9	0.173	1	0.678
≥ 30	37.5	42.1			
DULATION OF WORK					
1	45.0	63.2	1.746	3	0.186
2	17.5	13.2			
3	20.0	7.9			
≥ 4	17.5	15.7			
PPE usage					
Usage	80.0	71.1	0.847	1	0.357
Never	20.0	28.9			
Smoking					
Currently still smoke	37.5	100	34.953	1	0.001*
Non-smoke	62.5	0			
Exercise					
Exercise	52.5	68.4	2.063	1	1.151
Non Exercise	47.5	31.6			
Past respiratory illness					
Had symptoms	82.5	76.3	0.457	1	0.499
No symptoms	17.5	23.7			
Asthma					
Had symptoms	0	5.3	2.161	1	0.142
No symptoms	100	94.7			

Copyright by Mahidol University

Table A-1 Association between gender and other factor. (Cont.)

Variables	Gender		χ^2	d.f.	p-value
	male	female			
Allergic					
Had symptoms	7.5	15.8	1.312	1	0.252
No symptoms	92.5	84.2			
Chronic Cough					
Had symptoms	17.5	13.2	0.282	1	0.595
No symptoms	82.5	86.8			
Tightness chest					
Had symptoms	27.5	18.4	0.905	1	0.341
No symptoms	72.5	81.6			
Dyspnea (walking)					
Had symptoms	5.0	5.3	0.003	1	0.958
No symptoms	95.0	94.7			
Dyspnea (steping)					
Had symptoms	7.5	13.2	0.678	1	0.410
No symptoms	92.5	86.8			
Wheeze					
Had symptoms	2.5	10.5	2.093	1	0.148
No symptoms	97.5	89.5			
Past respiratory illness - Obstructive respiratory symptom					
Had symptoms	10.0	23.7	2.627	1	0.105
No symptoms	90.0	76.3			
Past respiratory illness - Restrictive respiratory symptom					
Had symptoms	7.5	15.8	1.312	1	0.252
No symptoms	92.5	84.2			

Copyright by Mahidol University

Table A-1 Association between gender and other factor. (Cont.)

Variables	Gender		χ^2	d.f.	p-value
	male	female			
Past respiratory illness - Combine respiratory symptom					
Had symptoms	37.5	28.9	0.641	1	0.423
No symptoms	62.5	71.1			

Table A-2 Association between zone of work and other factor.

Variables	ZONE OF WORK		χ^2	d.f.	p-value
	High	low			
SEX					
male	78.9	27.5	13.833	1	0.001*
female	21.1	72.5			
AGE					
< 30	26.3	52.5	3.583	1	0.061
≥ 30	73.7	47.5			
DULATION OF WORK					
1	29.0	70.2	7.751	3	0.005*
2	16.1	14.9			
3	29.0	4.3			
≥ 4	25.9	10.6			
PPE usage					
Usage	89.5	65.0	3.904	1	0.059
Never	10.5	35.0			
Smoking					
Currently still smoke	47.4	92.5	15.273	1	0.001*
Non-smoke	52.6	7.5			

Copyright by Mahidol University

Table A-2 Association between zone of work and other factor. (cont.)

Variables	ZONE OF WORK		χ^2	d.f.	p-value
	High	low			
Exercise					
Exercise	47.4	60.0	0.834	1	0.361
Non Exercise	52.6	40.0			
Past respiratory illness					
Had symptoms	89.5	72.5	2.160	1	0.142
No symptoms	10.5	27.5			
Asthma					
Had symptoms	0	5.0	0.983	1	0.321
No symptoms	100	95.0			
Allergic					
Had symptoms	10.5	17.5	0.485	1	0.392
No symptoms	89.5	82.5			
Chronic Cough					
Had symptoms	21.1	12.5	0.729	1	0.393
No symptoms	78.9	87.5			
Tightness chest					
Had symptoms	31.6	15.0	2.185	1	0.139
No symptoms	68.4	85.0			
Dyspnea (walking)					
Had symptoms	5.3	7.5	0.102	1	0.749
No symptoms	94.7	92.5			
Dyspnea (steping)					
Had symptoms	10.5	12.5	0.048	1	0.827
No symptoms	89.5	87.5			
Wheeze					
Had symptoms	5.3	7.5	0.102	1	0.749
No symptoms	94.7	92.5			

Copyright by Mahidol University

Table A-2 Association between zone of work and other factor. (cont.)

Variables	ZONE OF WORK		χ^2	d.f.	p-value
	High	low			
Past respiratory illness - Obstructive respiratory symptom					
Had symptoms	6.5	23.4	3.865	1	0.049
No symptoms	93.5	76.6			
Past respiratory illness - Restrictive respiratory symptom					
Had symptoms	10.5	17.5	0.485	1	0.392
No symptoms	89.5	82.5			
Past respiratory illness - Combine respiratory symptom					
Had symptoms	45.2	25.5	3.239	1	0.072
No symptoms	54.8	74.5			

Table A-3 Association between smoking and other factor.

Variables	Smoking		χ^2	d.f.	p-value
	Non-smoke	smoke			
SEX					
male	28.3	100	34.953	1	0.001*
female	71.7	0			
ZONE OF WORK					
High	19.6	76.9	15.273	1	0.001*
low	80.4	23.1			

Copyright by Mahidol University

Table A-3 Association between smoking and other factor. (cont.)

Variables	Smoking		χ^2	d.f.	p-value
	Non-smoke	smoke			
AGE					
< 30	41.5	36.0	0.215	1	0.043*
≥ 30	58.5	64.0			
DULATION OF WORK					
1	58.5	44.0	1.472	1	0.225
2	15.1	16.0			
3	9.4	24.0			
≥ 4	17.0	16.0			
PPE usage					
Usage	69.8	88.0	3.050	1	0.081
Never	30.2	12.0			
Exercise					
Exercise	54.7	72.0	2.119	1	0.146
Non Exercise	45.3	28.0			
Past respiratory illness					
Had symptoms	73.6	92.0	3.533	1	0.060
No symptoms	26.4	8.0			
Asthma					
Had symptoms	3.8	0	0.968	1	0.325
No symptoms	96.2	100			
Allergic					
Had symptoms	13.2	8.0	0.451	1	0.502
No symptoms	86.8	92.0			
Chronic Cough					
Had symptoms	9.4	28.0	4.498	1	0.034*
No symptoms	90.6	72.0			

Copyright by Mahidol University

Table A-3 Association between smoking and other factor. (cont.)

Variables	Smoking		χ^2	d.f.	p-value
	Non-smoke	smoke			
Tightness chest					
Had symptoms	18.9	32.0	1.650	1	0.199
No symptoms	81.1	68.0			
Dyspnea (walking)					
Had symptoms	3.8	8.0	0.624	1	0.430
No symptoms	96.2	92.0			
Dyspnea (steping)					
Had symptoms	11.3	8.0	0.204	1	0.652
No symptoms	88.7	92.0			
Wheeze					
Had symptoms	9.4	0	2.520	1	0.112
No symptoms	90.6	100			
Past respiratory illness - Obstructive respiratory symptom					
Had symptoms	20.8	8.0	1.990	1	0.158
No symptoms	79.2	92.0			
Past respiratory illness - Restrictive respiratory symptom					
Had symptoms	13.2	8.0	0.451	1	0.502
No symptoms	86.8	92.0			
Past respiratory illness - Combine respiratory symptom					
Had symptoms	26.4	48.0	3.562	1	0.059
No symptoms	73.6	52.0			

Copyright by Mahidol University

Questionaire

Part .....

Section 1 General Information

1. Current age ..... years old Sex .....
2. Marriage Status

   Single Married Widow, Divorced or Separated
3. Residence house

   Private

   Rented

   Others .....
4. Residence location

   City

   Outskirts

   Rural area
5. Number in family (person)..... persons
6. Education level

   No Primary school

   Grade 9 Grade 12

   Diploma Bachelor degree

   Other ……
7. Your salary per mount ..... Baht

Section 2 Working Record

1. Working at this factory for ..... years
2. Your minor job description ..... for ..... years
3. Are you work other job description

   No

   Yes (please specify) .....

   .....
4. Number of working day per week ..... Number of working hour per day.....

Copyright by Mahidol University

5. Job Description

In production line

In control room

Both

6. Did you work in area that contains dust

No

Yes, a little bit

Yes, a lot

7. What was your previous occupation ?

Yes (please specify)..... for ..... years

None, Just stay at home

8. Did you use personal protective equipment (dust mask) ?

Yes (please specify).....

No

Section 3 Other Behavior

1. Smoking

1.1 Do you currently smoke the cigarettes

Never smoke

Used to smoke but currently quit for ..... years but currently quit for …….. years ……. rolls per day

Currently still smoke for ..... years but currently quit for …….. years ……. rolls per day

1.2 Smoking characteristic

To emit smoke in the nose and mouth but no lungs inhalation

To emit smoke in the nose and mouth and inhalation in the lungs

1.3 Type of cigarette

Filter cigarette(brand name) .....

Non filter cigarette (brand name).....

Others ……..

Copyright by Mahidol University

2. Exercise

Do you currently exercise (30 min/time)

No

Yes, 2-3 times per week

Yes, every day

Section 4 Sickness records

1. Do you have personal sickness?

No

Yes (please specify) .....

2. Have you ever had any allergy record?

No

Yes (please specify) ..... for ..... years

3. Have you ever had a chronic cough?

No

Yes (please specify) ..... for ..... years

Types of cough symptom	Have phlegm
	Don't have phlegm
Cough period	During your work
	In the morning after weak up
	In the night after finish your work
	All the time
	Others …….

4. Have you ever felt suffocated or had a difficulty in breathing ?

No

Yes (please specify) ..... for ..... years

5. Have you ever gasped for breath or too frequently breathed when walking on flat part?

No

Yes (please specify) ..... for ..... years

Copyright by Mahidol University

6. Have you ever gasped for breath or too frequently breathed when walking on rise, stair or step part ?

No

Yes (please specify) ..... for ..... years

7. Have you ever had a wheeze symptom?

No

Yes (please specify) ..... for ..... years

8. Have you ever had the following symptom?

Tuberculosis

Pneumonia

Bronchial asthma

Heart trouble

Emphysema

Bronchitis

Any accident or operation related to lung

9. Have you ever had a skin irritation

No

Yes (please specify) ..... for ..... years

Momo

Weight ……. Kiligrams Height …… centimeters

The result from lung capacity test (Spirometry) at present (from blowing 3 times)

FVC ..... %

FEV1 ..... %

FEV1/FVC ..... %

FEF 25-75%..... %

Copyright by Mahidol University

BIOGRAPHY

NAME	Miss Kallaya Harnpicharnchai
DATE OF BIRTH	August 29, 1980
PLACE OF BIRTH	Khon Kaen, Thailand
INSTITUTIONS ATTENDED	Burapha University, 2002: B.Sc.(Public Health) majoring in Industrial Hygiene and Safety Mahidol University, 2006: M.Sc.(Industrial Hygiene and Safety)
HOME ADDRESS	256/14 Anamai Road, Meung, Khon Kaen, Thailand 40000 E-mail: nuch1003@yahoo.com

Copyright by Mahidol University